HM Government

# Greenhouse Gas Removals

## Call for Evidence

Closing date: 26 February 2021

December 2020



Any enquiries regarding this publication should be sent to us at:
ggr-call-for-evidence@beis.gov.uk

# Executive Summary

‘Greenhouse gas removals’ (GGRs) is the name given to a group of methods that directly remove greenhouse gases from the atmosphere. There are a range of approaches that may be counted as GGRs, which fall broadly into two categories:

- **Nature-based approaches:** such as afforestation, forest management, and soil carbon sequestration.
- **Engineering-based approaches:** such as Direct Air Carbon Capture and Storage (DACCS), Bioenergy with Carbon Capture and Storage (BECCS), wood in construction, biochar, and enhanced weathering.

The UK government is committed to decisive action to cut emissions across the economy in order to achieve our world-leading target of net zero emissions by 2050. To complement these efforts, the Climate Change Committee (CCC) has been clear that GGRs will be required to offset residual emissions in sectors that are difficult to decarbonise completely, such as heavy industry, agriculture, and aviation.

There is considerable uncertainty around the future costs and deployment potential of several GGRs – particularly engineered options, many of which are at an early stage of development and are not yet ready to be deployed at scale. The market for GGRs is currently constrained by a range of market barriers that will need to be overcome to achieve the scale of greenhouse gas removals that the CCC estimates will be required by 2050. These include, but are not limited to:

- **Innovation and demonstration barriers:** GGR options at early technology readiness levels will require innovation and demonstration support before they are ready for commercial deployment.
- **Financial barriers:** Large initial costs, long payback periods, and a lack of price incentives for negative emissions can limit commercial viability and hamper investment in GGRs.
- **Non-financial deployment barriers:** $CO_2$ transport and storage infrastructure will be required to enable rollout of BECCS and DACCS, as well as supply chain growth and the establishment of clear liability frameworks for the custody of captured and stored $CO_2$.
- **Accounting barriers:** Accounting principles are not yet well established to measure robustly and transparently the quantity and permanence of $CO_2$ storage through GGRs.
- **Environmental barriers:** The immaturity of some GGR techniques means that their local impacts on soil, water and air quality are not yet fully understood. Requirements for resources such as heat, water and biomass may also create trade-offs with other objectives and must be met sustainably.

The government intends to position the UK at the forefront of new markets for low carbon technologies and services in the transition to net zero, and there will likely be substantial economic opportunities for the UK to lead the way in developing and adopting cutting-edge GGR approaches.

In November 2020, we launched a Direct Air Capture and other GGR Innovation Programme that will, over two phases, aim to invest up to £70m in GGR innovation. Alongside over £30m invested into GGRs by UK Research and Innovation (UKRI), this takes UK funding in this area to over £100m over the next 4 years. The Programme will help to improve our understanding of these technologies, reduce their cost, and demonstrate feasible GGR approaches at scale. However, a wider suite of policies could be required to address the full range of market barriers outlined above.

This call for evidence aims to strengthen our evidence base on nascent GGRs that are not yet widely practised, and invites views from stakeholders on the role of government in incentivising their development and deployment in the UK over the medium and longer-term through an effective policy and regulatory framework and, where needed, targeted support. In particular, it seeks information on:

- The latest evidence on the viability of different GGRs in the UK – including future costs, deployment potential, lifecycle emissions and wider environmental impacts.
- Policy mechanisms that government could consider to address market barriers in order to accelerate the development and deployment of GGRs.
- Supporting policies needed to enable deployment and scale-up in future, such as a robust framework for monitoring, reporting and verification of negative emissions.

Alongside wider channels of stakeholder engagement, this information will play a vital role in helping to inform the government's future policy on GGRs, which we will set out in due course.

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# General information

## Why we are issuing a call for evidence

For the UK to reach net zero emissions in 2050, greenhouse gas removals (GGRs) will be necessary to offset residual emissions in hard-to-abate sectors, as advised by the Climate Change Committee. Many GGRs are at an early stage of development, and stakeholders have highlighted a range of market barriers that currently limit their development and deployment.

This call for evidence will help to strengthen the government's understanding of nascent GGRs that are not yet ready to be deployed at scale, for reasons such as technological immaturity, uncertain environmental impacts, or absence of enabling policies and infrastructure. It will also consider the role of government in addressing key market barriers. We welcome views and evidence from a wide range of stakeholders with an interest in GGRs, such as developers, researchers, investors, academics, social scientists, think tanks and NGOs, including those involved in accreditation and verification of negative emissions. The information we receive will help to inform the development of the government's future policy on GGRs.

## Call for evidence details

**Issued:** 4 December 2020

**Respond by:** 26 February 2021

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**Document reference:** Greenhouse Gas Removals – call for evidence

**Territorial extent:**

This call for evidence seeks information for consideration by the UK government but does not contain policy proposals. Some matters covered by the call for evidence may be devolved to Scotland, Wales and Northern Ireland. The UK government will work with the devolved administrations to ensure that the development of future policy takes account of devolved responsibilities and policies across the UK.

# How to respond

We are inviting responses to this call for evidence via email.

**Email to: ggr-call-for-evidence@beis.gov.uk**

Please take note of the following guidance for submissions:

- Your response will be most useful if it is framed in direct response to the questions posed, and with evidence in support wherever possible. Further comments and wider evidence are also welcome.
- We recommend that your overall submission to the call for evidence does not exceed 20 pages. We welcome further details, sources and reports as annexes.
- It is not necessary to answer every question.
- When responding, please state whether you are responding as an individual or representing the views of an organisation.

All submissions will be acknowledged by BEIS. If you do not receive acknowledgement of receipt within 3 working days, please re-send your submission.

We advise that you do not send responses by post to the department at this time, as we may not be able to access them.

# Confidentiality and data protection

Information you provide in response to this consultation, including personal information, may be disclosed in accordance with UK legislation (the Freedom of Information Act 2000, the Data Protection Act 2018 and the Environmental Information Regulations 2004).

If you want the information that you provide to be treated as confidential please tell us, but be aware that we cannot guarantee confidentiality in all circumstances. An automatic confidentiality disclaimer generated by your IT system will not be regarded by us as a confidentiality request.

We will process your personal data in accordance with all applicable data protection laws. See our privacy policy.

Information submitted in response to this call for evidence may be shared with third party contractors to analyse the responses. Please clearly indicate in your submissions if you do not give permission for your evidence to be used in this way.

We will summarise all responses and publish this summary on GOV.UK. The summary will include a list of names or organisations that responded, but not people's personal names, addresses or other contact details.

# Quality assurance

This consultation has been carried out in accordance with the government's consultation principles.

If you have any complaints about the way this consultation has been conducted, please email: beis.bru@beis.gov.uk.

# Introduction

## Context

### Delivering net zero

The UK has a longstanding record of global leadership in tackling climate change. Between 1990 and 2018, we have reduced our emissions by 43%[1] while growing the economy by 75%[2] - decarbonising our economy faster than any other G20 country since the turn of the century.[3] In June 2019, we built on these achievements by becoming the first major economy to set in law a target for 'net zero' emissions, ending the UK's contribution to global warming by 2050.

Reaching net zero will involve fundamental changes across the UK economy, requiring steep emissions reductions on a scale not previously seen. The government has already taken huge strides in bringing forward ambitious net zero policies across all sectors of the economy, and we are putting net zero at the heart of our economic recovery from the coronavirus pandemic.

In November 2020, the Prime Minister set out his ambitious Ten Point Plan that will lay the foundations for a Green Industrial Revolution.[4] Spanning clean energy, buildings, transport, nature, and innovative technologies, the Ten Point Plan will support our efforts to build back greener from coronavirus, generating jobs and bolstering the economy, whilst continuing to drive down emissions both now and in the future.

In the lead up to the UN Climate Change Conference, COP26, the government will bring forward further plans for reducing emissions from key sectors of the economy – including an Energy White Paper, Transport Decarbonisation Plan and Heat and Buildings Strategy. We will also publish HM Treasury's Net Zero Review into the costs of the transition in Spring 2021, with the interim report due in Autumn 2020, and our comprehensive Net Zero Strategy, which will set out the government's vision for transitioning to a net zero economy.

### Greenhouse gas removals

For the UK to reach net zero emissions in 2050, greenhouse gas removals will be required to balance residual emissions from some of the most difficult to decarbonise sectors, such as industry, agriculture, and aviation. This is supported by analysis from the independent Climate Change Committee (CCC).[5]

[1] BEIS (2020), BEIS Final UK greenhouse gas emissions statistics 1990-2018
[2] ONS (2020), UK Accounts: The Blue Book time series (Series Gross Domestic Product: chained volume measures: Seasonally adjusted £m).
[3] PwC, Low Carbon Economy Index 2019
[4] HM Government (2020), The Ten Point Plan for a Green Industrial Revolution
[5] CCC (2019), Net Zero – The UK's contribution to stopping global warming

'Greenhouse gas removals' (GGRs) is the name given to a group of methods that actively remove greenhouse gases from the atmosphere. There are a range of methods which may be counted as GGRs – from nature-based solutions such as afforestation, to engineered solutions such as Direct Air Carbon Capture and Storage (DACCS), which separates a stream of $CO_2$ from the air that can then be captured and stored.

GGRs are not a substitute for decisive action across the economy to cut emissions. The government's priority is to tackle the root cause of climate change by reducing emissions of greenhouse gases from human activities whilst adapting to those impacts that are unavoidable. Many GGR methods are at an early stage of development and have not yet been deployed at scale in the UK, and there remain significant uncertainties around their future costs, environmental impacts, and deployment potential. Nevertheless, there is a growing consensus that even when firm action is taken to decarbonise the economy, reaching net zero is likely to require GGRs to offset residual emissions in the most hard-to-abate sectors that cannot be decarbonised completely, and to support cost-effective achievement of our net zero target.

The important role of GGRs in global efforts to tackle climate change has been recognised by the Intergovernmental Panel on Climate Change (IPCC). In 2018, the IPCC's landmark Special Report on the impacts of global warming of 1.5°C noted: "All pathways that limit global warming to 1.5°C with limited or no overshoot project the use of carbon dioxide removal (CDR) on the order of 100–1000 $GtCO_2$ [billion tonnes] over the 21st century."[6] In the UK, the CCC has estimated between 75 and 84 $MtCO_2$ of greenhouse gas removals could be required annually by 2050 to achieve net zero.[7]

As the most mature and well-established GGR method, afforestation will be an important component of these efforts. The government recently consulted on a new England Tree Strategy that will set out policies to deliver England's contribution to our ambitious commitment to increase tree planting across the UK to 30,000 hectares per year by 2025, in line with the CCC's recommendations. Yet to achieve the scale of greenhouse gas removal implied in the CCC's analysis, it will be necessary for nature-based approaches to be complemented by engineering-based GGRs.

Forecasts about which GGR technologies will be dominant in 2050 are highly uncertain given the technological immaturity of most options, but recent analysis suggests DACCS and

[6] IPCC (2018), Summary for Policymakers – Special Report on the impacts of global warming of 1.5°C, p.19
[7] CCC (2019), Net Zero – The UK's contribution to stopping global warming; and CCC (2019), Net Zero Technical Report. The estimates represent overall deployment potential across GGR approaches in 2050 in the Further Ambition scenario, including engineered removals such as BECCS and DACCS, as well as land-based removals. The lower estimate (75 $MtCO_2e$) represents the potential of BECCS, DACCS, wood in construction and forestry combined, while the upper estimate (84 $MtCO_2e$) also includes other land-based removals. The CCC Further Ambition scenario includes measures that, taken together, would reduce UK emissions by 95-96% from 1990. According to the CCC, additional measures would be needed to cover the remaining emissions, including potentially larger deployment of GGRs.

BECCS (Bioenergy with Carbon Capture and Storage) could make the most significant contribution to the negative emissions required to meet net zero.[8]

**Opportunity for the UK in greenhouse gas removals**

The government has been clear on its commitment to position the UK at the forefront of new markets for low carbon technologies and services in the net zero transition. GGRs have the potential to attract investment, stimulate job creation, and drive regional productivity, delivering a stronger, greener UK. As a country we are particularly well positioned to take advantage of this opportunity by capitalising on our existing strengths, such as the UK's academic expertise and large carbon storage potential.[9] We will look to maximise opportunities for the UK to be early developers and adopters of these technologies.

**Current policy support for GGRs**

The Carbon Emissions Tax (CET) consultation, which closed on 29 September, signalled the government's interest in exploring whether tax could play a role in supporting the emergence of greenhouse gas removal technologies and industries. It asked stakeholders to come forward with views of how the Carbon Emissions Tax, or other polices, could be enhanced over the medium term to support GGRs. The majority of respondents were in favour of the government exploring incentives for the use of GGRs. The government will publish a summary of responses in due course. The responses submitted to the CET consultation that commented on incentives for GGRs have informed this call for evidence.

The government recognises that greenhouse gas removal methods are at varying stages of development and will vary in potential scale of deployment in the UK. We are taking steps to strengthen our understanding of GGRs before moving forward with deployment. We are already rolling out cost effective and reliable nature-based solutions, whilst in parallel supporting innovation and commercial development of more nascent technologies. For example:

- In June 2020, the Prime Minister announced up to £100m for Direct Air Capture R&D. The Direct Air Capture and other GGR Innovation Programme, which launched in November, seeks to pilot feasible GGR approaches at scale as well as better our understanding of governance and ethics of GGRs.

- We launched the £50m Woodland Carbon Guarantee, which will boost the domestic carbon offset market and provide long-term payments for land managers who plant trees to sequester carbon.

- We are progressing work on developing Carbon Capture, Usage and Storage (CCUS) infrastructure that will be essential for the deployment of BECCS and DACCS. This

[8] Vivid Economics for BEIS (2019), Greenhouse Gas Removal (GGR) policy options. Based on analysis from Royal Society and Royal Academy of Engineering (2018), Greenhouse gas removal.
[9] BEIS (2018), The UK carbon capture usage and storage deployment pathway: an action plan

includes a £1 billion commitment to develop four CCUS clusters by 2030, with the first two in the mid-2020s.

Beyond these actions, the government is committed to exploring the longer-term policy support that could be needed to enable a market for GGRs and accelerate the development and deployment of less mature technologies. While there remains uncertainty around the viability and mix of various options, the CCC has recommended that a policy framework should be in place to support initial deployment of engineered GGRs such as BECCS in the late 2020s, ahead of wider rollout of other engineered GGRs such as DACCS in the 2030s and 2040s.

# Details of the call for evidence

**Purpose and objectives**

The purpose of this call for evidence is to strengthen the government's evidence base around GGRs and their potential contribution to net zero – including the viability of different GGR methods in the UK, possible policy incentives to address key market barriers, and potential solutions to wider challenges around innovation, enabling infrastructure, and accounting and verification.

The information we receive from stakeholders will be used to inform policy development in this nascent area, supporting government to consider the role it could play in accelerating the development and deployment of a range of GGRs. This will build on the evidence assembled as part of a study by Vivid Economics into policy options for greenhouse gas removals, published by BEIS in 2019.[10] It forms part of a suite of research the government is currently conducting on GGRs, including research projects to be undertaken by BEIS and the National Infrastructure Commission.

While the details of the government's approach to GGRs will be informed by the evidence and information gathered from stakeholders, it is currently our intention to:

- **Establish a policy framework to incentivise innovation, deployment and cost reduction of GGRs** – with a view to building a market for greenhouse gas removals to support the UK's efforts to reach net zero emissions by 2050.
- **Position the UK as a leader in the development and deployment of GGRs** – growing supply chains, attracting inward investment, and capitalising on new export opportunities.

We invite views from a range of stakeholders, particularly developers and researchers involved in GGR technologies, investors, the academic community, those involved in accreditation and

[10] Vivid Economics for BEIS (2019), Greenhouse Gas Removal (GGR) policy options

verification of carbon emissions, as well as social scientists with an interest in public perceptions of emerging energy and climate technologies.

**Information submitted in response to this call for evidence may be shared with third party contractors for the purpose of analysis. Please indicate in your submissions if you do not give permission for your evidence to be used in this way.**

1. **Do you give permission for your evidence to be shared with third party contractors for the purpose of analysis?**

**Scope**

Analysis by the CCC suggests that a combination of nature-based and engineered GGR methods are likely to be required to achieve the UK's climate ambitions. This call for evidence is primarily interested in the role of government in incentivising emerging GGR techniques that are not yet ready to be deployed at scale – due to factors such as technological immaturity, uncertain environmental impacts, or absence of enabling policies and infrastructure. This includes DACCS and BECCS as well as untested land-based solutions such as biochar, enhanced weathering and soil carbon sequestration. We are interested in a broad suite of GGRs and are not proposing to back any specific technologies at this point in time.

Chapter 1 outlines the GGR options that are assessed as being at a level of development such that they might feasibly contribute to net removals of greenhouse gases in the UK in 2050 (see Figure 1). This list should not be considered exhaustive nor determinative: as noted in the Vivid Economics for BEIS (2019) report, there are a number of further GGR options under development which may emerge as viable candidates for deployment in the UK, such as ocean fertilisation, ocean alkalinity, and mineral carbonation. In this call for evidence, we would welcome relevant information in relation to these and other early stage GGR options.

This call for evidence is designed to address evidence gaps around technological development and deployment potential specifically in relation to nascent GGR methods. Therefore, mature and widely-practised GGR methods such as afforestation and wood in construction are considered to be outside of the scope of Chapter 1 and 2: we are not seeking new evidence or views on incentive mechanisms for these methods. Habitat restoration is similarly out-of-scope – CCC analysis suggests that while peatland restoration reduces losses of carbon to the atmosphere, peatland overall will remain a net source of emissions rather than a net carbon sink in 2050.[11]

In Chapter 3, we invite evidence on monitoring, reporting and verification of greenhouse gas removals in relation to all GGR methods. In this case, we would welcome evidence that relates to mature options such as afforestation and wood in construction, as well as emerging options such as BECCS and DACCS.

[11] CCC (2019), Net Zero Technical Report.

The development of business models to enable deployment of CCUS is the subject of previous policy consultations by BEIS and is therefore out of scope of this call for evidence. However, Chapter 3 considers how the development of GGRs that are dependent on $CO_2$ transport and storage infrastructure, such as BECCS and DACCS, should be coordinated with our stated CCUS ambitions.

**Structure of the document**

This call for evidence is comprised of three main chapters:

- **Chapter 1** summarises the main engineered and nature-based GGR methods, and seeks views on the role, suitability and mix of GGRs in the delivery of net zero. It invites further evidence in relation to technological maturity, scale-up potential, costs, life-cycle emissions, wider environmental impacts and other constraints to deployment.
- **Chapter 2** explores the role of government in directly incentivising GGRs. It considers and invites stakeholder comment on:
    - **Market barriers** to investment in GGRs – including financial barriers such as high costs and the absence of a price for negative emissions, and non-financial barriers relating to innovation, infrastructure and accounting requirements.
    - **Principles** that government could use to evaluate policy options and the degree of intervention required to address market barriers.
    - **Potential policy options** for incentivising investment in GGR methods, drawing on the policies outlined in the Vivid Economics for BEIS (2019) report.
- **Chapter 3** explores supporting policies that will be needed to support at-scale deployment of GGRs in future. This includes robust frameworks for monitoring, reporting and verification of negative emissions, in addition to $CO_2$ transport and storage infrastructure, which is a critical enabler for GGRs such as DACCS and BECCS to ensure the permanent storage of carbon captured by these methods.

**Terminology**

There are various terms used to describe methods for atmospheric removal of greenhouse gases, including ‘greenhouse gas removals’ (GGRs), ‘negative emissions technologies’ (NETs), and ‘carbon dioxide removals’ (CDR). This call for evidence uses the term ‘greenhouse gas removals’, which is considered to be the term in most widespread use by stakeholders.

In this call for evidence, afforestation, habitat restoration (peatlands, wetlands and coastal habitats) and soil carbon sequestration are described as ‘nature-based’ approaches to greenhouse gas removal. Most other types of GGR are collectively referred to as ‘engineered’ methods, including BECCS, DACCS, biochar, enhanced weathering and wood in construction. Whilst some of these methods have both nature-based and engineered elements (such as biochar, which is produced by thermal decomposition of biomass in low-oxygen conditions for

subsequent application on soil), these are considered as ‘engineered’ removals in line with the CCC.[12]

Ocean-based removals such as ocean fertilisation and ocean alkalinity may be considered as a distinct third category (note that these methods are at a very early stage of technology readiness and are not included in Figure 1).

The term ‘negative emissions’ is used to refer to the removal of atmospheric greenhouse gases achieved through GGR methods.

[12] CCC (2019) Net Zero Technical Report p.275

# Chapter 1: Greenhouse gas removal methods

Greenhouse gas removal methods can be considered in broadly two categories: nature-based methods and engineering-based methods. Nature-based methods include afforestation and soil carbon sequestration. Engineering-based GGRs encompass a range of methods such as Bioenergy with Carbon Capture and Storage (BECCS), Direct Air Carbon Capture with Storage (DACCS), enhanced weathering, and biochar.

The Vivid Economics for BEIS (2019) report details how GGRs are at varying technology readiness levels and have varying levels of scale-up potential.[13] The report summarised the evidence base in relation to the main GGR methods which could contribute to net removals of greenhouse gases in the UK by 2050. This is reproduced in the table below (Figure 1).

**Figure 1 Overview of GGR methods[14]**

| GGR option | Description | Maturity (TRL) | Indicative scale 2050 ($MtCO_2$/yr) | Notable risks to the environment or GGR ($MtCO_2$) potential |
|---|---|---|---|---|
| **Engineering-based GGRs** | | | | |
| BECCS | $CO_2$ is captured and stored from combustion (or gasification) of biomass | TRL ~ 6. Bioenergy from biomass-based power plants is a mature technology, as is $CO_2$ capture in other applications, but the combination is largely at the demonstration stage | 50 | - Use of unsustainable feedstock<br>- Competition for land may limit feedstock availability |

[13] Vivid Economics for BEIS (2019), Greenhouse Gas Removal (GGR) policy options

[14] Table reproduced from Vivid Economics for BEIS (2019). Indicative UK deployment scales and notable risks are based on Royal Society & Royal Academy of Engineering (2018). TRL levels were triangulated between Royal Society & Royal Academy of Engineering (2018), Mclaren (2011), (CCC, 2016), and expert interviews.

| GGR option | Description | Maturity (TRL) | Indicative scale 2050 ($MtCO_2$/yr) | Notable risks to the environment or GGR ($MtCO_2$) potential |
|---|---|---|---|---|
| Biochar | Storing carbon through partially combusted organic matter (char) by burying it in topsoil | TRL ~ 5. Method has been piloted, but not yet widely applied in UK | 5** | - Negative impacts on soil quality from both heavy metals and organic contaminants<br>- Reversibility and irreversibility risks<br>- Competition for feedstock with BECCS and, to a lesser degree, wood in construction |
| DACCS | Absorption of $CO_2$ directly from the atmosphere using amines, suspended on a branched framework | TRL* ~ 4. Only small-scale DACCS currently piloted | 25 | -Wastes produced from DACC process (absorbents etc.) |
| Enhanced weathering | Spreading silicate minerals across soils to increase soil alkalinity, which increases absorption of acidic $CO_2$ | TRL ~3. Needs to be piloted in the field | 15 | -Immaturity of technique means GGR potential in various local UK environments not yet fully understood<br>-Impact on soil and water quality<br>-Environmental impacts due to large-scale mining of required minerals<br>-Reversibility and irreversibility risks |
| Magnesium silicate/oxide in cement | Replacement of carbonate in cement allows for potential absorption of $CO_2$ over concrete lifecycle | TRL ~ 6. There are several start-ups attempting to implement this | 1 | -Net GGR over lifetime of concrete not fully understood<br>-Full life cycle impacts (including emissions from inputs) may be significant<br>-Regulatory standards for concrete strength etc. may prohibit implementation |
| Wood in construction | Increased use of domestically produced wood in buildings (in nearly all new build homes) to | TRL ~ 9. Approximately 50,000 homes a year already constructed with | 5 | -Ability to source enough domestic timber of appropriate quality<br>-Processing and transportation may reduce GGR potential<br>-Requires adjustments to building requirements and safety and quality assurance to enable sufficient scale |

| GGR option | Description | Maturity (TRL) | Indicative scale 2050 ($MtCO_2$/yr) | Notable risks to the environment or GGR ($MtCO_2$) potential |
|---|---|---|---|---|
| | permanently store carbon | wood frames in the UK | | |
| **Nature-based GGRs** | | | | |
| Afforestation/ forest management | Increasing forest area to increase $CO_2$ absorption from the atmosphere | TRL ~ 9. Already widely practised throughout the world | 15 | -Biodiversity risks<br>-Competition for land may limit deployment |
| Habitat restoration | Rewetting and restoration of peatlands, wetlands, and other coastal habitats to enhance natural carbon absorption | TRL ~ 5. Significant knowledge and readiness around habitat restoration, but not focussed on GGR | 5 | - Expected that the evidence will imply this will not be a GGR but rather an emission reduction measure<br>- Short-term emissions of non-$CO_2$ GHGs as a result of restoration<br>- Competition for land may limit restoration or lead to indirect land use change emissions elsewhere |
| Soil carbon sequestration | Implementing land management options thought to increase soil carbon sequestration | TRL ~ 8. Ready for implementation and many of the practices are already used in some places | 10** | -Reversibility risk: After approx. 20 years soil becomes saturated, requiring maintenance to avoid $CO_2$ being re-emitted<br>-Limited evidence of efficacy in the UK context and risk of possible increased emissions of $N_2O$ |

Note: *TRL: Technological readiness level, method of estimating technology maturity. TRLs are based on a scale from 1 to 9, with 9 being the most mature technology.
**Negative emission potential in the UK is contested despite relatively high TRL.

Given the immaturity of most GGRs, there is ongoing debate around the viability of various methods to remove $CO_2$ from the atmosphere and scientific consensus is currently limited, particularly for soil-based options. The deployment potential presented in Figure 1, based on a report by the Royal Society and the Royal Academy of Engineering[15], is considered to be

[15] Royal Society & Royal Academy of Engineering (2018), Greenhouse gas removal.

optimistic for a number of GGR options including soil carbon sequestration, biochar, habitat restoration, and DACCS.[16]

The potential costs of GGR deployment are similarly uncertain, with estimates varying from £4-£20/t$CO_2$ for soil carbon sequestration and up to £160-£470/t$CO_2$ for DACCS.[17]

**The potential role of GGR methods**

The government is committed to pursuing decarbonisation of our economy in order to achieve net zero by 2050. To achieve net zero, however, the CCC has advised that some greenhouse gas removals will need to be deployed in order to offset residual emissions in parts of difficult-to-decarbonise sectors.

2. **Do you agree that some GGRs will be required to achieve the UK's net zero target by 2050? What are your views on the suitability and mix of different technologies in supporting the delivery of net zero?**

The government recognises that new evidence is continually emerging in the field of GGRs, and there has been ongoing activity around the development and deployment of many of the methods outlined above since the Vivid Economics for BEIS (2019) report was published.

3. **In relation to the GGRs listed in Figure 1 (except afforestation, habitat restoration and wood in construction), is there new evidence that you can submit in relation to any of the following:**

   **(i) technology readiness levels**

   **(ii) scale-up potential (in the UK and/or globally)**

   **(iii) costs per tonne of $CO_2$ removed, including any additional information about cost savings per tonne for removals "in bulk" (where possible, please provide evidence for cost breakdowns across the various elements e.g. capture costs, transport and storage costs)**

   **(iv) constraints to deployment**

[16] Vivid Economics for BEIS (2019), Greenhouse Gas Removal (GGR) policy options. The CCC has provided alternative analysis of potential deployment of GGR methods across a range of scenarios – see CCC (2019), Net Zero Technical Report, Chapter 10.

[17] Vivid Economics for BEIS (2019), Greenhouse Gas Removal (GGR) policy options. For consistency purposes we report estimates from the Vivid Economics report; however, other studies have also assessed the costs of DACCS through a systematic review of the literature, suggesting DACCS removal costs could amount to £190-£540 per tonne of $CO_2$ removed from the atmosphere – see UKERC (2019), Bioenergy with carbon capture and storage, and direct air carbon capture and storage: Examining the evidence on deployment potential and costs in the UK. The report includes studies published between 2011 and 2018.

**(v) ability to verify removals, taking into account considerations of permanence of removal (i.e. how accurately can you measure the amount of $CO_2$ removed and stored by this method)**

**(vi) lifecycle emissions for these methods in the UK (please specify any assumptions as part of this calculation, for example the carbon intensity of the electricity being used. If you are assuming a lower carbon intensity than the modern grid, why?)**

**(vii) wider environmental impacts and risks.**

4. **Is there any evidence you would like to submit in relation to other nascent GGR methods <u>not</u> outlined in Figure 1? If so, please provide a clear description of the method and the evidence available in respect to the categories listed above, including deployment potential in the UK. If evidence is not available, please outline why and when it might become available.**

**Please ensure that you cite the appropriate sources and publications in relation to evidence submitted, if relevant, as BEIS will seek commercial and engineering support in considering stakeholder responses.**

# Chapter 2: Incentivising investment in greenhouse gas removals

This chapter examines the market barriers which constrain deployment of GGRs in the UK, and seeks views on the role of government in addressing those barriers in order to stimulate the development and deployment of nascent GGR methods.

**Barriers to deployment**

At present, carbon removal practices are not specifically incentivised in the UK except for afforestation, and most methods are at an early stage of development, currently moving into demonstrator or pilot stages.

It is widely recognised that GGR development is constrained by a lack of incentives for deploying these methods at scale, alongside other market barriers. The Vivid Economics for BEIS (2019) report identified five main market barriers which will need to be overcome to accommodate large-scale GGR deployment by 2050:

- **Innovation and demonstration barriers:** GGRs at early technology readiness levels will require innovation and demonstration support before businesses will deploy these in response to policy incentives.
- **Non-financial deployment barriers:** Infrastructure and supply chains will be required to enable GGR deployment, including $CO_2$ transport and storage infrastructure for the rollout of BECCS and DACCS as well as the establishment of clear liability frameworks for the custody of captured and stored $CO_2$.
- **Financial barriers:** Potentially large upfront investment, long payback periods, and uncertain long-term incentives may impact on investment in GGRs.
- **Accounting barriers:** Uncertainties in the amount of $CO_2$ removed, the permanence of storage, and challenges around monitoring and verification of negative emissions creates barriers to deployment of GGRs.
- **Environmental barriers:** Large-scale deployment of GGRs, particularly land-based methods, will have implications for national land use patterns and could create local risks to soil, water and air quality.

The report concluded that no single policy is likely to be effective in overcoming all types of market barrier to GGRs, and a suite of policy interventions is therefore likely to be required.

In addition to these barriers, many GGRs are associated with co-benefits such as low-carbon electricity in the case of BECCS, and biodiversity benefits in the case of some nature-based solutions. In order to accurately price GGR services, the value of these co-benefits will need to

be appropriately quantified and taken into account alongside the value of the greenhouse gas removed.

**5. What do you consider to be the main barriers to the development and deployment of GGRs?**

### Principles

As we begin to develop our approach to GGRs, the government is seeking views on a potential set of principles which could guide future policy. These could encompass:

- Making sure removals are verifiable and quantifiable;
- Instilling confidence in investors;
- Attracting innovation;
- Ensuring value for money;
- Being technology neutral; and
- Making a wider economic contribution.

**6. What principles would you like to see included in a framework for incentivisation of greenhouse gas removals?**

### Policy approaches to incentivise GGRs

There are a range of policy levers which could potentially form part of a longer-term framework for incentivising GGR technologies. The policy options outlined below (Figure 2) are drawn primarily from the Vivid Economics for BEIS (2019) report, which outlined a number of policy approaches which government could consider to address the lack of a commercial incentive to deploy GGRs at scale.

**Figure 2: Policy options**

**Tax incentives**

Tax incentives for investment in GGR technologies could take various forms. The introduction of tax credits, for instance, could be effective in encouraging deployment of GGRs by reducing the tax liability of businesses that invest in these technologies.

There are multiple options for implementing tax credits to incentivise GGRs. Tax credits could be paid for each tonne of $CO_2$ removed, with different tax bands available for different methods based on their relative costs. Tax credits could also be made available for capital investment for GGR. This type of tax credit may be used to complement the tax

credit available per $tCO_2$, and would be particularly relevant to capital-intensive GGRs such as BECCS with large up-front costs and infrastructure requirements.

A tax credit approach could be modelled on the 45Q scheme in the USA, which provides a tax credit to projects that capture and store or utilise $CO_2$ that would otherwise be emitted into the atmosphere.

**Obligations**

A GGR obligations scheme could require businesses to deploy or invest in a defined level of a GGR option or face a penalty. The obligation may be paired with a tradeable certificate scheme to allow the obligated party to pay others to deploy the GGR. The level of the obligation (i.e. the percentage of emissions the business is required to compensate for through deployment of GGRs or the purchase of negative emissions certificates) would be increased over time.

There are several successful examples of obligations policies in the UK. For example, the Renewable Transport Fuel Obligation places an obligation on fuel suppliers to blend an increasing share of renewable fuels in the fuel they supply, rising to at least 12.4% by 2032. The UK Renewables Obligation (now closed to new projects) placed an obligation on electricity suppliers to source a proportion of the electricity they supplied from renewable sources, using tradeable renewable obligation certificates to demonstrate the obligation was met.

An obligation is a flexible instrument which could be applied to a range of actors, and could be used to incentivise a wide range of GGRs. For instance, the obligation could be placed on large fossil fuel wholesalers (obligated to compensate for a percentage of the $CO_2$ embedded in the fuel they sell within the UK), electricity suppliers (obligated to purchase a percentage of the electricity they supply from BECCS power stations), or supermarkets (obligated to purchase a percentage of their produce from accredited farmers who apply GGR techniques on their land). In each case, the obligation could be met through certificates for each tonne of $CO_2$ stored.

**Regulation**

Beyond obligations, other regulatory interventions could be used to incentivise investment in greenhouse gas removals. For instance, this could involve soil standards to require landowners to enhance soil carbon storage through methods such as biochar and enhanced weathering.

**Payments and Service Contracts**

Provision of finance and risk-sharing can provide a significant incentive to deploy GGRs. This type of support could be available in a number of forms such as payment schemes, grants and loans, and long-term contracts for developers.

Targeted grants and loans could be provided to farmers and land managers to deploy small-scale GGRs, particularly land-based solutions such as enhanced weathering and biochar once they are deemed commercially mature. This could involve up-front finance for projects, or payments for each tonne of $CO_2$ stored.

Service contracts could be aimed at businesses that deploy large-scale GGR projects. To secure the contracts, businesses would be required to submit project proposals that outline the volume of greenhouse gas removal that they expect to achieve and the timeframe for delivery. Projects would be screened for feasibility and selected through a competitive bidding process, with contracts awarded to successful bidders. The primary difference between these contracts and the targeted grants is the scale, with service contracts designed to be bespoke, depending on the needs of large projects (such as a BECCS power station).

Contracts could be linked to the costs of delivery, the carbon price, or (in the case of BECCS) the electricity price. Different instruments may be appropriate for early-stage and later-stage options, depending on investors' cost certainty and risk appetite.

**Cap and Trade**

Under a cap and trade scheme, emitters must hold tradeable certificates (allowances) equal to the number of tonnes of $CO_2$ they emit. Emitters can trade these allowances, which creates an incentive to reduce emissions and sell surplus allowances. GGRs could potentially be included in a cap and trade scheme by allowing businesses to offset their carbon price by using or purchasing GGRs; for example, through the creation of negative emission certificates which can be exchanged against allowances. A wide range of GGRs could be included in such a scheme. Alternatively, a narrower range of GGRs may be included by only making negative emission certificates available to certain technologies.

**Voluntary Private Sector Action**

The last year has seen a number of leading businesses commit to funding nascent GGRs as part of their corporate social responsibility strategies. For example, Stripe pledged at least $1m per year to pay for permanent, direct removal of $CO_2$ and announced its first purchases in May 2020[18] and Microsoft has pledged to go 'carbon negative' by 2030 through GGRs such as DACCS and BECCS[19]. This reflects growing public awareness and activism on climate change which is increasingly affecting consumer and corporate behaviour.

There is a potential role for government in supporting more companies to make similar commitments in the UK – for example, by promoting voluntary offset markets, or by

[18] https://stripe.com/blog/first-negative-emissions-purchases (viewed 1 December 2020)
[19] https://blogs.microsoft.com/blog/2020/01/16/microsoft-will-be-carbon-negative-by-2030/ (viewed 1 December 2020)

setting out standards to underpin integrity and consistency in the monitoring, reporting and verification of negative emissions.

The policy options outlined above are not exhaustive or mutually-exclusive – for example, a GGR obligation scheme may include government subsidies to help certain sectors meet their obligations. There may also be merit in adopting different approaches over time; some policy levers may work better as short-term incentives to kick-start GGRs in the UK, whereas others may be more appropriate in supporting GGRs over the medium- and longer-term. For instance, a tax credit may be used as an initial policy lever to stimulate investment and contribute to developing a market for greenhouse gas removal methods. For market-based schemes, we recognise that time is needed to establish credibility and a liquid market for trade, which can underpin deployment in the late 2030s and early 2040s.

It should be noted that the development of business models to enable deployment of CCUS has been the subject of previous policy consultations by BEIS[20] and is therefore out of scope of this call for evidence. However, we are interested in how the development of GGRs that are dependent on $CO_2$ transport and storage infrastructure, such as BECCS and DACCS, should be coordinated with our stated CCUS ambitions. This is addressed in Chapter 3 (question 25).

The following section seeks views from stakeholders on potential policy approaches to GGRs. It consists of a set of general questions on the design of a future policy framework and questions relating to the specific policy options outlined above.

General questions

The Vivid Economics for BEIS (2019) report noted that many of the policy options described above are unlikely to incentivise innovation in early-stage GGRs that are not yet ready for commercial deployment (e.g. DACCS). These instruments may therefore need to be complemented by innovation policy and bespoke interventions to enable immature technologies to develop and bring forward initial (First of a Kind) deployment.

7. **What specific policy mechanisms could the government consider to incentivise (a) innovation and (b) initial deployment? Could any of the policy options outlined above be designed in a way that stimulates investment in innovation, including pilots and demonstrators for less mature technologies?**

The role of government may change over time as a market for GGRs develops. For instance, a tax credit may be used as an initial policy lever to stimulate investment and contribute to developing a market for greenhouse gas removal methods, until such a market is able to become self-sustaining. The government would consider a sunset clause with any tax credit option or subsidy.

[20] BEIS (2020) Business models for carbon capture, usage and storage: government response

8. **How could government best contribute to establishing optimum market conditions for GGRs to be developed and deployed at a large scale?**

9. **How might the role of government change over time to bring GGR technologies to market and encourage their deployment up to 2050?**

10. **Which factors should be considered when assessing the suitability of different policy options for businesses?**

11. **Are there any existing business models in other sectors – such as power, industry, transport or land use – that could complement new schemes to incentivise GGRs?**

The Vivid Economics for BEIS (2019) report distinguished between 'price mechanisms' and 'quantity mechanisms' for incentivising GGRs. Tax credits and payment schemes are examples of price mechanisms, offering an incentive to deploy GGRs at a defined price. On the other hand, quantity mechanisms such as an obligation scheme set a target or requirement to achieve a certain amount of greenhouse gas removal, with the price determined by the market through supply and demand for certificates.

12. **Are price instruments or quantity instruments likely to be more effective in encouraging and sustaining deployment of GGRs? Or will a combination be required?**

Schemes to incentivise greenhouse gas removals could be designed either to encourage a wide range of GGRs or to support specific technologies. The government recognises the potential merits of implementing different business models for certain GGR methods with distinct characteristics. For instance, BECCS applications have a unique position amongst GGRs due to their association with a variety of revenue generating products, such as electricity, heat, and low carbon gas. Support for BECCS technologies may therefore need to account for income derived from the sale of these products, alongside the value of the negative emissions they create.

13. **How far should a policy framework aspire to be technology-neutral between different GGR options?**

The government acknowledges that specific policy approaches to GGRs incentivisation have the potential to inadvertently affect mitigation efforts in other emissions sectors. Different policy options could generate unintended effects on the development and commercialisation of other technologies by, for example, contributing to market distortions in those sectors.

14. **Could wider support for GGRs have any unintended effects on the development and commercialisation of technologies in other sectors, and how could this be mitigated?**

The Vivid Economics for BEIS (2019) report acknowledged that there are very few international examples of policies that are explicitly designed to support deployment of GGRs. Policy examples supporting GGRs indirectly include the 45Q tax credits scheme to encourage carbon capture and storage (CCS) deployment in the USA, the inclusion of forestry in the New Zealand ETS, forest project offsets in California's Cap-and-Trade Program, and incentives for CCS in the EU ETS (though this does not currently extend to BECCS). The government is interested to receive evidence of any other schemes to incentivise GGR deployment.

**15. Are there any international examples that have proved effective at incentivising GGRs? Why were they effective, and are there any barriers to taking similar action in the UK? Are there examples of international approaches that have not worked well?**

Tax Incentives

Tax incentives could include explicitly allowing business to offset their carbon price liability (for example the Carbon Price Support, or other similar carbon price) by using or purchasing GGRs. Another option to incentivise investment in greenhouse gas removals could be the provision of a tax credit against other tax liabilities, per tonne of $CO_2$ removed through specified GGR methods, which accounts for the varying cost of development and deployment. Tax credits could also be made available for initial capital investment for GGRs or early-stage pilots and demonstrators.

**16. Should the government introduce a tax credit, and if so, how should this be designed? Should it be provided only for specific GGR technologies or a broad range of methods? Would multiple, specific rates be effective at incentivising as much investment as possible?**

If introduced, the government would want to ensure that a tax credit provides value for money for the taxpayer.

**17. Should participants from specific sectors with historical carbon emissions be eligible to apply for the credit or should the credit be economy-wide?**

Obligations

Obligation policies have been established to increase the supply of biofuel and renewable electricity in the UK, and could also be used to require businesses to deploy or invest in GGRs.

**18. If the government were to introduce a GGR obligation scheme, which businesses and emitting sectors could this cover? How could such a scheme be designed to minimise competitiveness impacts and regressive passed-through costs (e.g. to consumers and bill-payers)?**

Regulation

The government would welcome evidence on other regulatory levers that could promote deployment of GGRs, whether linked to specific technologies or a broad range of methods.

**19. What other regulatory approaches could government explore to incentivise GGR deployment?**

Payments and Service Contracts

Direct payments (e.g. grants and loans) could be made to actors who deploy GGRs. This could involve up-front finance for projects, or payments for each tonne of $CO_2$ stored.

**20. What are the merits and risks of introducing payment schemes for GGRs, potentially involving up-front grants or payments for each tonne of $CO_2$ stored? Which GGRs would be suitable for a payment scheme?**

Service contracts could be aimed at businesses that deploy large-scale GGRs, providing certainty to capital-intensive GGRs with long payback periods.

**21. Could a contract scheme be effective in incentivising GGRs such as DACCS and BECCS? What would be the main challenges and limitations of such a mechanism, and how could it be designed to maximise its effectiveness?**

Cap and Trade

The government recognises that a cap and trade system could support investment in GGRs through offsetting against the carbon price and the creation of tradeable negative emission certificates.

**22. What could a cap and trade scheme for negative emissions look like, and which sectors would you propose to be included in such a market?**

**23. The costs of different GGR technologies vary significantly. How could a cap and trade system address these differences? How could a cap and trade system be used to incentivise initial investment in any future emerging GGR technologies over a long-term trajectory?**

Voluntary Private Sector Action

The government is committed to supporting businesses to decarbonise to achieve our net zero commitments by 2050, and there are a variety of policies in place in order to assist this. However, there could be a role for government in encouraging businesses to invest in GGR projects, for instance through voluntary offset markets.

**24. What role can government play in encouraging more companies to make voluntary commitments to invest in GGR technologies in the UK? To what extent can this support innovation in, and deployment of, these technologies?**

# Chapter 3: Supporting and enabling policies for greenhouse gas removals

The policy mechanisms outlined in Chapter 2 could play an important role in addressing key barriers to GGR development, such as the lack of a financial incentive to deploy at scale. However, these policies alone are unlikely to incentivise significant GGR deployment without a wider suite of supporting and enabling policies.

In addition to direct incentives, the government recognises that supporting policy actions will be required to ensure that critical infrastructure and accounting frameworks are in place to support scaling up in the future. It will also be important to ensure that GGR deployment complies with the government's wider environmental goals, such as the 25 Year Environment Plan commitment to leave the natural environment in a better state than we inherited it.

**Infrastructure**

The deployment of some GGRs, most notably DACCS and BECCS, is reliant on carbon capture and storage infrastructure for the transport and storage of the $CO_2$ they capture. We are already taking a wide range of actions in this area, to deliver on the ambitions outlined in the CCUS Action Plan.

At the Budget 2020, the Chancellor announced at least £800 million for a Carbon Capture and Storage Infrastructure Fund to develop CCUS clusters in the UK. The Prime Minister's Ten Point Plan announced a further £200 million, increasing the fund to £1 billion, to establish four CCUS clusters by 2030, with the first two in the mid-2020s. This investment could help to support up to 50,000 jobs, potentially in areas such as the Humber, North East, North West, Scotland and Wales. In August, we also published the Government Response to the consultation on CCUS business models, which set out the government's proposed business model for transport and storage infrastructure.

The government will seek to capitalise on its investment in CCUS, and the UK's natural competitive advantage in this area, as we develop our approach to GGR deployment. In addition, we are mindful of the importance and opportunities of coordinating deployment of some GGRs with CCS infrastructure, given the dependence of GGRs like DACCS and BECCS on transport and storage infrastructure. Therefore, the government believes that we should be working to incentivise initial deployment of GGR technologies in line with our stated CCUS ambitions.

**25. What are your views on the government's intention to coordinate deployment of GGR technologies such as DACCS and BECCS in line with our stated CCUS ambitions, and how could we best do this?**

### Accounting and verification

GGR accounting improvements will be crucial to ensure that removals can be robustly and transparently included in the UK's emissions inventory, as well as enabling policy mechanisms to be linked to performance and outcomes. However, the technological immaturity of various GGR options means accounting principles are not yet well established. Uncertainty around the amount of $CO_2$ removed, permanence of storage, life-cycle emissions and difficulties around monitoring, reporting and verification (MRV) are all barriers to large-scale deployment of GGRs.

Several GGRs are already explicitly covered by existing guidelines by the Intergovernmental Panel on Climate Change for reporting of greenhouse gas emissions and removals – including afforestation, soil carbon sequestration, building with biomass, biochar and BECCS.[21] However, this is not the case for a range of other methods such as DACCS, enhanced weathering and removal of greenhouse gases other than $CO_2$.

Accreditation of negative emissions, via robust and consistent monitoring and validation, will also be important to increase confidence in voluntary offset markets and capitalise on the willingness of companies that want to offset their emissions and use their finances to combat climate change.

The government would like to identify the key barriers to developing a robust MRV system for GGRs, including those that are more developed such as afforestation.

**26. What principles would you wish to see in any accreditation scheme for negative emissions? How should the government regulate this? Any evidence relating to best practice of existing negative emissions MRV is welcomed.**

**27. What are the most significant barriers to developing a robust monitoring, reporting and verification system for GGRs?**

[21] IPCC (2006), 2006 IPCC Guidelines for National Greenhouse Gas Inventories; IPCC (2013) 2013 Supplement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories: Wetlands; IPCC (2019) 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories

# List of questions

1. Do you give permission for your evidence to be shared with third party contractors for the purpose of analysis?

2. Do you agree that some greenhouse gas removal methods will be required to achieve the UK's net zero target by 2050? What are your views on the suitability and mix of different technologies in supporting the delivery of net zero?

3. In relation to the GGRs listed in Figure 1 (except afforestation, habitat restoration and wood in construction), is there new evidence that you can submit in relation to any of the following:

   (i) technology readiness levels

   (ii) scale-up potential (in the UK and/or globally)

   (iii) costs per tonne of $CO_2$ removed, including any additional information about cost savings per tonne for removals "in bulk" (where possible, please provide evidence for cost breakdowns across the various elements e.g. capture costs, transport and storage costs)

   (iv) constraints to deployment;

   (v) ability to verify removals, taking into account considerations of permanence of removal (i.e. how accurately can you measure the amount of $CO_2$ removed and stored by this method);

   (vi) lifecycle emissions for these methods in the UK (please specify any assumptions as part of this calculation, for example the carbon intensity of the electricity being used. If you are assuming a lower carbon intensity than the modern grid, why?);

   (vii) wider environmental impacts and risks.

4. Is there any evidence you would like to submit in relation to other nascent GGR methods not outlined in Figure 1? If so, please provide a clear description of the method and the evidence available in respect to the categories listed above, including deployment potential in the UK. If evidence is not available, please outline why and when it might become available.

5. What do you consider to be the main barriers to the development and deployment of GGRs?

6. What principles would you like to see included in a framework for incentivisation of greenhouse gas removals?

7. What specific policy mechanisms could the government consider to incentivise (a) innovation and (b) initial deployment? Could any of the policy options outlined above be designed in a way that stimulates investment in innovation, including pilots and demonstrators for less mature technologies?

8. How could government best contribute to establishing optimum market conditions for GGRs to be developed and deployed at a large scale?

9. How might the role of government change over time to bring GGR technologies to market and encourage their deployment up to 2050?

10. Which factors should be considered when assessing the suitability of different policy options for businesses?

11. Are there any existing business models in other sectors – such as power, industry, transport or land use – that could complement new schemes to incentivise GGRs?

12. Are price instruments or quantity instruments likely to be more effective in encouraging and sustaining deployment of GGRs? Or will a combination be required?

13. How far should a policy framework aspire to be technology-neutral between different GGR options?

14. Could wider support for GGRs have any unintended effects on the development and commercialisation of technologies in other sectors, and how could this be mitigated?

15. Are there any international examples that have proved effective at incentivising GGRs? Why were they effective, and are there any barriers to taking similar action in the UK? Are there examples of international approaches that have not worked well?

16. Should the government introduce a tax credit, and if so, how should this be designed? Should it be provided only for specific GGR technologies or a broad range of methods? Would multiple, specific rates be effective at incentivising as much investment as possible?

17. Should participants from specific sectors with historical carbon emissions be eligible to apply for the credit or should the credit be economy-wide?

18. If the government were to introduce a GGR obligation scheme, which businesses and emitting sectors could this cover? How could such a scheme be designed to minimise competitiveness impacts and regressive passed-through costs (e.g. to consumers and bill-payers)?

19. What other regulatory approaches could government explore to incentivise GGR deployment?

20. What are the merits and risks of introducing payment schemes for GGRs, potentially involving up-front grants or payments for each tonne of $CO_2$ stored? Which GGRs would be suitable for a payment scheme?

21. Could a contract scheme be effective in incentivising GGRs such as DACCS and BECCS? What would be the main challenges and limitations of such a mechanism, and how could it be designed to maximise its effectiveness?

22. What could a cap and trade scheme for negative emissions look like, and which sectors would you propose to be included in such a market?

23. The costs of different GGR technologies vary significantly. How could a cap and trade system address these differences? How could a cap and trade system be used to incentivise initial investment in any future emerging GGR technologies over a long-term trajectory?

24. What role can government play in encouraging more companies to make voluntary commitments to invest in GGR technologies in the UK? To what extent can this support innovation in, and deployment of, these technologies?

25. What are your views on the government's intention to coordinate deployment of GGR technologies such as DACCS and BECCS in line with our stated CCUS ambitions, and how could we best do this?

26. What principles would you wish to see in any accreditation scheme for negative emissions? How should the government regulate this? Any evidence relating to best practice of existing negative emissions MRV is welcomed.

27. What are the most significant barriers to developing a robust monitoring, reporting and verification system for GGRs?

# Next steps

This call for evidence will close on 26 February 2021. We are committed to ongoing dialogue with stakeholders as we review responses to this call for evidence and develop our policy thinking in this area. We will publish a response and set out our next steps in due course.

This consultation is available from: https://www.gov.uk/government/consultations/greenhouse-gas-removals-call-for-evidence

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