Department for
Energy Security
& Net Zero

Engineered Greenhouse Gas Removals

Government response to the consultation on a GGR Business Model

June 2023

© Crown copyright 2023

This publication is licensed under the terms of the Open Government Licence v3.0 except where otherwise stated. To view this licence, visit nationalarchives.gov.uk/doc/open-government-licence/version/3 or write to the Information Policy Team, The National Archives, Kew, London TW9 4DU, or email: psi@nationalarchives.gsi.gov.uk.

Where we have identified any third-party copyright information you will need to obtain permission from the copyright holders concerned.

Any enquiries regarding this publication should be sent to us at: GGR.BusinessModels@beis.gov.uk

General Information

Confidentiality and Data Protection

Information that has been provided in response to this consultation, including personal information, may be subject to publication or disclosure in accordance with UK legislation (primarily the Freedom of Information Act 2000, the Data Protection Act 2018 and the Environmental Information Regulations 2004).

If we receive a request for disclosure of the information, we will take full account of requests for confidentiality and the explanations behind this, but we cannot give an assurance that confidentiality can be maintained in all circumstances. An automatic confidentiality disclaimer generated by an IT system will not, of itself, be regarded by us as a confidentiality request.

Quality Assurance

This consultation has been carried out in accordance with the Government's Consultation Principles.

If you have any complaints about the consultation process (as opposed to comments about the issues which are the subject of the consultation) please address them to:

Email: beis.bru@beis.gov.uk

Disclaimer

The policy positions contained in this consultation response remain subject to further development by the government and do not represent final positions. We intend to develop positions further with relevant regulatory bodies, the devolved administrations, industry and other interested stakeholders. Policy positions are subject to Parliamentary approval of any necessary legislation, and completion of necessary contractual documentation. The proposals, as set out in this consultation response, do not therefore constitute an offer by government and do not create a basis for any form of expectation or reliance. We reserve the right to review and amend all proposals set out within the document, in particular to ensure that proposals provide value for money and are consistent with the current subsidy control regime.

Contents

Executive Summary

Engineered greenhouse gas removal (GGR) technologies will play a vital role in tackling climate change and achieving the UK's net zero target. Most climate models show that billions of tonnes of annual CO_2 removal are likely to be needed globally by 2050, and the Intergovernmental Panel on Climate Change (IPCC) has described GGRs as "unavoidable" to limit global warming to no more than 1.5˚C.[1]

Globally, the engineered GGR sector is small but rapidly expanding. Over the last two years there has been accelerated action from governments to spur investment in cutting-edge GGR technologies that can deliver permanent and verifiable removal of carbon from the atmosphere – such as Direct Air Carbon Capture and Storage (DACCS) and Bioenergy with Carbon Capture and Storage (BECCS) – while corporate-led initiatives have also emerged to generate supply and help the sector to scale up.

As highlighted by the Independent Review of Net Zero[2] and the National Infrastructure Commission[3], the GGR sector presents major economic opportunities for the UK. We intend to capitalise on the potential benefits of this emerging sector to deliver new export opportunities and support tens of thousands of high-quality green jobs across the country. To this end, the Net Zero Strategy[4] established the government's intention to develop markets and incentives for GGRs, with a world-leading ambition to deploy at least 5MtCO_2 of removals annually by 2030, scaling up to around 23MtCO_2 by 2035. This builds on our pioneering GGR research and innovation portfolio, supported by up to £100 million of government funding.

Achieving large-scale commercial deployment will require policy support to overcome current barriers to investment, including high capital requirements and revenue uncertainty linked to the absence of a reliable market for negative emissions. In July 2022, the government therefore published an early-stage consultation on the design of a business model to unlock private investment in a portfolio of GGR technologies.[5] It proposed the introduction of a contractual business model, subject to affordability and value for money, to provide revenue support for first-of-a-kind GGR projects in order to reduce exposure to market uncertainty and provide investors with greater confidence around return on investment.

We have now analysed all stakeholder feedback to the consultation. This government response summarises the information and views provided by stakeholders and outlines our latest position on the GGR business model and related policy issues.

We welcome the strong support for a GGR business model to provide revenue support for negative emissions. This government response confirms our intention to proceed with the development of a GGR business model, subject to affordability and value for money, based on a contract for difference structure where the subsidy is determined by the difference between a 'strike price' reflecting the cost of producing negative emissions and a 'reference price' reflecting the market value.[i]

We consider a Negative Emissions Contract for Difference (CfD) model to be the most effective approach to deliver our policy objectives. It would provide familiarity to investors given

[i] We will outline our proposals on setting the reference price in due course, following further engagement with stakeholders. The complexities of establishing a reference price in the absence of a transparent price index for negative emissions are discussed in the 'Government Response and Next Steps' section of this document.

the use of similar frameworks in other low-carbon sectors, maximise value for money, and allow an efficient transition to a market-led framework and reduced government support over time. As a bespoke business model for an emerging sector, further work is required to determine the detailed design of the policy and ensure it meets the needs of project developers, investors and the government. Building on our initial analysis of the consultation responses, we will continue to develop the business model design with input from stakeholders, including through the GGR Business Model Expert Group, with a view to setting out our preferred positions on the core design features later this year, including the reference price. In doing so, we will consider precedents in existing government policy and will align our approach with other business models where appropriate, including the power BECCS business model.

A GGR business model will be necessary but not sufficient to make the UK a global hub for GGRs. It will also require a suite of complementary measures including access to CO_2 transport and storage networks and interventions to stimulate the market for engineered removals, underpinned by rigorous standards for monitoring, reporting and verification (MRV).

As announced in the Net Zero Growth Plan[6], the government is minded to enable engineered GGR projects to apply for Track-1 Expansion and Track-2 of the Carbon Capture, Usage and Storage (CCUS) Programme, subject to criteria under development. One of our objectives for Track-2 of the CCUS Programme is to select two new CO_2 clusters that together have the potential to store at least 10Mt/year of CO_2 by 2030 through a range of carbon capture projects.

Stakeholder feedback to the consultation has reinforced the importance of building an enduring market for negative emissions. The government will work with the UK ETS Authority to consider options for integrating GGRs into the UK Emissions Trading Scheme (ETS) subject to the outcomes of last year's 'Developing the UK ETS' consultation[7], a robust MRV regime being in place, and the management of wider market impacts. Further detail will be provided in the Government Response to the ETS consultation, to be published later this year. We also recognise that high-integrity Voluntary Carbon Markets, as well as international carbon trading under Article 6 of the Paris Agreement, could play a valuable role in mobilising private finance in GGR projects. We therefore intend to design the GGR business model in a way that can harness the potential benefits of these markets, alongside potential integration with the UK ETS.

The importance of credible, government-approved MRV standards was a consistent theme among consultation respondents. Alongside the business model, we recognise the need to develop an approach to MRV that provides confidence that GGR projects deliver verifiable climate benefits based on a full lifecycle assessment. This response confirms the criteria we will use for defining a 'negative emission' and sets out the principles that will guide the development of our MRV framework. Building on responses to the consultation, our MRV proposals will be informed by an independent review of the existing landscape of standards being conducted by E4Tech and Element Energy.

In an increasingly competitive global landscape, the UK remains well-positioned to take an early leadership role in this sector. We will continue to work closely with stakeholders to develop our policy proposals over the coming months.

Introduction

Background

In July 2022, the Department for Energy Security and Net Zero (DESNZ) – then the Department for Business, Energy, and Industrial Strategy (BEIS) – published a consultation on a proposed Greenhouse Gas Removals (GGR) business model to overcome key barriers to deploying engineered GGR technologies in the UK.[5]

The Net Zero Strategy[4] had committed to deploying GGRs at scale from the late 2020s, with an ambition to deliver at least 5MtCO_2/year of engineered removals by 2030. It confirmed that our long-term ambition is to deliver a competitive and self-sustaining market for GGRs. However, while negative emissions markets are at an early stage of maturity, we recognise that innovative GGR projects are likely to require revenue support to bridge the gap between market revenues and the cost of producing negative emissions.

Therefore, the purpose of the consultation was to seek views on the design of a business model to unlock private investment and enable GGR projects to deploy at scale from the late 2020s. The primary intent of the business model is to provide ongoing revenue support for negative emissions in order to mitigate exposure to low and volatile market prices and create an investable proposition for technology developers and investors.

The consultation contained 24 questions across five sections. We invited views from stakeholders on the following:

- our intention to introduce a contract-based business model to enable deployment of a wide portfolio of GGR technologies, subject to affordability and value for money
- three options for the contract structure and other primary design features of the business model
- potential market frameworks for negative emissions in order to channel private finance into GGR projects
- our approach to the monitoring, reporting and verification of negative emissions to ensure that projects deliver permanent, verifiable and sustainable removals of greenhouse gas from the atmosphere
- the applicability of a GGR business model to specific technologies and possible interactions with other government support schemes.

This followed the ‘Developing the UK ETS’ consultation[7], published in March 2022, which included a call for evidence on the role of the UK Emissions Trading Scheme (UK ETS) as a potential long-term market for GGR technologies. This invited evidence on the potential benefits of inclusion of GGRs in the UK ETS; the key considerations for policy design; the range of associated market participation criteria; and different ways of integrating and phasing GGRs into the market over time. As outlined in the Net Zero Growth Plan[6], the government will

work with the UK ETS Authority to consider options for integrating GGRs in the UK ETS subject to the outcomes of the consultation, a robust MRV regime being in place, and the management of wider impacts. Further detail will be provided in the Government Response to the ETS consultation, which will be published later this year.

In August 2022, the government consulted separately on the design of a business model for first of a kind (FOAK) power BECCS projects[8], which could play a valuable role in delivering negative emissions whilst providing security in our energy mix. The government's response to the power BECCS business model consultation[9] was published in March 2023, setting out our latest position on the design of the business model. Stakeholders with a specific interest in power BECCS are advised to review the power BECCS response alongside this document, as this response contains relevant considerations in relation to negative emissions markets and MRV.

Overview of consultation responses

The GGR business model consultation ran from 5th July until 27th September 2022. We held a public webinar to discuss the consultation on 10th August, which was attended by a range of interested parties across industry and academia.

We received 66 responses to the consultation through the Citizen Space online response tool and by email. Consultation responses were received from a wide range of stakeholders including from project developers, trade associations, non-governmental organisations (NGOs), academia, local authorities, devolved governments, standards bodies, members of the public, and prospective buyers of future GGR credits. We are grateful to all individuals and organisations who took the time to respond.

Stakeholders expressed a broad range of views and opinions, and the final section of this document provides a detailed summary of responses to each question. A number of common themes and recommendations for government emerged, as described below:

- The **vast majority of respondents supported the government's proposal to develop a contract-based business model** to address key barriers to investment and enable GGR projects to deploy at scale in the UK.
- A Negative Emissions **Contract for Difference (CfD) was the most widely supported contract mechanism** given the use of similar frameworks across low-carbon technologies and its familiarity to the market, developers, and investors. A number of respondents believed a Negative Emissions Payment (NEP) could be effective in supporting early projects before transitioning into a CfD structure.
- There was a strong consensus that the GGR business model **should support a diverse range of GGR technologies** that can deliver highly-durable and verifiable carbon removal – including Direct Air Carbon Capture and Storage (DACCS), Direct Ocean Capture, and BECCS technologies that are not eligible for other business model support (e.g. the Waste Industrial Carbon Capture or power BECCS business models).

It was argued that this would facilitate a more flexible and competitive market in the future and stimulate innovation across the sector.

- The majority of stakeholders that responded to the MRV section agreed that the GGR business model should be underpinned by **government-approved monitoring, reporting and verification (MRV) standards and guidelines on storage permanence**. This was considered to be essential to build confidence in the integrity of GGR projects and facilitate the growth of the negative emissions market.
- There was **widespread support for the introduction of a compliance market** for negative emissions, such as the inclusion of GGRs in the UK ETS. Many industry respondents also believed that **voluntary carbon markets could play a valuable role** in the near-term as an immediate route to market, though concerns around quality and integrity were raised. There was broad support for government intervention to drive voluntary demand for removals by instilling confidence and credibility in the market, with a particular focus on standards.
- To provide certainty to project developers and investors, the government was urged to **clarify the eligibility criteria of the business model and the timing of allocation windows** as soon as possible.
- Several respondents **highlighted international developments in GGR policy since the consultation was published**, with a number of countries and regions developing incentives and regulatory framework to accelerate the development and roll-out of GGR projects. They called for the government to deliver the business model at pace in order to maintain international competitiveness.

Since the consultation closed, DESNZ has continued to work with key stakeholders and interested parties to support the development of government policy. This included the launch of a new GGR Business Model Expert Group, bringing together a broad range of project developers, trade associations and academics to advise on the design of the business model. The first meeting was held on 30th January 2023, which focused on design challenges associated with the three shortlisted contract mechanisms set out in the consultation. This response takes into account insights from the Expert Group and wider stakeholder engagement that has taken place since the consultation was published.

DESNZ will continue to work with the relevant devolved administrations to ensure that the proposed policies take account of devolved responsibilities and policies across the UK to facilitate successful deployment.

Structure of the document

The remainder of this document is structured in two sections.

The ‘Government Response and Next Steps’ section outlines the government’s latest position on the GGR business model, by theme, in response to the views provided by stakeholders. It describes our current proposals for the design of the business model and supporting policy related to negative emissions markets, MRV, technology scope and deployment timelines. It

also identifies areas for further work on issues where the government does not set out a policy position. We understand the need for clarity on a range of elements and will continue to develop the business model design with input from stakeholders, including through the GGR Business Model Expert Group.

The 'Summary of responses to the consultation' summarises the information and views provided in response to each question in the consultation. The stakeholder views described in this section have been summarised without any commentary from the government and therefore should not be interpreted as government policy.

Terminology

This government response uses the term 'greenhouse gas removal' (GGR) to refer to the removal of greenhouse gases from the atmosphere. In doing so, it acknowledges the potential development of technologies that capture and store greenhouse gases other than carbon dioxide (CO_2), such as methane, nitrous oxide and F-gases. We consider this term to be preferable to 'carbon dioxide removal (CDR)', which is often used in the international context. However, we recognise that CO_2 is the primary greenhouse gas emitted through human activities and that CO_2 removal is currently the most mature greenhouse gas removal option. This document therefore often refers to 'carbon' and 'CO_2', but we remain mindful of options focused on other greenhouse gases and will keep these under review.

Request for Information

Alongside this document, we are issuing a Request for Information from GGR projects that may wish to apply for revenue support through the GGR Business Model in future.

Technology developers are invited to provide information about their projects and deployment plans using the form provided. The information provided within this form will help the government to understand the range and scale of GGR projects with an interest in applying for the business model and ensure we have the most up-to-date evidence on the project pipeline.

All technology types are invited to respond to the Request for Information. This includes both CCUS-enabled projects and non-CCUS projects.

The Request for Information is entirely voluntary. Any information provided does not constitute an application for business model support and does not create a basis for any form of expectation or reliance. Information on the allocation process and eligibility criteria for the GGR Business Model will be published in due course. Full guidance can be found in the form provided.

The deadline to respond to this Request for Information is 17:00 p.m. on 1st August 2023.

Government Response and Next Steps

GGRs in the net zero economy

This section relates to Question 1 of the consultation

There is scientific consensus that greenhouse gas removals (GGRs) are essential for limiting the effects of climate change and meeting the goals of the Paris Agreement. In 2022, the Intergovernmental Panel on Climate Change (IPCC) described GGRs as 'unavoidable' for counterbalancing residual emissions from hard-to-abate sectors that are unlikely to achieve full decarbonisation by 2050.[1]

Nature-based methods such as afforestation, habitat restoration and soil sequestration will be essential to remove and store carbon dioxide at scale while delivering a range of additional co-benefits such as biodiversity gain, air quality and soil health. However, due to factors such as land constraints and timescales for sequestration, the evidence is clear that nature-based solutions must be deployed alongside engineered GGRs such as Direct Air Carbon Capture and Storage (DACCS) and Bioenergy with Carbon Capture and Storage (BECCS) to remove CO_2 at the speed and scale needed to meet our climate targets. The global engineered GGR sector is currently small and forms less than 0.1% of all GGR activities worldwide. To meet the Paris temperature goal, the sector needs to scale up rapidly, in some global scenarios by up to a factor of 540 by 2030 and 4900 by 2050.[10]

The potential size of this sector presents economic opportunities for the UK. GGRs could become a rapid growth area for green technology, with significant intellectual property and tens of thousands of jobs supported as the market size increases through to 2050. This substantial economic opportunity has been recognised by the National Infrastructure Commission[3], who have suggested that engineered GGRs could become "a major new infrastructure sector for the UK" worth billions of pounds per year by 2050 and that "securing even a small comparative advantage in a potentially large global market could lead to significant economic benefits for the UK". The Independent Review of Net Zero[2], led by the Rt. Hon. Chris Skidmore MP, also acknowledged that "with our world-class research institutions and technological and engineering expertise, the UK is well-placed to become a global leader in engineered GGRs."

The global policy landscape for GGRs has evolved since the consultation was published in July 2022. Governments around the world are taking ambitious action to incentivise investment in GGR technologies, including enhanced incentives for Direct Air Capture in the US Inflation Reduction Act and the European Commission's proposals for a new framework to certify high-quality carbon removals, as well as a wider package of funding to support low-carbon technologies and infrastructure. The UK welcomes increased ambition to accelerate the roll-out of clean technologies, and these developments are likely to spur the growth of a vibrant global market for engineered removals.

In this context of increased international ambition, the government remains committed to supporting the engineered GGR sector in the UK. In the Net Zero Strategy[4], we established a world-leading ambition to deploy at least 5MtCO_2/year of engineered removals by 2030, potentially scaling to 23MtCO_2/year by 2035 and 75-81MtCO_2/year by 2050. We are already investing up to £100m in research and innovation for GGRs, including through the Direct Air Capture and GGR Innovation Competition[11]. Phase 2 of the competition was announced in July 2022, with over £54m of government funding awarded across 15 of the most promising demonstration projects.

However, for progressing to large scale commercial deployment we recognise that there remain significant barriers to investment for first of a kind GGR projects. These include high capital requirements, the absence of a reliable market or revenue stream for negative emissions and access to carbon capture and storage (CCS) infrastructure.

Following strong support from stakeholders in the consultation, the government intends to proceed with the development of a GGR business model to provide revenue support for negative emissions, subject to affordability and value for money. The purpose of the business model is to unlock private investment by reducing exposure to market risks and providing investors and technology developers with greater certainty around return on investment. All projects supported by the business model will be required to comply with rigorous standards for monitoring, reporting and verification (MRV). We outline our next steps on MRV in this document.

We believe that the UK is well-positioned to take an early leadership role in this sector with our diverse innovation portfolio, pioneering green finance sector, and access to world-class engineering alongside abundant offshore geologic storage sites. Acting early to support the deployment of GGR technologies will be essential to delivering the UK's near-term climate goals, including the Sixth Carbon Budget (2033-37), as well as opening up new economic opportunities. This early experience of constructing and operating a range of GGR plants will also help to build domestic supply chains, realise technical improvements, and facilitate price discovery, providing the foundations for scaling up the sector through the 2030s and 2040s.

GGR policy principles

This section relates to Question 3 of the consultation

In section 1.3 of the consultation, the government laid out a set of 'guiding parameters' which summarised our overall strategic priorities for deploying GGRs in the UK. Building on this, section 2.2 of the document outlined proposed policy design principles that will be used to inform policy decisions specifically on the design of the business model.

We welcome the feedback we received from stakeholders, which demonstrated broad support for our policy design principles. Much of the stakeholder commentary focused on how the principles would be interpreted and applied in practice. A number of respondents considered

the interactions and potential trade-offs between the principles, while others proposed additional principles for the government to consider.

We note that the distinction between the guiding parameters (section 1.3) and policy design principles (section 2.2) was not well understood. We have therefore combined the two sets of principles, with minor revisions, into an integrated set of 'GGR policy principles' that will underpin our future policy framework and guide the next level of design on the GGR business model. The revised GGR policy principles are described below.

Principle	Description
Revenue Certainty	Policy should provide sufficient revenue certainty to unlock private sector investment. It should provide clear and strong policy signals to boost investor confidence and ensure that risks are allocated to the parties who are best placed to manage them.
Value for Money	Policy should deliver its objectives at the lowest cost to government and in a way which adheres to subsidy control rules, prevents double-subsidisation with other support schemes and avoids excessive returns for developers.
Simplicity	Policy can be implemented at pace in line with our GGR deployment ambitions and avoid unnecessary complexity and administration costs for both government and project developers.
Market Development	Policy should incentivise project developers to seek private buyers for credits and support the growth of a robust market for negative emissions, providing a clear pathway to reducing government support over time.
Technology Portfolio	Policy should support a diverse portfolio of high-quality GGR technologies to commercialise in order to advance the government's deployment ambitions; promote continued innovation, learning-by-doing and cost reductions; and foster a competitive market over time.
Climate Integrity	Policy should be underpinned by robust standards for monitoring, reporting and verification (MRV) to ensure GGR projects deliver verifiable and highly-durable removal of CO_2 from the atmosphere. Projects should adhere to high standards of sustainability and environmental protection.
Economic Benefits	Policy should position the UK as a global pioneer in the development and deployment of GGR technologies, providing green jobs and export opportunities to strengthen the low-carbon economy.
Reaching GGR Ambitions	Policy should enable GGR projects to deploy this decade, at the speed and scale required to support the delivery of the UK's Carbon Budgets and our ambition to deploy at least 5Mt/yr of engineered removals by 2030.

Principle	Description
Wider Decarbonisation	Policy should ensure that GGR projects are deployed to balance residual emissions from hard-to-decarbonise sectors, complementing efforts to reduce emissions across the economy. It should not create perverse outcomes or distortions in existing markets.

Design of the GGR Business Model

This section relates to Questions 4-14 of the consultation

We note the strong support from respondents for our intention to develop a contract-based business model to provide revenue support for negative emissions. Building on the stakeholder feedback we received, we have continued to examine the strengths and potential design challenges of the shortlisted contract mechanisms described in the consultation: a Negative Emissions Contract for Difference (CfD), Negative Emissions Payment (NEP), and Negative Emissions Guarantee (NEG).

We intend to proceed with the development of a Negative Emissions Contract for Difference (CfD), which we consider to be the most effective approach to deliver our policy objectives. This will provide revenue stability for project developers through a fixed ‘strike price’, with the government providing the difference between the strike price and a market ‘reference price’ which will be determined in due course.

As acknowledged in stakeholder responses to the consultation, a GGR business model based on a contract for difference structure would provide a number of advantages for project developers, investors and the government. The Contracts for Difference scheme for low-carbon electricity generation has a track record of accelerating investment and reducing costs of renewable technologies, and similar models are in development to support deployment of CCUS, power BECCS, and low-carbon hydrogen. Designing a bespoke business model for GGRs based on similar principles will help to increase investor confidence in the scheme, provide alignment with other low-carbon sectors, and improve efficiency in policy design by allowing the government to draw on precedents set in other support schemes, while retaining the flexibility to diverge from existing models where we consider it best to meet our objectives for GGRs. Furthermore, the use of a market reference price will maximise value for money, ensure the provision of revenue support based on need, and allow an efficient transition to a market-led framework and reduced government support over time.

We have considered the feedback we received on the other shortlisted contract mechanisms, with some stakeholders identifying a Negative Emissions Payment or a Negative Emissions Guarantee as their preferred option. However, we do not believe these options would offer the most effective means of achieving our deployment objectives as described in the policy principles above.

A number of respondents highlighted the potential value of a simplified Negative Emissions Payment to support early projects until the GGR sector has reached a state of maturity. In order for such a policy to deliver on our policy principles, it would need to be combined with measures to promote market participation and ensure that the costs of the scheme are not

borne solely by the government. As proposed in the consultation, this may take the form of a gainshare mechanism whereby a portion of market revenues from credit sales are repaid to the government to recover the costs of the initial payment.

An effective gainshare mechanism would require contractual arrangements and clauses relating to eligible market participation, reporting of sales price, and provisions to avoid poor value for money outcomes. This is likely to negate the overall simplicity of a Negative Emissions Payment and effectively create a mechanism akin to a Contract for Difference. Our view is that a Contract for Difference would provide a more streamlined payment mechanism, ensuring that government expenditure occurs only where necessary to close the gap between market revenues and the cost of producing negative emissions. Nevertheless, we recognise the importance of minimising the complexity of the policy while ensuring that it delivers on our policy principles. As we progress work on the detailed design of the business model, we will consider any adaptations that may be required to ease implementation and account for the particular characteristics of FOAK GGR projects and the negative emissions market.

There was limited support among stakeholders for introducing a Negative Emissions Guarantee, and we believe that this mechanism would be the most complex to implement and the least likely to achieve our policy objectives. There are a number of uncertainties and drawbacks to such a mechanism – most notably, the risk that introducing an option to sell credits to the government at a guaranteed price could diminish the incentive for project developers to participate in the market, inflate market prices by creating an artificial price floor, and lead to poor value for money outcomes. This is because there is little incentive for project developers to sell on the market below the guaranteed price.

In designing a Negative Emissions Guarantee, a key challenge would be setting the guaranteed price at a level that is sufficient to deliver negative emissions production but still incentivises projects to participate in the market rather than relying on the guaranteed price from government. In the absence of a clear solution to this trade-off, we believe that a Guarantee scheme which provides the required level of investor certainty would carry an inherent risk of excessive reliance on government support at the expense of market growth. Purchasing credits from developers would also create a very active role for government in the market, which is considered to be undesirable compared to a CfD model where role of government is limited to providing a top-up on the market price. For these reasons, we are minded not to pursue a Negative Emissions Guarantee.

When progressing work on a Negative Emissions CfD, we are mindful of the specific challenges in the GGR sector that will need to be considered in policy design. In particular, we recognise the challenge of setting a reference price in the absence of a transparent and stable market price for negative emissions. Stakeholders have put forward a variety of possible options for setting the reference price, such as using the achieved sales price on voluntary carbon markets or the UK ETS carbon price if projects are permitted to sell negative emissions credits in that market during the contract term. We are considering these options carefully and will continue to work closely with interested parties, including through the GGR Business Model Expert Group, to develop effective proposals that align with our long-term vision for negative emissions markets.

The consultation responses have provided a rich evidence base to support policymaking on other important features of the business model – including contract length, treatment of CO_2

transport and storage (T&S) fees, cross-chain risks posed by interactions with the T&S Network, demand-side volume risk, and strike price indexation (e.g. for variable opex costs).

We understand that project developers require clarity on these crucial design elements. Building on our initial analysis of the consultation responses, we will continue to develop the business model design with input from stakeholders, including through the GGR Business Model Expert Group, with a view to setting out our preferred positions later this year. In doing so, we will consider precedents in existing government policy and will align our approach with other business models where appropriate, including the power BECCS business model. Final decisions will be subject to affordability and value for money considerations.

Finally, the government welcomes stakeholder feedback on the potential role of capital support instruments, such as low-interest loans or loan guarantees. We share the view, expressed by many respondents, that revenue support through the GGR business model is the primary measure for bringing forward projects, and the strike price should be set appropriately to account for capital and finance costs. However, we recognise there are circumstances in which capital support instruments can further support commercial viability, particularly for FOAK commercial deployment. This could include a potential role for the UK Infrastructure Bank to help reduce the cost of capital and increase investor confidence. The Bank is monitoring investment opportunities in the GGR sector as policy frameworks are developed. It can invest across the capital structure, including senior debt, mezzanine, debt guarantees and equity. Where possible, it does so on terms in line with other sources of finance; however, it can go further by:

- taking on risks that other investors are unwilling – or not yet willing – to take, if that, for example, encourages the development of markets; and
- offering concessional terms, including on price and tenor, where that is necessary and subject to subsidy control obligations.

Any projects which the Bank finances must meet the investment principles set in its Strategic Plan[12]. The government will continue to work with the UK Infrastructure Bank and other financial institutions to explore how capital support instruments could mitigate project risks and support deployment.

Developing the negative emissions market

This section relates to Questions 15-18 of the consultation

Building an enduring negative emissions market is a central pillar of the UK's GGR strategy. As indicated in the Net Zero Strategy, our ambition is to achieve a competitive market which is able to sustain GGR deployment without government support. A market approach will ensure that the cost of GGRs is ultimately borne by sectors that require carbon removals in order to balance their remaining emissions (e.g. aviation). It will also encourage competition between projects, helping to deliver benefits in terms of reduced costs and improved performance.

Negative emissions are not currently recognised in compliance markets in the UK, and rules for international carbon trading under Article 6 of the Paris Agreement remain under development. Voluntary carbon removal markets are also at an early stage of maturity. In the near-term, markets alone are unlikely to be sufficient to sustain capital-intensive GGR projects

at scale, and there will be a role for the government in providing support for early projects to de-risk investment decisions and provide revenue certainty for technology developers. However, this should provide the minimum necessary support, and we are taking early action to develop negative emissions markets in order to catalyse private demand for carbon removal credits and support our longer-term ambition of a self-sustaining market.

The consultation explored potential market frameworks for negative emissions, inviting views from stakeholders on the role of compliance markets and voluntary markets in supporting early GGR projects. This built on the 'Developing the UK ETS' consultation[7], published in March 2022, which explored the potential role of the UK ETS as a long-term market for GGR technologies.

There was strong support for the creation of a compliance market for GGRs among respondents to the GGR business model consultation, with many favouring the inclusion of negative emissions in the UK ETS. As stated in the Net Zero Growth Plan[6], we recognise that the integrity offered by the UK ETS could unlock investment at scale in the UK's GGR sector by providing an integrated market where businesses can make economically efficient choices on how to decarbonise or remove their emissions. We will work with the UK ETS Authority to consider options for integrating GGRs in the UK ETS, subject to the outcomes of last year's UK ETS consultation, a robust MRV regime being in place, and the management of wider impacts. Further detail will be provided in the Government Response to the ETS consultation, which will be published later this year.

While respondents generally supported the creation of a compliance market for negative emissions, many also expressed the view that voluntary carbon markets offer a clear and immediate route to market and have the potential to play a valuable role in supporting early GGR projects. However, concerns were raised around the variable quality or 'integrity' of carbon credits currently sold in voluntary markets and the potential for greenwashing. To fully harness the potential benefits of voluntary carbon markets as a source of demand for negative emissions, there was a widely-held view that government intervention is required to improve transparency and integrity in the market, with a particular focus on MRV standards (see section below on Monitoring, Reporting and Verification) and clear guidance on the role GGR credits should be permitted to play in net zero transition plans.

It is clear from recent market activity that we are witnessing a rapid growth in voluntary demand for carbon credits that offer highly-durable carbon removal. A number of corporate initiatives have emerged to generate GGR supply. This is exemplified by the 'Frontier' advance market commitment[13], led by Stripe and other companies that have committed to buying over $1 billion of permanent carbon removal by 2030. Companies such as Microsoft[14], Swiss Re[15] and JPMorgan Chase[16] have signed long-term purchase agreements from Direct Air Capture and other GGR projects to remove thousands of tonnes of CO_2 from the atmosphere, while many other companies have identified engineered removals as an important part of their climate strategies. Furthermore, current evidence suggests that demand for GGR credits is not constrained to those generated in the buyer's host country.

The government believes that high-integrity voluntary carbon markets could play a valuable role in supporting early GGR projects in the UK. Allowing GGR projects to access these markets could mobilise significant levels of private finance, support the growth of international carbon removal markets that are currently supply-constrained, and significantly reduce support costs to government. We therefore intend to design the GGR business model in a way that can

maximise the potential benefits of voluntary carbon markets (VCMs), alongside potential integration with the UK ETS.

However, to unlock the potential of high-integrity VCMs to contribute to our policy ambitions for GGRs, we recognise that ongoing concerns around market integrity need to be addressed. This will be vital to create confidence that GGR projects deliver high-quality carbon removals that are verifiable, permanent and additional. As announced in the update to the Green Finance Strategy[17], the government will consult later this year on specific steps and interventions needed to develop high-integrity VCMs and protect against the risk of greenwashing. This will build on the work of key international initiatives to develop guidance for best practice – such as the Integrity Council for the Voluntary Carbon Market (IC-VCM)[18] and the Voluntary Carbon Markets Integrity Initiative (VCMI)[19] – and consider how their findings should be applied in the context of the UK market and regulatory regime. In developing consultation proposals, the government will consider the role of VCMs in mobilising finance for GGR projects receiving business model support. The Transition Plan Taskforce[20], launched by the government to develop guidance for gold standard private sector transition plans, will also provide clarity on the use of high-integrity VCMs within its framework. The Taskforce is expected to publish its Disclosure Framework and Implementation Guidance for transition plans in the summer 2023.

As we progress work on the design of the business model, the government will set out further detail on the future market framework for negative emissions. This will clarify how both voluntary markets and compliance markets like the UK ETS will play a role in supporting the deployment of engineered GGRs in the UK.

Technology scope and allocation

This section relates to Question 2 and Questions 22-24 of the consultation

The CCUS cluster sequencing process will play a key role in supporting the deployment of GGR projects. Later this year, we will launch a process to enable further expansion of the Track-1 clusters, beyond initial deployment. This will select additional projects to connect into the HyNet and East Coast Clusters – including the Humber – and their associated stores as they become viable, to be operational by 2030.

In addition, the government has launched Track-2 of the CCUS sequencing process[21]. One of our objectives for Track-2 is to select two new CO_2 clusters that together have the potential to store at least 10Mt/year of CO_2 by 2030 through a range of carbon capture projects. As announced in the Net Zero Growth Plan, the government is minded to enable engineered GGR projects to apply for Track-1 Expansion and Track-2 of the CCUS Programme, subject to criteria under development.

Our policy framework will aim to support a mix of GGR technologies to achieve commercialisation. We believe this will be essential to reduce reliance on any single technology, allow innovative and highly-scalable solutions to demonstrate cost reductions, and spur the growth of a resilient market that can support decarbonisation at the lowest cost to business while maximising the benefits to the UK economy. These ambitions are supported by

the suite of business models we are developing to accelerate GGR deployment, including the GGR business model, power BECCS business model, and ICC and Waste ICC business models.

We acknowledge that stakeholders require clarity on the technology scope of the GGR business model and eligibility criteria to go on to apply for the CCUS clusters, and we will set out further details later this year. When developing our policy on technology scope and eligibility criteria, we will consider a range of factors such as technology maturity, removal volume, scalability, existing business model provision, affordability, system requirements for CO_2 transport and storage infrastructure, wider impacts on specific sectors, and where the UK may have competitive strengths. The views received through the consultation will help to inform our position.

Furthermore, we recognise that there are a variety of potential GGR approaches that do not require offshore geological storage. There is a growing international focus on methods such as mineralisation, biochar and enhanced weathering, and the consultation responses indicated a high level of interest in their development among stakeholders in the UK. These approaches could enable the deployment of GGR projects with highly-durable carbon storage outside of the CCUS clusters. However, further work is needed to understand the feasibility of deploying large-scale non-CCUS GGR approaches in the UK – including a robust evidence base on storage permanence and reversibility, MRV challenges, regulatory barriers, and wider environmental impacts.

Based on a recent evidence review and engagement with academic partners, the government has developed a taxonomy of alternative CO_2 storage options for GGR technologies that do not require CCUS, which is intended to provide a basis for further policy development (Table 1). The taxonomy summarises our current understanding of the durability and reversal risk of non-CCUS carbon stores, and our early-stage view of wider risks, limitations and evidence gaps that will need to be considered before any decision can be made on their potential inclusion in the GGR business model.

The taxonomy focuses exclusively on engineering-based GGR processes and does not include nature-based solutions (e.g. afforestation, habitat restoration and organic soil carbon sequestration), biological approaches to enhancing coastal ‘blue carbon’ ecosystems (e.g. mangroves, tidal salt marshes, and seagrass meadows), or the use of wood in construction. The government will continue to support nature-based solutions which sequester carbon through other policy frameworks.

Table 1: Alternative CO_2 storage options for non-CCUS projects

Type of Storage	Description	Durability and reversal risk	Risks, limitations and evidence gaps
Mineral storage in carbonated building materials	CO_2 reacts with alkaline minerals to form a stable mineral carbonate which can be sequestered in long-lived building materials (e.g. concrete). Mineralisation may occur in engineered reactors using a concentrated CO_2 source (e.g. from a Direct Air Capture plant) or under ambient conditions.	>1000 years Low risk of reversal. Mineralisation produces stable carbonates that are not released at the end of the product's life, except through very exceptional and deliberate circumstances (e.g. extreme acid conditions and calcination).	• High energy requirements will impact the carbon balance and volume of negative emissions produced. • Building regulations and industry practices may limit uptake.
Mineral storage on land via enhanced weathering	Ambient CO_2 reacts with alkaline minerals that have been finely ground and dispersed on the land in order to speed up the natural weathering process.	>1000 years Low risk of reversal. Mineralisation produces stable bicarbonates and/or carbonates. However, potential decades-long (or longer) delay between deployment and carbon removal, and the fate of carbon from minerals spread on land is uncertain.	• Efficacy of CO_2 capture is uncertain and evidence from field studies is required. • GHG removal is more difficult to monitor, report and verify compared to contained processes where the amount of mineralized CO_2 can be measured. • Availability of large supply of reactive silicate rock and high energy requirements for rock extraction, grinding and transportation. • Potential environmental impacts of small rock particles and trace elements. • Spreading waste material on land requires an environmental permit.
Subsurface mineral storage in mafic formations	CO_2 reacts when injected into mafic rock formations underground (e.g. basalt or peridotite) and converts to a stable mineral carbonate.	>1000 years Very low risk of reversal. In situ carbonation does not carry a risk of CO_2 leakage.	• Dependent on reservoir geology and geochemistry – availability of suitable reservoirs requires further testing in the UK • Public perception risks of onshore underground storage, although offshore storage is also possible.
Mineral storage in oceans or seawater	CO_2 is stored in oceans as mineral carbonate or dissolved inorganic carbon. This may occur as a result of electrochemical processes, the addition of alkaline minerals to alter seawater pH, and the run-off of stable carbonates (e.g. from enhanced weathering) from land into rivers and oceans.	>1000 years Low risk of reversal. Carbon stored in the ocean is stable as long as alkalinity remains high. However, pH changes can reverse the CO_2 uptake.	• Environmental risks and the impact of enhanced alkalinity on local ecosystems need to be better understood. • London Convention and Protocol controls addition of material to the ocean. This may constrain addition of alkaline materials for GGR purposes. • Direct measurement of CO_2 uptake by the ocean in response to alkalinity addition would be challenging. Long term monitoring of the dissolved inorganic carbon pool needs further research. • The possibility of partial reversal by mineral precipitation would require evaluation and may need to be monitored, particularly close to sites of alkaline addition.

Type of Storage	Description	Durability and reversal risk	Risks, limitations and evidence gaps
Biochar in infrastructure	Biochar, from pyrolysis of biomass, is incorporated into long-lived construction and infrastructure materials e.g. in buildings, roads, pavements and other structural applications.	>100s years to 1000s years Reversal risk is low as biochar is less exposed to degradation. When incorporated into building materials, the biochar is protected against biological and chemical decay. This ensures long-term durability and reversal is considered very low risk.	• Permanence depends on the fate of products over time. • Effectiveness as a greenhouse gas removal technique depends on use-specific lifecycle analysis. • Availability of sustainable biomass at sufficient scale and competition with other uses • Building regulations and regulations on use of waste.
Biochar as a soil additive	Biochar is applied to soils to improve soil health while providing a long-term carbon store in the soil.	Degrades over decades to thousands of years, with some carbon potentially stored on geological timescales. The persistent aromatic carbon (PAC) pool may persist for more than 1,000 years independent of the soil type and climate The semi-persistent carbon (SPC) may reside in soils for 50 to 100 years depending on soil type and climate.	• Uncertainty around environmental impacts (e.g. soil and water quality), crop yields, and storage permanence, being addressed through research and field trials. • Carbon stability varies as a function of the feedstock type, pyrolysis temperature, soil properties, and local climate conditions. • Availability of sustainable biomass at sufficient scale and competition with other uses • Floods, drought, and fire can result in reversal. • Energy requirements for pyrolysis will impact on the carbon balance and net negativity • Research needed to understand how biochar application may increase other GHGs (e.g. methane, N2O). • Difficult to monitor, since the changes in soil carbon stocks are small relative to the large background level. • Regulations on use of waste
Subsurface biomass burial	Solid biochar is buried in underground storage repositories. Alternatively, liquid bio-oil is injected in geological rock formations where it solidifies.	>1000 years Low risk of reversal. Degradation and leakage is highly unlikely except in extreme circumstances e.g. combustion.	• Availability of sustainable biomass at sufficient scale and competition with other uses • Dependent on availability of suitable reservoirs

A full list of sources is provided in the 'Endnotes' section at the end of the document.

Request for Information

Alongside this document, we are issuing a Request for Information from GGR projects that may wish to apply for revenue support through the GGR Business Model in future.

Technology developers are invited to provide information about their projects and deployment plans using the form provided. The information provided within this form will help the government to understand the range and scale of GGR projects with an interest in applying for the business model and ensure we have the most up-to-date evidence on the project pipeline.

All technology types are invited to respond to the Request for Information. This includes both CCUS-enabled projects and non-CCUS projects.

The Request for Information is entirely voluntary. Any information provided does not constitute an application for business model support and does not create a basis for any form of expectation or reliance. Information on the allocation process and eligibility criteria for the GGR Business Model will be published in due course. Full guidance can be found in the form provided.

The deadline to respond to this Request for Information is 17:00 p.m. on 1st August 2023.

Monitoring, Reporting and Verification

This section relates to Questions 19-21 of the consultation

Monitoring, reporting and verification (MRV) protocols will be essential to accurately quantify the amount of CO_2 removed from the atmosphere and permanently stored by GGR projects. The consultation outlined our view that science-led MRV standards will be critical to bolster confidence in the integrity of GGR projects, ensure government support is channelled to projects that deliver real climate benefits, and enable the growth of well-functioning and trusted negative emissions markets.

Among consultation respondents, the current lack of clearly-defined and standardised MRV guidelines was widely cited as a barrier to scaling up GGR technologies by eroding confidence among investors and credit buyers. We welcome the widespread agreement that the GGR business model should therefore be underpinned by rigorous, government-approved MRV standards and guidelines on storage permanence.

Whilst the majority of respondents believed that the government has an important role to play in developing a credible MRV framework for negative emissions, there were mixed views on the most effective way of achieving this. Stakeholders suggested a range of different options including:

- government endorsement or certification of third-party standards

- adoption of voluntary market standards in the short-term while government standards are developed over time
- government setting standards for MRV while relying on third-party bodies for the verification and certification function
- government endorsement of negative emissions from specific projects in order to influence future market developments

Given the range of stakeholder views, we will continue to consider the responses to the consultation as we develop our approach to MRV. To support this, we have developed a set of principles to guide decision-making specifically on the MRV framework for GGRs, drawing on stakeholder feedback, the wider GGR policy principles set out above, and existing principles for MRV the government has in other areas, such as those for the UK ETS. They are intended to provide clarity and reassurance on the key factors we will consider when developing our MRV framework.

Principle	Description
Accurate	The policy establishes robust methodologies that are scientifically precise and verifiable to measure greenhouse gas removals.
Consistent	The policy is aligned with international best practice and existing standards for engineered GGR technologies, such as those set by the UNFCCC.
Continuous improvement	The policy will adapt and evolve flexibly in response to new innovations and emerging scientific evidence.
Environmental Safeguards	The policy should adhere to the government's environmental safeguards and minimise the impacts and risks to our environment – air, land, and sea.
Simplicity	The policy can be implemented in line with our GGR deployment ambitions, avoid undue complexity, and minimise undue administrative burdens for market participants.
Parity	The policy should provide a coherent framework across the range of GGR technologies, whilst recognising the different needs and characteristics of these technologies, such as their different capture and storage processes.
Transparent	The policy establishes transparency in the methodologies used to calculate negative emissions across the range of GGR technologies. GGRs are quantifiable, are accurately and clearly reported, and independently verified.

Approach to MRV for initial GGR projects

As set out in the consultation, the government's immediate priority for MRV is to develop clear guidance for defining negative emissions and to strengthen our understanding of the current

landscape of standards for GGRs. We are pleased to note that there is significant support for this approach among stakeholders.

There was broad agreement with our proposal to review the existing landscape of MRV standards to determine which, if any, could underpin business model support for initial GGR projects. A robust evidence base on existing standards for GGRs will provide a sound basis for future policymaking, and we are mindful of the risk of unnecessarily complicating the market if the government intervenes without due regard for standards that are already operating or in development across the marketplace.

For that reason, we have commissioned E4Tech and Element Energy to conduct an independent review of MRV standards currently in use across the GGR sector. We expect this to be completed by Autumn 2023, and we will publish its findings. This will consider an extensive list of GGR standards and methodologies, building on the non-exhaustive list outlined in the consultation document, and assess them against a range of quality criteria. Respondents to the consultation confirmed the importance of including both international approaches and private sector action on GGR MRV, and the feedback we received is helping to inform the scope of the study.

Stakeholders also noted that MRV standards should be applicable across a broad range of GGR technologies and that this should be reflected in the review. The independent review of standards will conduct an objective assessment of the activities that should be part of the MRV framework for a range of engineered GGR technologies, including those within scope of the ICC, Waste ICC and power BECCS Business Models.

Criteria for negative emissions

For any GGR technology to deliver a ‘negative emission’, it must remove more greenhouse gases from the atmosphere than are generated from the carbon removal process. In the consultation, we emphasised the importance of a common understanding of what constitutes a high-quality ‘negative emission’ to inform our future work on MRV for GGRs, and identified a set of principles for determining the legitimacy of a negative emission that drew on the MRV Task and Finish Group’s report for BEIS.[22]

Most stakeholders expressed broad agreement with the principles for negative emissions legitimacy, though a number of minor modifications were proposed. Prominent suggestions included:

- expanding the CO_2 source definition to include seawater
- acknowledging the potential for highly-durable non-geologic carbon stores
- considering risk of reversal when assessing the ‘permanence’ of a carbon store
- removing reference to avoided emissions or utilisation in the definitions, to avoid the risk of confusion or misinterpretation

We welcome the views we have received from stakeholders and have revised our approach to defining negative emissions to reflect this feedback. Furthermore, we noted that the terminology used in the consultation – ‘principles for determining the legitimacy of a negative emission’ – was questioned by some stakeholders, who were unclear whether these were

principles or assessment criteria. We will henceforth refer to these principles as ‘criteria for robust negative emissions’.

Our revised criteria are set out below:

Criteria	Description
CO_2 source	CO_2 must be directly captured from the atmosphere or seawater (via biological, chemical or geochemical means).
Net Negativity	End-to-end CO_2 emissions must be lower than the total amount of stored carbon. For some technologies we propose that we would set requirements to limit the level of supply chain emissions, to ensure that GGR technologies achieve a minimum level of net negative emissions.
Permanence	Once captured by a project, carbon must be sequestered in a highly-durable store. The assessment of permanence should consider durability and ‘risk of reversal’ (likelihood of captured carbon being re-emitted into the atmosphere) associated with a carbon store. Utilisation of carbon in short-lived products, such as fuels and plastics, does not constitute a negative emission.

Where biomass is used in BECCS or biochar, as well as setting requirements to limit the level of supply chain emissions to ensure that the technologies achieve a minimum level of negative emissions, it will be expected that the biomass will meet strict sustainability criteria relating to land use and biodiversity, amongst other criteria. The Biomass Strategy, which the government intends to publish shortly, will present recommendations on how the existing biomass sustainability criteria could be enhanced. The GGR business model will align with the wider work on biomass sustainability criteria.

Next Steps

The government will progress work on business model development at pace, in support of our ambition to deploy GGR projects through the CCUS clusters. We recognise that further policy development is needed on important design elements of the business model, and we look forward to continuing to work closely with interested parties to develop and refine our proposals. This will include regular engagement with industry and investors through the GGR Business Model Expert Group, which we will convene regularly to allow us to gather feedback on policy options related to the contract design. The Expert Group will complement our ongoing wider engagement with academics, NGOs, and other stakeholders. The stakeholder feedback we received through the consultation will help to inform our policy positions.

We will publish an update setting out our latest positions on the design of the GGR business model later in the year. In parallel, we understand the need for clarity on the technology scope and eligibility criteria of the business model and will continue to develop our position on this issue as a priority.

Summary of responses to the consultation

Introduction to the analysis

In this section, we summarise the information and views provided in response to each question in the consultation. The stakeholder feedback has been summarised without any commentary from the government and should not be interpreted as government policy.

Stakeholders were not required to respond to all questions in the consultation, meaning that each question received a different number of responses. A number of stakeholders who responded via email provided a general submission and did not answer specific questions. Where information was deemed to be relevant to a particular question, it is included in the summary of responses to that question.

When summarising responses, we have aimed to provide an accurate picture of the mix of views and the distribution between respondents. Nevertheless, this should be treated as a guide given the open nature of many of the questions and the large number of suggestions we received. Whilst it is not practicable to detail every viewpoint or piece of evidence in this document, all submissions have been reviewed and considered by the government in full. We are grateful to all individuals and organisations who took the time to respond.

Section 1: Rationale for developing a GGR business model

Section 1 of the consultation described rationale for developing a business model for engineered Greenhouse Gas Removals (GGRs), setting this in the wider policy context. It outlined the Government's overarching vision for GGR deployment and our intention to develop a model that can attract investment in a mix of technologies.

Q1: Do you agree that the Government should develop a GGR business model to enable a diverse portfolio of GGR technologies to deploy at scale in the next decade?

Number of responses: 63

Response summary	
Yes	59
Conditional 'yes'	1
No	1
Did Not State / Unclear	2

The vast majority (94%) of respondents to this question agreed that the Government should develop a GGR business model to enable a diverse portfolio of GGR technologies to deploy at scale in the next decade.

Many stakeholders agreed with the reasons for establishing a GGR business model outlined in the consultation document. The main themes were:

- Engineered GGRs will be essential to reach net zero by 2050. Several respondents referred to evidence from the Climate Change Committee, Intergovernmental Panel on Climate Change, and the Government's Net Zero Strategy.
- A GGR business model is necessary to address current barriers to investment by providing a reliable revenue stream for nascent technologies that are not yet commercially viable at scale. This will reduce the risk to investors and allow developers to raise the amounts of finance necessary to support the industry's growth.
- Markets alone will not provide sufficient revenue certainty to leverage private sector investment at the pace and scale required to deploy GGR in line with the Government's ambitions, given the absence of a stable market price and the high capital and operating costs associated with innovative GGR technologies.
- A business model will be crucial to bolster voluntary carbon removal markets and in time underpin the development of a regulated market.
- The deployment potential of different GGR technologies is deeply uncertain, and early deployment of a diverse mix of technologies is needed to enable the development of a robust market for GGRs in the longer-term.
- The GGR industry must be scaled up rapidly to reach the levels required by 2050 – this will be a significant challenge and is unlikely to be achieved without government support and a clear policy framework.
- A GGR business model can support subsequent scale-up by encouraging innovation and realising early cost reductions and efficiency gains from learning-by-doing.
- Access to geological storage means the UK is well positioned for the development of GGR technologies.

One stakeholder explicitly disagreed with the Government's intention to develop a GGR business model. They expressed concern that GGR technologies are expensive, unproven at scale, and may not deliver at the scale and speed required to make a significant contribution to tackling climate change. Instead of providing support through a GGR business model, it argued that the Government should focus on expanding existing decarbonisation technologies such as renewable electricity.

Two stakeholders did not indicate clear agreement or disagreement with the development of a GGR business model. A trade union advocated the development of a UK GGR industry via public ownership of pipeline infrastructure and the inclusion of credits in the UK ETS to reward industry for the capture and permanent storage of carbon. However, it also favoured an initial guaranteed price for carbon credits to encourage private investment. An academic disagreed with a UK-focused approach to developing GGRs and advocated an international approach to

scaling new technologies, but recognised the need for government intervention to build pilot installations and guarantee demand (e.g. through a GGR obligation scheme).

Wider policy considerations

Some respondents who were supportive of a GGR business model provided caveats and wider considerations for government policy. This included calls for the Government to:

- ensure that economy-wide emissions reduction remains a priority
- provide a funding framework spanning a sufficiently long timeframe to provide confidence for the private sector to invest
- consider interactions with other business models to ensure there are no unintended consequences
- develop the business model as part of a longer-term strategy to sustain demand for engineered removals through carbon markets
- include a wide range of GGR technologies within scope of the business model

Q2: To support a portfolio approach to GGR deployment, do you agree that Government policy for incentivising negative emissions should be technology-neutral as far as possible?

Number of responses: 58

Response summary	
Yes	50
No	2
Don't Know	3
Did Not State / Unclear	3

Overview of responses

Overall, there was a strong consensus on the merits of a technology-neutral approach to GGR deployment. However, it was widely noted that 'technology-neutral' is an ambiguous concept open to different interpretations. In their responses to this question, stakeholders expressed views on whether a technology-neutral approach should imply (i) policy support for the widest range of GGR technologies rather than prioritising specific types, and/or (ii) a single model or level of support for all GGR technologies, regardless of their cost or other characteristics.

A majority of respondents believed that GGR policy should aim to support the broadest possible portfolio of technologies, while also noting that different technologies might require different forms or levels of support. It was widely argued that GGR technologies are at different

levels of maturity and cost, and respondents raised concern that a single model or level of support for all technologies could hinder innovation and market growth and create over-reliance on technologies that are more deliverable in the short-term. A small number of respondents disagreed with a portfolio approach and believed certain types of GGR should be prioritised. A similar number believed the level of policy support should be the same across all GGRs and should not be modified or adapted for specific technologies.

Two respondents did not agree with a technology-neutral approach but qualified their positions. A research institute agreed it is sensible to pursue a portfolio of technologies, but believed policy support may need to be tailored as GGR technologies are at different stages of development and have different costs. In this respect, their views were closely aligned with the majority of respondents to this question. An individual believed that while technology-neutrality would be a good ambition in other circumstances, this may not be appropriate for the GGR sector given the large differences between technologies in terms of, for instance, the scale of permanence, technology readiness levels, and environmental impacts. Instead of strict technology-neutrality, they advised government to pursue several full-scale demonstrations in commercial conditions to allow valuation of performance, underpinned by MRV protocols for each technology.

The following sections summarise stakeholder comments in relation to the two interpretations of technology-neutrality: (i) the ‘technology scope’ interpretation, relating to the range of technologies supported through the government’s GGR policy, and (ii) the ‘policy design’ interpretation, addressing the extent to which GGR policies should be tailored or adapted to specific technologies.

Arguments relating to technology scope

There was widespread agreement on the advantages of supporting the deployment of a broad range of GGR technologies. The main arguments were:

- The GGR sector is at a nascent stage and it is too early to attempt to pick ‘winning’ technologies. It is not possible to know which technologies will prove to be the most technically or economically effective over time, and key solutions for the future may not have been invented yet.
- Prematurely dictating technology choices may lead to technology lock-in and preclude the growth of a wide market with multiple participants.
- Delivering a GGR sector at the likely size required to reach the UK’s carbon budgets and net zero target will be a very significant challenge. It is unlikely any one category of GGR will deliver the scale of removals required, and multiple solutions will be needed to de-risk delivery of the UK’s ambitions.
- Supporting a diverse range of GGR technologies will stimulate innovation in new approaches and enable market discovery of the best combination of measures, ensuring technologies are developed to remove greenhouse gases in the most effective manner and at the lowest possible costs.

- A portfolio approach will create a more competitive market in future, enhancing market resilience and mitigating against an over-reliance on specific technologies.
- Early investment in a mix of technologies can support subsequent scale-up by realising early cost reductions and technical improvements, whilst allowing government to evolve the policy and regulatory framework based on learnings from earlier deployment.
- There are deployment constraints and trade-offs with every GGR approach (e.g. biomass, energy or land requirements). A diverse portfolio of technologies is desirable to mitigate the challenges associated with any one technology.

A number of respondents recommended that government policy should incentivise a defined *outcome* rather than specific technology pathways, based on clear criteria for the achievement of 'negative emissions'. This would allow market entry for novel technologies that can achieve the desired outcome. Some argued this outcome should be defined in terms of permanent or highly-durable CO_2 storage; others highlighted the importance of rigorous monitoring, reporting and verification standards.

Several respondents encouraged the government to ensure that promising early-stage technologies are given an opportunity to demonstrate their potential, such as biochar, enhanced rock weathering, and ocean carbon capture. A few stakeholders suggested the UK could take a pioneering role in ocean-based GGR in light of its island geography and ocean research expertise. Some respondents highlighted the vital role of nature-based solutions such as afforestation, peatland restoration and soil carbon enhancement.

Despite general agreement that a diverse technology portfolio is desirable, some respondents believed there should be limitations and caveats to account for large differences between technologies. They argued it will be important to prioritise certain technologies over others based on characteristics such as technology maturity, scalability, durability of carbon storage, co-benefits, and sustainability (including environmental and social impacts).

One organisation suggested the government should focus on technologies that are most likely to provide a cost-effective solution or capitalise on UK supply chain advantages. Numerous respondents highlighted access to CO_2 transport and storage infrastructure as an important consideration. An individual argued that while a technology-neutral position is correct, it is incorrect to assume that a broad suite of GGR technologies will be needed. They argued that GGR buyers will seek out the most cost-effective solutions, which will rapidly lead to the dominance of a handful of technologies.

<u>Arguments relating to policy design</u>

Most respondents to this question suggested the concept of 'technology neutrality' should not imply a single level of support for all technologies. Given the diversity of GGR technologies, it was widely argued that GGR policy must be flexible to adapt to technologies that are at different stages of development and face different cost profiles and risks. Some respondents raised concerns that a lack of technology-specific policies at the early stages of deployment could lead to technology lock-in and a lack of dynamic efficiency.

Stakeholders mainly focused their answers on technology cost and the level of revenue support provided by government. Several argued that technologies that might deliver the best long-term value may also be more expensive to operate in the short-term, and will therefore require higher contract prices to be commercially viable. DACCS was often cited as an example. Given the nascent state of the market and differences between technologies, respondents raised concern that price-driven competition or a fixed level of support may favour technologies with lower capital and operating costs, block investment in other promising technologies, and undermine the delivery of a diverse market for GGRs. A number of respondents therefore encouraged government to consider tailored strike prices via bilateral negotiations, or the introduction of separate competitions or technology 'pots' to ensure there is diversity in the types of projects supported.

While many respondents favoured different levels of support within a common incentive structure, a small number suggested a more targeted approach involving different business models or contracts adapted to the specific needs of different technologies. Alongside the GGR business model, it was noted that the government is already developing separate policy measures to support power BECCS and industrial carbon capture (including energy from waste).

Three respondents argued that technologies should not receive different levels or types of policy support, regardless of their costs or other characteristics. A developer advocated a uniform price per tonne of CO_2 across all GGR technologies, and expressed concern that strike prices negotiated on a project-by-project basis would incentivise more costly techniques and represent poor value for government. Similarly, a not-for-profit organisation argued the government should not pursue bespoke strategies for specific technologies.

Another developer supported an approach in which the carbon price is broadly similar across all GGR technologies and is not modified up or down to ensure that higher-cost technologies receive a greater level of support. However, it noted that this would only support technologies that fall within the cost bounds determined to be acceptable to government and may not deliver a wide portfolio.

Section 2: A contract-based business model for negative emissions

Section 2 outlined the Government's intention to introduce a contract-based business model for engineered GGRs, subject to affordability and value-for-money. This would address one of the main investment barriers by providing revenue support for negative emissions. It examined three leading options for a contract-based business model – a Negative Emissions Contract for Difference (CfD), Negative Emissions Payment, and Negative Emissions Guarantee – and invited views from stakeholders to enable the Government to decide on a preferred approach.

This section of the consultation also invited views on a set of draft 'principles for policy design', which will be used to inform and guide policy decisions on the detailed design of our preferred scheme. The principles were: Revenue Certainty, Value for Money, Deliverability, Competition, Market Development, Technology Neutrality, Reduced Support, Compatibility, and Reaching GGR Targets. Finally, it set out early considerations and sought views on the key design features of the business model.

Q3: Do you agree with the Government's principles for policy design?

Number of responses: 51

Response summary	
Yes (Agree)	38
No (Do Not Agree)	2
Don't Know	6
Did not state	5

Overview of responses

The majority of respondents to this question agreed with the principles for policy design. Some observed that the principles are well-aligned with the general approach taken with the deployment of other low-carbon technologies, such as CCS and hydrogen. While expressing agreement with the principles as a whole, many respondents provided comments on specific principles as well as suggestions for how they could be applied in practice. Stakeholders also proposed a number of additional principles for government to consider.

Only two respondents – a developer and a charity – stated that they did not agree with the principles. In their answer, however, the developer said that the principles listed in the consultation "are all correct" but did not include a principle on providing "differing levels of support for solutions of differing quality". The charity disagreed with the principles on the grounds that GGR is a public good and should not be delivered by the private sector.

Some respondents noted that the principles are “high level” and encouraged the government to provide greater detail and consider the interactions and trade-offs between them. Others stated that the policy principles are necessary but not sufficient. One respondent felt that the principles alone will not give the required certainty that the policy will deliver its intended ambition, and encouraged government to provide early clarity on the levels of GGR projects it is likely to support. A developer believed there should be a more profound appreciation of the barriers to investment associated with the novelty and uncertain performance attributes of GGR technologies.

Stakeholder feedback on the policy principles

The principles outlined in the consultation document attracted varying levels of commentary. An overview of stakeholder feedback on each policy principle is set out below.

Technology Neutral

Respondents generally agreed with a technology-neutral approach to designing the GGR business model in order to support a range of different technologies to commercialise. It was noted that multiple GGR solutions will be required to remove CO_2 at scale, and it would be premature to prioritise one solution over another.

However, there were differing views as to how this principle should be applied. Numerous respondents believed that ‘technology-neutral’ should not entail a ‘one-size-fits-all’ policy or competition on the basis of cost, which might prevent uptake of important technologies and favour ones with lower capital costs. It was proposed that different levels of support for different solutions may be required to deliver a range of GGR technologies. A research institute believed that technology-specific policies such as investment grants may be needed for certain technologies, while another respondent proposed allowing varied contracts for different types of projects. On the other hand, a developer argued that technology neutrality can only be achieved if each technology receives the same funding per tonne of CO_2 removed, rather than providing different levels of policy support based on cost.

A few respondents expressed reservations over the technology neutrality principle. A university highlighted that policy should consider the resource needs and other social and environmental externalities of GGR technologies (including land-use and ecosystem impacts) to avoid adverse impacts. A developer argued it is important to consider the varying levels of maturity, potential and scalability between different technologies. Another developer noted that some GGR technologies are naturally aligned to certain products which may benefit from other government support or other beneficial market conditions, which may undermine a technology-neutral approach.

Market Development

This was identified as an important principle by some respondents. A trade association argued that the principle should relate to both voluntary carbon markets and a compliance-based market. However, other trade associations cautioned that it might take significant time for a

competitive market to develop and that this should be pursued as a longer-term principle. A not-for-profit organisation believed that the government should remain open to having a direct role in the carbon removal marketplace, such as holding stakes in the credits that it purchases and determining appropriate allocation of those credits.

Reduced Support

Stakeholders who commented on this principle generally agreed that direct government subsidy should reduce over time. However, a not-for-profit organisation warned that this principle should be implemented in a manner that does not erode other principles such as revenue certainty. Similarly, an environmental consultancy acknowledged it is essential that the contract fixes the subsidy/price expectations for the full contract duration. A developer stated that if government could unilaterally reduce support within the contract life, this would increase the risk profile of projects.

Value for Money

A number of stakeholders raised concerns around how the value for money principle would be applied. Two industry respondents agreed with the overall principle, but warned that delivering value-for-money should not be confused with delivering removals at the lowest price. For the same reason, an environmental consultancy said that value for money should not be the deciding factor in project selection, as the cheapest projects in the short term may not provide the biggest return in the long term. A prospective buyer agreed that too strong a focus on value for money may result in technologies that are initially more expensive, but are vital for the success of the UK's net zero ambitions, not receiving sufficient funding.

One developer disagreed with the definition of the principle in the consultation, specifically the notion that the policy should not lead to excessive returns for developers. They argued that returns for developers should be based on them delivering removals at the lowest cost – even if it means they make greater returns than other developers who have higher costs.

Competition

Some stakeholders believed this principle should play a limited role in the early stages of GGR deployment and should instead be implemented as a medium-term principle. A trade association and developer believed the initial priority should be to deliver a wide range of GGR technologies, while a research institute agreed with a focus on bringing technologies towards commercialisation in the first instance. A prospective buyer noted that competition may be limited in the early stages of the market due to a relatively small number of projects.

Revenue Certainty

No respondents disagreed with this principle or proposed significant amends, and some suggested that the principle should be prioritised above others. However, a few developers noted that the principle must cover demand/volume risk alongside price risk if the project cannot find a buyer for its removals. One developer recommended including a principle on Demand Certainty that guarantees all negative emissions projects supported via the GGR

business model receive a minimum level of remuneration, believing that this would encourage the government to consider interventions which support growth in market demand. Alongside near-term revenue certainty, a research institute urged government to consider the transition to a sustained long-term market to unlock the large volumes of private investment and innovation needed. An environmental NGO believed that the appointment of a robust counterparty should be included as a sub-objective of the revenue certainty principle.

Compatibility

Stakeholders generally recognised this as an important principle to avoid double-subsidisation and to ensure that other market risks are understood and mitigated. One respondent noted that some GGRs will operate in multiple markets, particularly BECCS plants that deliver negative emissions and other services (e.g. power and hydrogen) simultaneously, and that any interaction with these markets must be carefully managed to avoid unwanted impacts. A developer suggested that government should aim for alignment between compliance and voluntary markets to encourage competition and investment. A not-for-profit organisation raised concerns that some GGR technologies could dominate if eligibility for other support schemes makes them more attractive. A trade association believed the compatibility principle should be extended to ensure all negative emissions receive the same treatment, whichever business model they are supported under.

Reaching GGR Targets

Some respondents suggested that the principle should explicitly mention specific targets, such as the ambition to deploy at least 5Mt of engineered removals by 2030 or ensuring the scale of negative emissions is sufficient to reach the UK's interim carbon budgets. One stakeholder believed the government should recognise the risk of failure for some methods and support a portfolio of technologies accordingly.

Deliverability

A few respondents identified deliverability as a key principle and stressed the urgency of developing the business model at pace. However, respondent raised concerns that delivering GGR projects too quickly may distract from delivering other emission reduction approaches such as CCS and hydrogen fuel-switching.

Additional policy principles proposed by stakeholders

In addition to the policy design principles set out in the consultation document, multiple stakeholders recommended that the government should consider additional principles on the following themes:

Monitoring, Reporting and Verification

Many respondents believed that a principle was needed to reflect the importance of robust MRV to provide confidence in the 'quality' or 'integrity' of GGRs. A research institute suggested this principle could draw inspiration from the UNFCCC's five pillars of MRV: transparency,

accuracy, comparability, consistency, and credibility. It also recommended that the policy should include incentives to minimise supply chain and process emissions to maximise 'net negativity'.

Environment and Sustainability

Several respondents called for a principle aimed at minimising adverse environmental impacts and negative externalities across the GGR process. One stakeholder suggested this should include the promotion of UN Sustainable Development Goals and environmental integrity relating to land, environments, and ecosystems.

Permanence

Several respondents believed the principles should reflect the importance of CO_2 storage permanence but did not share a consistent view on what this should mean for policy design. One environmental NGO believed the business model should only support GGR technologies that guarantee permanent removal of GHGs from the atmosphere. Two trade associations disagreed and suggested different levels of permanence should be allowed as long as they are explicitly accounted for and priced accordingly. Similarly, a developer recommended providing different levels of support for solutions of differing 'quality' (defined in terms of permanence, measurability and additionality). One trade association argued that 'permanent' storage must be defined in broader terms than just geological storage and should include CO_2 storage in concrete.

Supporting decarbonisation

Some respondents believed the policy principles should include explicit recognition of the need for GGRs to complement ongoing emissions reduction efforts while using them only to address hard-to-eliminate residual emissions. They added this would be crucial to developing public confidence in the sector. One trade association suggested a principle on 'Promoting Decarbonisation in the Wider Economy', to encourage GGR technologies which offer positive externalities and co-products (e.g. hydrogen BECCS which delivers negative emissions alongside clean fuel to decarbonise industry, transport, power and heat). A developer proposed a principle on 'achieving high resource efficiency' to ensure GGR incentives do not support lower-efficiency GGR activities above the production of low-carbon fuels for hard-to-decarbonise sectors.

Alongside balancing emissions from hard-to-decarbonise sectors, one developer believed there are two additional uses for negative emissions which should be factored into GGR policy design: going beyond net zero to 'net negative', and enabling corporates to remove historic emissions.

Other principles

The following policy principles were proposed by a smaller number of stakeholders:

- Risk management: A developer recommended a principle on ensuring risks are managed efficiently and effectively in first-of-a-kind (FOAK) projects.
- Transparency: A not-for-profit organisation believed the policy should provide learnings to the public in the form of cost discovery and disclosure. A developer also believed the policy should encourage transparency through the entire GGR supply chain in order to instil confidence.
- Fair cost distribution: Two respondents believed that the costs of the scheme should not disproportionately impact low-income households. One of those suggested a 'polluter pays principle' where higher-emitting sectors bear the costs.
- Social acceptance: A not-for-profit organisation identified the achievement of broad social acceptance for GGRs as an important principle to ensure the long-term viability of the sector. Other respondents noted that robust MRV and a strong definition of permanence will be critical for achieving public confidence.
- Internationally compatible: A not-for-profit organisation believed the business model should maximise compatibility with international policies, including MRV and certification schemes, to reduce regulatory and administrative burden on recipients of UK GGR support. The same respondent also suggested the model should be 'geographically flexible' by allowing some stages of the GGR process to take place outside the UK, e.g. the carbon capture process, transport and storage, or the purchase of credits.

Q4: Do you agree with our overall approach to introduce a contract-based business model for GGRs to provide revenue support for negative emissions?

Number of responses: 52

Response summary	
Agree	45
Conditional or qualified agreement	2
Do Not Agree	2
Don't Know / Did Not State / Unclear	3

The vast majority of respondents (87%) agreed that a contract-based revenue support mechanism is the most desirable approach to designing the GGR business model.

The main reasons were:

- A contract-based model is best suited to attract private investment by providing revenue certainty for GGR projects.
- A stable contracted price for negative emissions will minimise exposure to market risks and provide investors with a secure return on investment, lowering the cost of capital and bringing down the cost of delivery.

- Contract mechanisms have a proven track record of supporting the deployment of innovative technologies in the UK (e.g. renewables) and are familiar to investors.
- A private law contract between government and developers will provide security against future policy changes.
- A contract scheme offers the flexibility to support diverse technologies at different scales, with the ability to target support and account for unique project characteristics.
- A contract-based approach would provide consistency with other business models being developed (e.g. for industrial carbon capture, hydrogen, power BECCS).
- Successive competitive auctions can accelerate learning rates and cost reductions.

A number of respondents pointed out that a contract-based business model is a necessary provision but insufficient on its own, and should be accompanied by other policy interventions such as: innovation funding to support the development of novel technologies; robust certification and standards for monitoring, reporting and verification (MRV); capital support for FOAK projects; and interventions to develop the negative emissions market. A developer cautioned that revenue certainty for GGR operations may not protect investors if a novel technology fails to perform to specification, and therefore the novel or unproven status of early-stage technologies could remain a barrier to investment.

Two respondents gave conditional or qualified support for a contractual business model. A not-for-profit organisation believed that while a contract mechanism is superior to the other options considered in the consultation, the government should consider alternative approaches including a policy mechanism that provides a flat price for removals; however, it recognised that this could be considered a variation of the contract models outlined. A research institute agreed with the need for targeted early-stage support, but stressed that the implementation of contract-based schemes must be considered as part of a wider package of market interventions to drive sustained long-term demand for GGRs.

Only two respondents disagreed with the government's approach: a charity and a trade union both advocated public ownership of GGR assets rather than delivery through the private sector, although the trade union accepted that a contract-based mechanism would be the most favourable of the options outlined in the consultation.

Alternative supply-side support mechanisms

Some respondents provided views on the alternative supply-side support measures considered in the consultation document: tax credits, grant funding competitions, and regulated asset base. None favoured these measures above a contract-based business model for supporting commercial deployment. They highlighted a number of disadvantages of these approaches, as follows:

- Tax credits: overly complex, do not give the required degree of revenue certainty for first-of-a-kind projects, lack of experience and market appetite in the UK, would not incentivise start-up companies that do not pay tax. However, a developer referred favourably to the 45Q tax credit in the USA and suggested the UK government could consider a similar scheme alongside a contract-based mechanism.

- Competitions: not suited to supporting commercial deployment at scale, more appropriate for supporting pilot plants and demonstration projects, government takes the risk of projects that do not deliver.
- Regulated Asset Base: more suited to monopoly suppliers where there is a single large, regulated asset, not sufficiently flexible to account for the varied characteristics of different GGR projects, does not provide a route to reduced levels of government support, lack of natural customer base for raising finance compared to energy and utility sectors, applying a heavily regulated model to a large number of smaller suppliers will create excessive administration.

Q5: What is your preferred contract scheme of those outlined in the consultation? Please provide arguments to support your view.

Number of responses: 48

Response summary	
Negative Emissions Contract for Difference (CfD)	19
Negative Emissions Guarantee (NEG)	5
Negative Emissions Payment (NEP)	6
NEP for initial projects, transitioning to a CfD once the market is developed	7
Contract for Difference or Negative Emissions Payment	3
Negative Emissions Payment or Negative Emissions Guarantee	2
No preference	2
Other mechanism	3
Not stated or unclear	1

Overview of responses

The Negative Emissions Contract for Difference (CfD) and Negative Emissions Payment (NEP) models were the most widely supported by stakeholders for early GGR projects. More than a third of respondents indicated a preference for a CfD contract structure (40%). In total, 27% of respondents preferred a Negative Emissions Payment; however, more than half of those suggested the business model could transition to a CfD once costs are better understood and a negative emissions market of sufficient scale is established.

A smaller number of stakeholders favoured a Negative Emissions Guarantee scheme, while some did not have a strong preference between the options. Several respondents believed that each of the three schemes share similar characteristics and could all be effective at providing the stable revenue streams needed to attract investment. One developer commented that the similarities between the options are much greater than their differences, while an NGO believed that the differences between them can mainly be addressed in policy design. Two trade associations suggested that a CfD model may be the most workable in practice but noted that members did not have a unanimous view and that all three could potentially work. A regular theme was that the mechanisms could be phased, combined and adapted over time to reflect the evolving market and changing needs of the sector.

For each mechanism, most respondents broadly agreed with the advantages and disadvantages set out in the consultation document. The following sections summarise the stakeholder feedback on each option.

Negative Emissions Contract for Difference

Arguments in support of a CfD model

The most common arguments in support of a CfD model were:

- Revenue certainty for developers and investors by providing a fixed strike price for negative emissions. This will protect early-stage developers from uncertain market conditions and provide the confidence needed to secure investment in first of a kind (FOAK) projects.
- A record of success in the UK – particularly in the renewables sector where the model has helped to secure investment, promote innovation and drive down costs.
- The model has been adapted for other low-carbon technologies, including through the ICC and Waste ICC business models (industrial and waste sector CCS), Hydrogen business model (low-carbon hydrogen), and Dispatchable Power Agreement (power CCS).
- In light of this previous experience, the model is familiar to the market and well-understood by developers and investors.
- The reference price is linked to market prices which avoids over-rewarding projects, reduces the cost burden on government as the market develops over time, and provides a glidepath for projects to operate on a market-led basis.
- CfD balances risk by returning funds to government when market prices are above the strike price.
- The model can be applied across a range of technologies with a tailored strike price.

Some respondents argued that regular allocation rounds and competitive auctions for CfD contracts could deliver innovation and cost reductions. Three respondents noted that the consultation on the power BECCS business model included proposals to adopt a contract for difference for negative emissions derived from this technology, and suggested that a similar model may also be appropriate for other GGRs. A trade association pointed out that under a CfD framework, particular projects can achieve sustainable self-financing even if they continue to receive contractual price certainty, whilst others can continue to benefit from revenue support where needed. A research institute stated that a CfD mechanism does not require government to sell credits which would require extensive regulatory architecture to be built. A developer argued that due to the level of certainty a CfD scheme provides it would create a greater pool of investors, a lower average cost of capital, and potential for greater debt leverage, all of which increase the likelihood of project delivery.

Concerns about a CfD model

The main concerns around a Negative Emissions CfD focused on the absence of an established market for negative emissions, with some stakeholders commenting that the GGR

sector is highly complex and unlike other markets that have employed a CfD. A number of respondents noted that while the Contracts for Difference scheme for low-carbon electricity was introduced when there was already a functioning energy market and transparent market prices, the GGR sector is in its infancy and price discovery has yet to be achieved.

Due to the nascent state of the GGR market, several respondents highlighted the difficulty of setting an appropriate reference price when no transparent market price or reliable price index is available. A number of potential solutions were put forward, most notably the use of the UK ETS carbon price or the achieved sales price; options for setting the reference price for a Negative Emissions CfD are considered in detail under Question 8. However, several respondents believed that a CfD is likely to be a more appropriate contract mechanism once there is a more mature and stable market on which to base the reference price. The majority of those respondents suggested that a Negative Emissions Payment may be simpler to administer for early GGR projects. One trade association argued that the difficulty of modelling a CfD for initial projects may result in a higher cost of capital than an NEP approach.

Some industry respondents commented that a successful GGR Business Model must protect developers from two components of revenue risk: price risk (the risk that developers do not secure the required price for their negative emissions) and volume/demand risk (the risk that developers are not able to sell sufficient volumes of negative emissions on the market). It was generally agreed that a CfD mechanism will mitigate price risk if the strike price is set at an appropriate level. However, respondents were uncertain as to whether the CfD would also protect the developer from volume/demand risk, i.e., whether it would receive the full strike price if there are no commercial buyers for some or all of its negative emissions. Government was asked to provide clarity on whether developers would be required to find commercial customers in order for the CfD mechanism to take effect and enable the strike price to be achieved. If so, there were concerns that the model could expose GGR providers to significant uncertainty of revenue if there are low levels of offtake when the market is in its infancy. One developer proposed that this could be addressed by the CfD mechanism allowing for a defined quantity of early purchases by the government even if no commercial buyer has engaged.

A few respondents expressed concern that a CfD may disproportionately favour large-scale projects and established technologies at the expense of smaller projects. For instance, a research institute noted that the administrative burden on smaller-scale GGR developers could be larger relative to the project value, potentially stifling innovation. To address this risk, respondents recommended either (i) introducing separate pots or dedicated funding pools for small-scale projects within the CfD mechanism, or (ii) awarding a Negative Emissions Payment for such projects for simplicity. However, one respondent did not agree that a Negative Emissions CfD presents a barrier to smaller developers, on the basis that small-scale projects have been successfully supported under similar models in other sectors.

Other concerns with a CfD model included:

- The risk of perceived ‘greenwashing’ if companies are able to purchase and claim ownership of subsidised carbon removal credits when the price paid does not cover the cost of delivery.
- If the reference price is based on the achieved sales price, the CfD will not incentivise the industry to find the highest paying customer. This means credits may therefore be sold too cheaply, distorting the carbon market price.

- The challenges presented by discontinuation of support at the end of the CfD contract. One developer proposed that this risk could be reduced through a falling strike price over time which would slowly reduce the market impact of the CfD, rather than a complete expiry on a particular date.
- A trade association favoured a CfD model but disagreed with the principle that funds should be returned to government if the reference price exceeds the strike price, arguing that developers should be able to take advantage of higher market prices as proposed for the Negative Emissions Guarantee.

Negative Emissions Payment

Arguments in support of a NEP model

Advocates of a Negative Emissions Payment highlighted three main benefits of this contract structure:

- A straightforward payment for negative emissions (£/tCO_2) would be the simplest to administer and could apply to a range of GGR technologies. This was considered to be a particular advantage over a CfD given the absence of an established market or appropriate reference price for negative emissions.
- A fixed payment would provide a high level of confidence for investors and support developers to obtain project financing. This may also help to reduce the cost of capital by offering the most clarity and certainty on revenue streams.
- The NEP addresses price *and* demand/volume risk by guaranteeing a price per tonne of CO_2 for all negative emissions generated by the project. This manages the risk of the developer not finding a commercial buyer while there is no developed voluntary or compliance market.

A number of respondents agreed that an NEP scheme could be combined with a gainshare mechanism to encourage developers to sell credits to private buyers and support the development of a negative emissions market. This would allow project developers to retain a proportion of revenues from credit sales and enable the government to recover some of its costs. A developer suggested that the incentive for developers to secure the best price on the market could be sharpened by allowing them to retain a greater proportion of the revenue.

Stakeholders did not agree on whether responsibility for selling credits on the market should sit with the government or developers. Three developers favoured a NEP model in which the government sells credits itself, arguing that this would allow new industries to focus on the development and deployment of early-stage technologies rather than the ‘burden’ or ‘distraction’ of finding the best price for their credits and administering sales in an evolving market. In a similar vein, a not-for-profit organisation believed a NEP model has merit especially if the government is able to minimise complexity for developers by taking on the responsibility to sell credits back to the market, or to retire credits and attribute them to hard-to-decarbonise sectors of the economy. In contrast, a number of respondents believed developers are better-placed to participate in the market and sell credits directly to commercial buyers as part of a gainshare agreement with government.

Some respondents noted that a NEP is similar in concept to the renewable energy Feed-In Tariffs scheme, and could provide similar advantages in terms of administrative simplicity and investment certainty. Others believed that the NEP could efficiently operate in conjunction with other support mechanisms for co-products, such as the Renewables Obligation and the Renewable Transport Fuels Obligation.

Most respondents who expressed a preference for the NEP believed that this model should be used for a limited time period to enable price discovery and the development of a liquid market. They argued that once there is a functioning market with a clear market price that could serve as the reference price, the design of the GGR contract could transition to a CfD. This was likened to early renewable projects transitioning from Feed-In Tariffs to CfDs once the sector had matured. Others suggested that the transition to a CfD structure should take place at the point at which technologies are better understood, prices have stabilised, or a compliance market has been introduced.

Concerns about a NEP model

The main concerns around a Negative Emissions Payment related to the level of government involvement in the negative emissions market. Several respondents believed that the government should not be an active participant in the market in terms of the buying and selling of credits. It was argued that such an active role could slow down the development of a free-standing negative emissions market driven by private sector demand, and extend reliance on government support to make GGR projects viable.

A small number of respondents pointed to the challenges in designing a gainshare mechanism and suggested that this would be undesirable and/or complex. Two developers highlighted concerns that a Negative Emissions Payment would create market uncertainty over the additionality of carbon credits, which could add unnecessary complexity and erode confidence in the scheme. One suggested that the level to which a company can claim legitimate ownership a credit would depend on the degree to which it covers the cost of delivering the removals. However, an NGO did not agree that additionality should be an obstacle, on the basis that the credits generated by the support mechanism would be distinct from other carbon credits and “will not interfere with other voluntary carbon markets, many of which will mainly trade nature-based credits”.

Negative Emissions Guarantee

Arguments in support of a Guarantee

Four developers expressed a preference for a Negative Emissions Guarantee, providing the following reasons:

- A Guarantee provides revenue certainty at a relatively low cost to government whilst also incentivising project developers to make a higher return by selling on the market.
- The Guarantee does not ‘cap the upside’ for projects as it allows developers to benefit from higher prices above the guaranteed price. This will help to attract investment into the sector, reduce the cost of capital (and potentially overall costs to government), and provide a stronger incentive to sell on the market.

- The mechanism protects the additionality of carbon credits. If a company wishes to claim ownership of a credit, it must pay the full cost. This ensures that the government is not subsidising the cost of GGR credits for corporates.
- Complementary policy levers can be used to increase demand for GGRs so that the market price is greater than the Negative Emissions Guarantee floor price. This enhances the government's ability to control its total expenditure on the scheme.
- The complexity and administrative burden of a Guarantee scheme may be lower than a CfD.

One developer argued that the same guaranteed price should be uniformly applied across all technologies to ensure the incentive is outcome-based, technology-neutral and internationally competitive. Another believed the Guarantee scheme should include an OPEX opener for protection from energy prices.

A member of the public also favoured a Negative Emissions Guarantee but did not provide a clear rationale. A further two respondents were equally supportive of a Negative Emissions Guarantee and a Negative Emissions Payment scheme: a developer believed the Guarantee scheme provides a more market focused mechanism while retaining revenue certainty due to the 'buyer of last resort' guarantee from government, while a prospective buyer said that a Guarantee could help to scale demand and boost investor confidence if combined with government endorsement of negative emissions credits.

A not-for-profit organisation – who remained agnostic between the three contract mechanisms – believed that a Negative Emissions Guarantee could result in relatively small outlays of government funding if paired with other market development policies such as clearly-defined MRV standards. It also preferred a flat price set by government rather than price discovery on a project-by-project basis.

A number of respondents who did not favour a Negative Emissions Guarantee nevertheless recognised some potential benefits of the scheme, most notably that it would: mitigate price and volume/demand risk; provide an incentive to secure higher revenues by selling credits on the market; help projects to meet additionality criteria that are often required in the voluntary carbon market; and remove government support as soon as market prices are high enough.

<u>Concerns about a Guarantee</u>

There were two main concerns regarding a Negative Emissions Guarantee, both of which were raised by multiple respondents.

First, many stakeholders expressed concern that a Guarantee may not provide an adequate incentive for developers to seek a higher price on the market. Developers may instead rely on the guaranteed price from government, which could hinder the growth of the negative emissions market whilst maximising costs to the Exchequer.

Second, respondents highlighted the challenge of setting the intervals at which producers can sell credits to the government at the guaranteed price. A developer noted that too short a period may discourage projects from seeking the highest possible price in the market first, whilst too long a period may undermine the credibility and revenue certainty provided by the contract structure. A number of respondents believed that unless the guarantee can be exercised at regular intervals, this may expose projects to cash flow challenges or create

unnecessary interim funding requirements. A trade association argued that the scheme must allow at least annual payments in order to make it viable.

Alternative Proposals

Three stakeholders suggested an alternative approach to the three shortlisted contract mechanisms.

- A research institute believed that government should prioritise market interventions to drive sustained long-term demand and encourage supply. It argued the implementation of contract-based schemes would require careful design to minimise market distortion and encourage the smart integration of CCS infrastructure.
- A charity called for public ownership of GGR assets through a “government-owned, contractor-operated” model.
- A trade union favoured a model of public ownership in which the government manages and operates a major carbon capture and storage industry and rewards private businesses for injecting their captured carbon in the form of UK ETS credits.

A not-for-profit organisation believed that the government should implement a combination of the measures outlined in the consultation, along with a separate and distinct Advanced Market Commitment mechanism that could steer innovation and market focus towards specific priorities of strategic importance in the UK.

Wider policy considerations

A number of respondents believed that the chosen contract mechanism should support different technologies through technology-specific prices or ‘pots’ in allocation rounds, in order to enable fair competition between similar technologies. However, a developer argued that the use of technology-specific pots or prices would lead to uncertainty and gaming as to which pot a particular project falls into, complexity which will lead to delays and unnecessary costs, and restricting innovation as emerging techniques may not fit into pre-designed technology pots. A not-for-project organisation also favoured a fixed price over project-level cost discovery on the basis that this could invite gaming and potentially erode public trust. It argued that the government should provide a suitably high, stable and flat price for removals, but believed prices could be tiered based on several high-level categories of GGR.

Two respondents highlighted the need for the UK’s GGR policy to be internationally competitive, noting that the 45Q policy in the US provides eligible projects with a guaranteed, clear, and minimally burdensome incentive. They warned that the introduction of a cost-based funding mechanism in the UK could result in more competitive technologies relocating to the USA and less competitive, more expensive technologies moving to the UK.

Some respondents raised the importance of government-accredited MRV and clear definitions on what constitutes a negative emission. A developer argued that the chosen business model should reflect the changing needs of GGR developers throughout project development.

Q6: When might it be feasible to introduce an auction mechanism for GGR contracts, and what criteria should the Government consider when developing its allocation process?

Number of responses: 41

There was broad agreement among stakeholders that auction mechanisms would not be suitable for allocating early GGR contracts. Two main arguments were provided in support of this view. First, many respondents suggested that auctions work most effectively when there is a large number of projects competing for government support. It was pointed out that there is currently limited market density in the GGR sector, with a small pipeline of FOAK projects providing little scope for competition. Second, respondents raised concerns that introducing price-based competition too early may prevent the emergence of vital technologies due to their initial high cost. They argued that auctions would favour the lowest-cost solutions at the expense of fostering diversity, harming future growth potential in the sector.

Most respondents therefore believed it would be appropriate for the government to initially award contracts through bilateral negotiations, while the GGR market is in its nascent stages. In contrast to competitive price auctions, it was argued that bilateral negotiations would allow projects to be evaluated using a wider set of assessment criteria in addition to cost. Stakeholders proposed a number of criteria that should be considered in the allocation process – such as removal potential, scalability over time, innovation, technology diversity, permanence, project deliverability, efficiency, co-product benefits, and economic and social benefits (e.g. benefits to local economy and employment). The use of multiple assessment criteria was considered to be important to ensure that contracts are not awarded exclusively to the lowest-cost or most mature technologies.

A few respondents believed that bilateral negotiations and ‘open book’ contract awards will deliver the best outcomes in terms of value-for-money and deliverability; for instance, one respondent suggested it would allow projects to update and reappraise their bid as new information emerges. However, another respondent cautioned that every effort should be made to maintain competitive tension when pursuing bilateral negotiations.

Following a period of market discovery, most respondents believed it would be appropriate for bilateral negotiations to transition towards a competitive allocation process as the sector develops over time. Broadly speaking, stakeholders highlighted five main factors that should determine the feasibility and timing of the move from bilateral negotiations to auctions. It was argued that an auction-based approach may be appropriate once (i) technologies are better developed, (ii) there is a sufficiently large number of projects competing for support, (iii) there is a clear market for carbon removals with a relatively stable price, (iv) CCUS transport and storage infrastructure is available, and (v) it becomes possible to segregate technologies into similar pots to allow fair competition between technologies with similar features.

However, there were differing views as to when there is likely to be sufficient technological maturity and/or market depth to introduce an auction mechanism, and several respondents noted the difficulty of estimating a specific timeframe. A few respondents believed this could be achievable in the early 2030s once FOAK technologies have been demonstrated and the next generation of plants have been deployed. A developer proposed that if a sufficiently diverse pipeline of projects is brought forward to deliver the 23Mt of deployment anticipated by 2035, then reverse auctions may be an appropriate route for GGR contract allocation in this timeframe.

Many others believed it could take considerable time before competitive auctions are feasible, given the nascent state of the market and the complex technology landscape. One respondent drew comparisons with the power sector, noting that it took a decade to move from the Renewables Obligation scheme to auctioned Contracts for Difference. Some suggested that this may not be possible before the 2040s, while two industry respondents suggested it may never become possible for an auction mechanism to be introduced given the wide range of different technologies requiring different levels of support over different time periods.

A few respondents believed the government should transition to competitive auctions as quickly as possible in order to avoid the challenges of bilateral negotiations. For instance, one stakeholder argued bilateral negotiations are costly to negotiate and prone to entrenching a small number of large suppliers. Another agreed that bilateral negotiations are resource-intensive and less suitable for smaller developers, adding that the process is opaque, liable to garner mistrust, and subject to 'cost-padding' which would erode value for taxpayers. They suggested that projects under a certain size should therefore be able to forgo bilateral negotiations and instead receive a simplified fixed payment.

A project developer believed reverse auctions could start immediately, provided all companies that bid below the clearing price are offered the clearing price rather than price that they bid. They argued that this approach would ensure successful projects are receiving the same price while creating competitive pressure to drive down prices. Another developer proposed the government should offer a uniform strike price for early projects, with a volume cap to control risk of overpayment. If too many projects bid into the scheme, the government would introduce an auction to allocate the available funds. They argued that this approach would minimise complexity and provide developers with a clear target price, which they suggested could be determined based upon prevailing prices in voluntary markets and direct inquiry with project developers.

Q7: How can the Government most effectively reward innovation and cost reduction in early GGR contracts?

Number of responses: 38

Stakeholders provided a broad range of suggestions for how early GGR contracts could best incentivise innovation and cost reduction. The three most common proposals were:

- **Evaluation criteria used to allocate contracts:** evaluating projects against a broad set of criteria that values innovation, technology diversity, wider economic benefits and other outcomes, to ensure contracts are not simply awarded based on lowest cost. This should facilitate deployment of a portfolio of GGR technologies in different sectors and encourage innovation to meet such criteria.
- **Defining standards for negative emissions:** providing early clarity on how 'negative emissions' are defined, and the standards that projects will be expected to adhere to, will allow developers to innovate to meet those criteria and therefore reduce costs.
- **Innovation support:** innovation funding, pilots and field trials could support innovation and cost reduction. It was suggested that a separate tier for start-ups and smaller projects could be used to incentivise more novel technologies to compete, such as premium contracts or advance payments.

A number of stakeholders focused on the contract allocation method, providing similar arguments to those in Question 6. Several respondents – particularly those who favoured multi-criteria project assessment – believed that innovation and cost reduction is best achieved via bilateral negotiations with each project developer. In contrast, a few highlighted that regular reverse auctions would allow for price discovery and lower costs. Some respondents proposed that the best way to reward innovation is to use fixed price contracts, which would encourage companies to drive down costs in order to generate higher margins. It was also argued that the fixed price could be gradually reduced in future allocation rounds to drive further cost efficiencies.

A few respondents cautioned that cost savings from operational efficiencies are likely to be limited in initial projects. They suggested that innovation and cost reduction are more likely to arise over time as future generations of technologies deploy, rather than within a single generation.

Transparency was highlighted as an important principle for early GGR contracts. A couple of respondents argued the government should publish contracted prices to encourage new market entrants and enable wider price discovery. One believed that a standard cost model should be developed and published, containing all the cost elements that the government would expect to have quantified in the developer's strike price proposal. This would include capital costs, financing costs and operational costs.

Other stakeholders suggested a range of ideas to reduce costs and promote innovation, including: capital investment support through government-backed loans and grant funding; a gainshare mechanism to incentivise developers to achieve the best cost on the market, thereby reducing the cost of payments to the government; rewarding negative emissions on a 'net' basis to encourages efficiency gains and reduced supply chain emissions; opex reopeners to ensure opex uncertainty does not lead to strike price inflation; a robust market for GGRs which stimulates the development of multiple projects to compete for contracts; allocation of funds to targeted auction 'pots' for different types of technology; and strike prices based on an 'average case scenario' to provide an ongoing incentive for developers to innovate and reduce costs. A couple of respondents noted that cost reduction is most strongly associated with modular technologies in which identical units can be deployed rapidly and across a variety of contexts.

Q8: If the Government pursues a Negative Emissions Contract for Difference, what is the most appropriate basis for setting the reference price for initial contracts? Please provide arguments to support your view

Number of responses: 37

Overview of responses

Many stakeholders highlighted the complexity of setting a reference price for contracts for difference in a new market such as GGRs. It was widely acknowledged that setting a reference price is most straightforward when there is an existing established market with transparent market prices, as was the case for the renewable CfD scheme. In contrast, there is currently no mature market or transparent market price or index for negative emissions, and therefore no clear basis for setting a reference price for initial GGR contracts.

Stakeholders noted that the choice of reference price is critical to the effective operation of a CfD and will depend on the route to market available to project developers. One respondent emphasised that the reference price must be accessible by the project in order for the business model to be investable, i.e. the GGR project must be able to sell their negative emissions at or close to the reference price. Another highlighted that the reference price should provide a relatively predictable outlook over the contract term so that investors can be confident all costs will be recovered.

Respondents discussed the fact that negative emissions are not currently priced in the UK ETS, while the voluntary market for negative emissions is currently small. In addition to the small market size, several respondents noted that there is considerable price differentiation within voluntary carbon markets on the basis of technology and project types. They commented that projects may attract very different prices depending on their specific attributes, particularly in terms of environmental co-benefits and the durability or permanence of storage. This means that there is no reliable price index that can be readily applied across a diverse group of technologies or accurately capture premiums associated with different projects.

Some respondents expressed the view that the government should not pursue a CfD precisely because there does not appear to be a suitable market reference price. These respondents generally believed the government should award the first GGR contracts through a straightforward Negative Emissions Payment, transitioning to a CfD once the negative emissions market has matured and there is a clear market price which can serve as the reference price.

However, most stakeholders who favoured the introduction of a CfD identified potential solutions for setting the reference price. Two main proposals emerged: (i) using the UK ETS price, and (ii) the achieved sales price on voluntary carbon markets.

The UK ETS carbon price

As the UK's most established system of carbon pricing, many respondents believed the UK ETS carbon price is the appropriate basis for setting the reference price in a GGR business model. It was argued that the ETS price provides a stable, auditable and well-understood price for carbon across the UK economy and could be linked to other international carbon markets.

Some respondents acknowledged that the business model could only be referenced to the UK ETS once GGRs are integrated into the market and there is a clear economic linkage between negative emissions and the ETS carbon price. One stakeholder suggested that this integration may take time, but believed the business model should be designed to accommodate this possibility over the course of the contract. However, some respondents noted that UK ETS prices are subject to volatility, while others cautioned that introducing negative emissions credits could create imbalances in the market.

Achieved sales price

While negative emissions markets are immature, many respondents proposed the reference price could be linked to the sales price achieved in voluntary carbon markets (e.g. the monthly average achieved sales price for each project). This was identified as a suitable option given there are multiple voluntary marketplaces and different projects are likely to attract different

prices (e.g. due to differences in permanence), meaning there is unlikely to be a single cross-technology price index.

Some respondents noted that using the achieved sales price may not incentivise developers to find the highest paying customer, knowing that the difference payment from government will deliver the strike price. These credits may therefore be sold too cheaply, distorting the market and increasing support costs to government. To overcome this challenge, respondents suggested the inclusion of a gainshare mechanism which allows developers to retain a percentage of the achieved sales price so as to encourage them to seek out the best price.

Several respondents proposed the GGR business model could build on the approach proposed for the hydrogen business model, with a dual reference price which combines the achieved sales price and an appropriate price floor. This could be coupled with a contractual price discovery mechanism to incentivise the project to maximise the sales price and reduce the difference payment. Some suggested that the UK ETS price may offer an appropriate price floor for GGR sales.

Alternative proposals

A small number of respondents suggested alternative options for setting the reference price. These included:

- Establishing a government-led registry to sell credits under the GGR business model, using this as a reference price. This could support future integration with compliance markets.

- Setting the reference price at £0 until there is a more mature voluntary market or GGRs are integrated into the UK ETS.

- Designing a reference price on a pre-determined trajectory, analogous to the approach adopted for the ICC business model. However, some warned that this could increase the strike price unless projects were confident of obtaining the reference price on the market, while another believed it is impossible to set a reliable reference price trajectory given the small market size.

- Linking the reference price to an average of existing prices in voluntary marketplaces. One respondent proposed the government could work with existing carbon marketplaces to collect market data, though others warned that this option presents high risks of linking the reference price to a shallow market signal and highly volatile prices.

- Technology-specific reference prices based on recent market activity and private sector buyer procurements. However, others noted that there may be significant price differentiation even within the same technology type, which could limit the feasibility of this approach.

Q9: What mechanism could the Government introduce to ensure that project developers achieve the highest possible sales price for negative emissions credits on the market?

Number of responses: 37

The consultation highlighted the risk that projects may have little incentive to find the highest price for their credits if a Contract for Difference is referenced to the achieved sales price. This is because, under the typical symmetric CfD structure, projects would receive the difference payment for any sales below the strike price, and would be required to repay revenues achieved above the strike price. Similarly, a Negative Emissions Payment may not encourage developers to seek the highest price for their credits if they are required to repay market revenues to back to the government. Stakeholders coalesced around two main approaches to overcome this challenge and ensure that projects seek out the highest sales price on the market: (i) a gainshare mechanism and (ii) the inclusion of negative emissions certificates in the UK ETS.

Many respondents believed a gainshare mechanism, where market revenues are shared between the government and developer, would be an effective route to ensuring GGR projects are able to benefit from higher market prices. A few respondents suggested the gainshare mechanism could be designed using a sliding scale or graduated ratios, though there were differing views on what form this should take: for instance, one respondent believed higher prices should enable developers to keep a larger proportion of the revenues, while others suggested the level of the gainshare should taper off as prices increase. Some stakeholders believed that allowing projects to receive 10-20% of sales revenues may provide a sufficient incentive to find the best price. It was noted that the costs of engaging with the market are relatively small and there are high levels of demand for high-quality negative emissions credits.

The other main proposal to address this challenge was to include negative emissions certificates in the UK ETS. A number of respondents argued this would increase demand for negative emissions and help to drive up their value. In turn, this would minimise risk to government and create a strong, established price for negative emissions. One stakeholder believed the government should ensure GGR projects have fungibility between compliance and voluntary markets, which would allow developers to seek the highest price.

The use of a price floor was suggested by some respondents to ensure a minimum price of sale, with a few proposing this should be linked to the UK ETS price. It was argued that a price floor could be incorporated into the contract by adopting a dual reference price, as proposed for the hydrogen business model. However, others believed that a minimum price may not be practical due to various factors such as significant variation in costs, market distortions arising from international policies, the lack of an appropriate benchmark for determining the price floor, and the risk of stifling a nascent market is the price floor is too high. A couple of respondents suggested that once the negative emissions market is more developed and the price has stabilised, the reference price for a CfD could be benchmarked to this market price to provide the government with value protection.

Some stakeholders proposed that government accreditation of negative emissions from rigorous GGR projects would create a premium for those credits in voluntary markets, and thereby help project developers to achieve higher sales prices. One respondent believed that projects will be incentivised to achieve the best possible price as they know the government contract has a finite duration, meaning there will be a clear incentive to have buyers already

accustomed to a certain price point at the end of the contract to ensure the project remains profitable.

A few stakeholders believed the need for price discovery incentives exposed an inherent weakness in both a CfD and NEP. It was argued that a Negative Emissions Guarantee would encourage developers to engage with buyers to obtain a sales price above the guaranteed price, since all revenues would accrue to the project; this would remove the need for government spend and make it more likely a market will develop. One respondent believed the challenges around a gainshare mechanism demonstrate the value of providing a high and flat fee, so the incentive to sell at a higher price is not affected and individual contracts are not required.

Two respondents believed it would be a mistake for the GGR business model to encourage developers to seek the highest possible price, on the basis that this would burden buyers with higher costs and potentially stifle demand.

Q10: What do you think is the most appropriate option for setting the length of GGR contracts? Please explain your rationale.

Number of responses: 32

Contract length was widely acknowledged to be an important design consideration and critical to the success of a GGR Business Model. Although we received a variety of views, there was a broad consensus on the following themes:

- The contract length must be sufficient to allow projects to recover their high capital investment and make a return by the end of the contract, and provide security of opex support while there is no stable negative emissions market.
- A longer contract will offer investors greater certainty and help to lower the costs of capital by reducing risk as well as spreading costs over a longer period.
- Setting initial contract terms too short could create a cliff-edge for developers if market demand has not developed to a sufficient scale and price to support merchant operation (to allow GGR projects to recover their operational costs through sales into these markets) after the expiry of subsidy support.
- A contract term of around 15 years would be appropriate, reflecting a number of factors such as the expected asset lifetime and capital-intensity of GGRs, the typical length of business model support for other low-carbon technologies in the UK, and the likely time it will take for a deep and reliable negative emissions market to become established.
- Different technologies may require different contract durations, meaning it may be appropriate for contract length to be negotiated bilaterally on a project-by-project basis. A number of respondents suggested the length could be 10-15 years, based on precedent in the DPA and ICC.

<u>Stakeholder views on contract length</u>

As a fundamental principle, many respondents stated that the length of GGR contracts must be sufficient to allow investors to achieve the required return on their investment before revenue

support expires. It was noted that longer contracts will provide greater certainty to investors and help developers to secure finance, particularly for first-of-a-kind projects that have high capital and operating costs.

Many stakeholders highlighted an important link between contract length and market growth. They argued that business model support should be provided until there is a fully functioning and reliable negative emissions market that enables projects to cover operating costs through market sales. Some respondents argued the contractual period should cover the asset life of the technology. Others expected that most projects would wish to continue operating on a merchant basis after contract expiry, and would prefer contracts of longer duration given uncertainty surrounding market growth and future prices.

Among those who expressed a view, there was near-unanimous agreement that a minimum 10 year contract term is required to attract investment in GGRs. However, most suggested that 15 years (or up to 15 years) would be more appropriate to ensure a sufficiently long period for capex repayment, provide security for opex support, and allow the development of a reliable market for negative emissions that enables these projects to run independently of government support. Several respondents also noted that a 15 year contract length would reflect similar support mechanisms for renewable, hydrogen and CCUS projects, while one believed it would also compete with the US tax credit system which provides support over 12 years. One respondent proposed that initial contracts should be awarded at 15 years, with subsequent contract rounds designed with longer or shorter contract lengths based on early experience of the FOAK projects.

A small number of respondents favoured a longer contract term. One believed a 15-20 year contract term is desirable given the high capital requirements of GGR facilities, while two respondents proposed a similar term for plants in the AD sector based on the technology lifecycle. One respondent believed 25-30 years would be ideal for institutional investors seeking longer-term fixed income. Another proposed a 40 year contract term to provide decades of certainty and support climate recovery.

In contrast, two stakeholders proposed the government should initially award shorter contracts of around 5 years to allow the industry to mature more quickly and minimise lock-in to higher strike prices. They argued that regular tenders for shorter contracts would support rapid learning, technology improvements and cost reduction. It was suggested that shorter contracts would incentivise market participants to decommission or upgrade obsolete plants, and participate in future tenders with improved technologies. However, other respondents argued that while shorter term contracts enable government support to end faster, they would also result in higher support costs in the near-term as contracts must cover the lifetime costs of the plant and provide a return on investment over a shorter period.

Many respondents suggested that different technologies may require different contract durations to attract investment, meaning it may not be appropriate to impose a single contract term across all technologies and project types. It was noted that optimal contract length may vary based on a variety of factors such as overall project cost, capital intensity, period of time required for debt repayment, asset lifespan, coordination with support mechanisms for co-products, and the different appetites of specific projects and financiers. A stakeholder also noted that companies will have their own hurdle rates on which to invest until the project capex is paid off, and these will vary from company to company.

Around half of respondents therefore believed it would be appropriate to determine contract length through bilateral negotiation, arguing that this would allow for sensible and investable contract terms that accommodate different considerations across technology pathways. Some specified that developers could negotiate contract length within minimum and maximum ranges set by the government.

A few respondents noted that the Dispatchable Power Agreement (DPA) and Industrial Carbon Capture (ICC) business models offer flexibility on contract length. The DPA provides an option for developers to select an appropriate contract length between 10 and 15 years, while the ICC allows for 10 years with the option of a 5-year extension if specific market conditions are met. It was suggested that the GGR business model could take a similar approach.

However, one respondent expressed concern that bilaterally-agreed contract lengths may not achieve fair results. Another respondent recognised the value of a flexible approach, but also noted that contract lengths should in principle be comparable and similar to allow the government to fairly evaluate bids.

Additional policy considerations

Beyond general feedback on contract length, a number of respondents put forward specific design considerations relevant to the contract term.

A few respondents suggested the GGR business model could adopt key design elements from the ICC, specifically (i) front-loading of capex repayments whereby the capex repayment is made over a shorter period to reduce the cost of finance and ensure best value for money, and (ii) the option to extend contract length if the market price does not cover the ongoing operating costs at the end of the original term.

A couple of respondents drew a distinction between new-build GGR plants and retrofits. One advocated a higher contract price over a shorter contract term for capex-heavy new-build facilities. Another suggested that new-build plants are likely to require a 15 year contract, while 10 year contracts combined with shorter capital repayment periods could be suitable for retrofitted projects.

A developer proposed that a business model which supports multiple CfDs may help address the risks of financing FOAK projects – for instance, an initial CfD for 15 years linked to UK sales only, followed by a secondary CfD to cover the duration of the asset's life where international sales are permitted and shared with government. Another respondent suggested that novel smaller-scale technologies could be awarded a higher price through a shorter length contract, given the expectation of cost reductions as production is scaled.

Q11: Would it be desirable to include a review mechanism in early GGR contracts? If no, please outline your reasons. If yes, please give your views on how a review mechanism might be designed.

Number of responses: 35

Stakeholders were divided on the merits of including a review mechanism in early GGR business model contracts. There was a broadly even split between respondents who believed a well-defined review mechanism could be beneficial in accounting for variability in opex costs and performance risk, and those who believed it would undermine revenue certainty and deter

investors. A handful of respondents were cautious of the dangers of a review mechanism but did not expressly oppose the idea. Many of those who supported a review mechanism nevertheless believed this must have clearly-defined boundaries to ensure it does not undermine investable conditions or the certainty provided by the contract.

Arguments in favour of a review mechanism

The most common argument in favour of a review mechanism related to the risk of variable opex costs. It was noted that GGR technologies often face uncertain opex costs (e.g. energy costs, biomass costs, solvent costs, T&S costs) that could impact on project viability if not accurately accounted for when setting the 'strike price'. Respondents therefore suggested it would be desirable to include a review mechanism to adjust the opex costs reflected in the strike price and reduce the risks to investors of unexpected price shocks. One developer noted the inclusion of an opex reopener in the ICC and believed this may also be beneficial for the GGR business model. A couple of respondents noted cost uncertainty associated with the long lead-in times for GGR projects, meaning that the agreed terms might be insufficient once the plant is fully operational.

A few respondents favoured a review mechanism due to the technical immaturity and uncertain performance attributes of GGR technologies, and associated risks to both the project developer and government. One developer proposed quarterly reviews during construction and commissioning, and semi-annual or annual reviews once the operational phase is underway. However, they cautioned that mechanisms to adjust the contract price at these reviews may cause uncertainty and potential conflict.

While recognising the value of a review mechanism, many stakeholders caveated that any review clause must not be designed in a way that could negatively impact investor certainty. It was widely argued that reviews should apply only in well-defined circumstances to be agreed before contracts are signed, and with clearly set boundaries and rules on the ability to modify terms within the contract. A trade association proposed the reviews should be based on the project performance against pre-agreed Key Performance Indicators (KPIs) and other metrics.

Arguments against a review mechanism

Several respondents opposed the inclusion of review mechanisms and reopeners on the basis this could undermine investor confidence in the stability of the contract and the likelihood of securing the desired return on investment. It was argued that a review mechanism could create an additional level of risk for developers and investors, which in turn could push up the initial cost of capital and contractual prices. Some also believed that a review mechanism would be 'counterproductive' and directly erode the certainty that contract-based support is intended to bring.

A common argument was that a well-designed contract should ensure commercial and market risks are properly identified and mitigated from the outset. For instance, a developer argued that a review mechanism should not be necessary if key risks and uncertainties are appropriately accounted for in the design of the contract, including uncertainty in the pace of market development, market price volatility, and operating costs. They warned that a review mechanism could be perceived as an effective shortening of the contract term and may reduce the project's access to debt capital, in turn increasing financing costs.

Another respondent similarly argued that the allocation process for the first contacts should be designed to ensure that both developer and government are comfortable with the deliverability

of the project and GGR contract terms. Instead of including a review mechanism, an academic believed that the very first contracts should receive full government support to cover their actual costs. A developer suggested that shorter contract lengths for initial projects should be preferred to review mechanisms.

A few respondents acknowledged that whilst a well-designed contract should not require a review mechanism in theory, there may be inherent uncertainties that it would be best for a review process to address (e.g. through a price adjustment or another mechanism to mitigate risk) rather than simply allocating those risks to one of the parties. A respondent argued that a review mechanism could mutually benefit the government and provider 'in exceptional and tightly defined circumstances'; for example, relief or an increased payment could be negotiated to salvage the project if rapid cost increases make the project nonviable. Some reiterated that any review should be limited in scope, with the exact terms agreed as part of the contract negotiations and clear limits to the degree of contract adjustment.

Q12: Should the Government allow project developers to combine negative emissions support under a GGR business model with other support mechanisms for co-products? Please provide arguments to support your view on whether this could be an effective route to supporting multi-product GGR projects.

Number of responses: 48

Response summary	
Yes	35
No	5
Don't Know	4
Did Not State / Not Clear	4

The majority of respondents supported the view that projects receiving the GGR business model should be permitted to access additional support for co-products, on condition this does not lead to double-subsidisation or other unintended consequences.

Arguments in favour of combining support mechanisms

Most stakeholders believed that projects should be allowed to combine the GGR business model with support for co-products such as electricity and hydrogen. The main arguments in support of revenue stacking were as follows:

- If projects are able to deliver multiple benefits, it is appropriate that they should be able to combine market revenues and support schemes for each service – provided the boundaries are clearly drawn and projects do not receive double-subsidy for the same costs.
- Allowing projects to combine revenues for multiple value streams will maximise the socio-environmental benefits of GGR projects, support multiple policy goals, and encourage innovation to design optimal processes.
- Some GGR projects, particularly BECCS, may deliver negative emissions as a co-product or additional service to the primary site function, such as low-carbon electricity,

hydrogen, biofuel production, and waste management. The government has identified a need for policy support for many of these services, and where plants are being retrofitted it will be essential that existing policy support is not disrupted.

- The ability to stack revenue streams is likely to make innovative GGR projects financeable and deliverable. Preventing projects from benefitting from GGR support in addition to other support mechanisms could limit deployment.
- Preventing projects from accessing multiple support schemes would create an artificially high price for the GGR subsidy as it would also need to cover co-product costs and the foregone support package. In contrast, access to diverse income streams will improve investor confidence and help to keep the GGR support price lower.

Several respondents noted that – in most cases – existing support schemes in sectors such as power, hydrogen, biofuels, anaerobic digestion and biomethane are not designed to support deployment of CCS or the production of negative emissions. They argued that a GGR business model should therefore be able to operate in conjunction with policies such as low-carbon Contracts for Difference (CfDs), the Renewables Obligation (RO), the Renewable Transport Fuels Obligation (RTFO), the Renewable Heat Incentive (RHI), the Green Gas Support Scheme (GGSS), and the Hydrogen Business Model without creating a risk of double-subsidy. This would reward the multiple benefits that GGR projects can bring to the economy, with separate benefits being rewarded by their respective support mechanisms.

However, a couple of respondents noted that any negative emissions used to meet the GHG threshold of low-carbon fuel standards – such as the Low Carbon Hydrogen Standard – should not be eligible for additional negative emissions support through the GGR business model.

A few respondents argued that the principle of revenue stacking is recognised in the proposed design of the power BECCS Business Model, which differentiates between a CfD for electricity and a CfD for negative emissions.

Policy considerations in relation to revenue stacking

As discussed above, there was strong agreement that stacking should only be permitted if support mechanisms are clearly delineated and double-subsidy is avoided (i.e. projects do not benefit from multiple support schemes for the same product or activity). Some argued that policy must be designed to ensure transparency and minimise the opportunity for gaming, while others cautioned that revenue stacking could over-incentivise certain technologies and create competitive distortions by tilting the market towards certain solutions. An academic institute said that any support for co-products will need to be carefully managed to avoid picking winners and suppressing innovation.

Given the complex interfaces between policies, one respondent believed bilateral discussions will be required for early projects to determine how such models interface in a way that is fair, financeable and avoids double subsidy. Another agreed that profits from other sources should be considered when negotiating a strike price. A developer suggested revenue stacking should be reviewed on an ongoing basis to understand any market failures that may have emerged.

Some stakeholders warned of the commercial risks and administrative challenges of stacking multiple support schemes to create an adequate business case. One respondent noted this could entail significant complexity due to the need to negotiate, align and execute multiple contracts at once. Others discussed the coordination risks of having to apply for multiple

funding schemes at different times and across different timescales. They highlighted the importance of alignment between support schemes and allocation rounds, for instance by running simultaneous auctions or contract awards. A couple of respondents believed it would be helpful to have a process to rationalise and then execute multiple support mechanisms under a single contract, as proposed for the power BECCS business model.

A small number of respondents considered the commercial opportunities of storing captured carbon in long-lived products. It was noted that such products will have economic value – for instance, a price premium for carbonated building materials. These respondents generally agreed that the level of GGR support should be adjusted when projects are benefiting from incremental revenue from product sales. For instance, a not-for-profit organisation suggested that any GGR support should deduct proceeds from the sale of products with sequestered carbon (e.g. biochar or long-lived building materials). They argued that the GGR payment must always be sized to fill the uncompensated gap between the levelised cost of the GGR, and the total incoming revenue from the activity.

A few stakeholders stressed that the GGR business model should not support the utilisation of captured carbon in short-lived products such as fuels, plastics and fertilisers. However, two respondents believed the policy should encourage the use of captured carbon for SAF production and low-carbon fertilisers respectively.

Arguments against combining support mechanisms

A small number of respondents opposed the principle of combining the GGR business model and other support schemes. A developer argued it is not appropriate for a project to enjoy a double benefit from taxpayer funded initiatives, and believed the contracted price for negative emissions should be adjusted to account for other funding received by the project. An NGO believed the negative emissions contract should be designed to reflect the full value of the project and so reveal costs. A charity suggested the ideal scenario is to have co-products provide a revenue stream to finance the GGR without additional support; for example, revenues from the sale of hydrogen or carbonated building products. Two respondents did not provide a reason for their view.

Q13: Do you believe that capital support instruments are necessary to complement GGR business models? If so, please outline your reasons and your preferred type of capex support mechanism.

Number of responses: 45

Overview of responses

Most respondents believed capital support instruments could play a valuable role in supporting novel and capital-intensive GGR projects to deploy. However, opinion was divided on whether capital support is a necessary or secondary component of the government's GGR policy.

Some respondents argued that capital support instruments address a unique barrier facing technology developers, and will be essential to ensure the delivery of certain projects. On the other hand, several respondents believed additional capital support should not usually be required for projects benefiting from revenue support through the GGR business model. It was widely argued that a well-structured business model delivering a stable revenue stream should

be sufficient to encourage investor confidence and enable developers to attract competitive financing, without the need for further capex support. Some noted that capital support fails to tackle the primary barrier to deployment, namely financial risk from market uncertainty.

Nevertheless, several of these respondents believed that capital support instruments could be a helpful secondary measure to ensure the widest possible range of GGR projects can access capital and attract investment at a sensible cost, particularly for FOAK projects. To complement the business model and support the investment case, they suggested the government could consider making capital support options such as grant funding or low-interest loans available on a case-by-case basis.

The role of capital support instruments

The main arguments for the providing capital support focused on the high capital costs and low technology readiness levels (TRL) of many GGR technologies.

Many stakeholders cited high capital costs as a key barrier to investment and argued the government can address this challenge by providing capital support instruments to complement the GGR business model. One respondent noted that many companies developing GGR projects are start-ups or SMEs that may find it very difficult to raise the capital required for their first plants.

A few respondents believed capital support should aim to make borrowing cheaper than from the financial markets. One stakeholder noted that if capital support is not available from government, then a project will need to be financed through the commercial sector. They argued that the costs of such financing will be incorporated into the project's overall costs and the contracted price agreed with government, and therefore the government's costs will be directly affected by the commercial cost of borrowing. Another noted that access to financing at competitive rates will become of even greater importance if interest rates are high.

The second key argument for capital support related to the significant technology risks involved in FOAK GGR projects. A number of respondents argued that GGR technologies have relatively low TRL and significant delivery risks, and may struggle to secure the required finance even with long-term revenue support. They suggested FOAK technologies would benefit from additional capital support to increase confidence and strengthen investment cases.

A developer suggested that capital support might persuade a hesitant investor to commit to financing a project employing novel technologies, while noting this would not address the fundamental risk of investing in an unproven technology that fails to perform as required. While the GGR industry is still immature, some respondents also highlighted the importance of innovation and demonstration funding to allow proof of concept and gain confidence in emerging technologies.

There was broad agreement that the need for capital support will vary across technologies. Many stakeholders noted that GGR technologies are at different stages of development and face different technology risks and investment needs. Some argued that while certain projects may be able to deploy successfully through a revenue support mechanism alone, capital support instruments are likely to be vital for others.

Type of capital support

Among those who expressed a view, the most popular options for capital support were capital grants and loans. Some respondents suggested capital grants may be the most straightforward mechanism to support project financing. For instance, one developer argued that a fixed payment during the construction period would reduce the overall project costs. Another respondent similarly argued capital support should be provided at the FEED and construction phases, but believed the quantum of capital support should be deducted from the value of the business model. However, one developer warned that the sums involved may be too large for grants to be a realistic option and stated that a grant would not directly protect lenders.

A trade association suggested that capital grants could be of value where companies are capital constrained, and also believed using capital funding to lower the strike price could make projects more competitive or reduce the level of debt. In addition, they argued grant funding or some form of guarantee could be valuable to cover elements of technical risk in a technology that would otherwise prove unfinanceable. They noted that this could reduce costs associated with technology risks and therefore encourage greater innovation.

Several respondents believed the government could support borrowing costs for initial plants through mechanisms such as loan guarantees with the commercial finance sector or direct provision of low-interest loans. For instance, one respondent believed it may be better value to the taxpayer for the government to provide access to low-cost debt financing, especially for initial plants where perception of risk is higher and therefore the cost of commercial borrowing is higher. Another argued that loan guarantees will allow developers to engage investors with reasonable return profiles and bridge gaps related to uncertainties around carbon markets. A respondent who preferred loan guarantees believed this could be effective at mitigating risk for investors, with the government guaranteeing or insuring projects against technology failure or construction delay.

A few respondents acknowledged the potential role the UK Infrastructure Bank (UKIB) could play in supporting the GGR industry. One stakeholder argued UKIB is well-placed to offer finance that provides support for specific high-risk issues that commercial lenders struggle to mitigate or price, given the nascent status of GGR technologies. They suggested the type of capital support offered could be based on risk; for example, the highest risk project might be offered equity investment, medium risk FOAK projects offered low interest debt and the lower risk projects offered debt guarantees.

A stakeholder argued that bank guarantees would be helpful to support new projects and pointed to other models that could be adapted for the GGR sector, including bounce back loans, coronavirus business interruption loans, and export credit guarantee scheme. Another respondent highlighted that loan instruments (either at beneficial rates or with the government acting as guarantor) are already deployed to good effect in the USA through the Department of Energy's Loan Programs Office.

A few respondents raised caveats and potential limitations of loan schemes. A developer warned that loan guarantees would only be effective if the government or UKIB takes on a meaningful additional level of risk and does not simply apply commercial terms. Another respondent noted that low-interest loans have been used by the European Investment Bank to improve the economics of particular projects, but in themselves did not improve the risk of a project and typically were only offered once projects were already well-structured, mitigating

risk to the lenders. They also argued that while loan guarantees can reduce the risk to project lenders, they will not address the equity risks of projects materially.

A small number of respondents highlighted the opportunity for the use of other capital support instruments such as equity investments.

Arguments against capital support

Only two respondents were opposed to capital support in principle. One respondent believed capital support should not form part of the government's policy framework for GGRs as this would lead to differential levels of support for different approaches. They argued that if a particular project requires a capex support mechanism in order to be competitive with techniques that have lower capex requirements, this is an inherent disadvantage of the technology which limits its deployment potential. Another stakeholder argued that capital support instruments would effectively subsidise the GGR business model and thereby obfuscate the true costs and value of negative emissions.

Q14: What other issues should the Government consider when progressing work on the design of a GGR business model? Please focus your response on issues that are not directly considered through this consultation.

Number of responses: 40

Stakeholders who responded to this question highlighted a wide range of issues for the government to consider when developing the GGR business model, some of which were explored elsewhere in the consultation document. The most common issues raised were: eligibility criteria and allocation timings, MRV standards and accreditation, and interactions with CO_2 transport and storage networks.

Several respondents reiterated the need for government-approved MRV standards and accreditation to build the legitimacy of GGR projects and underpin the growth of negative emissions markets. Some stakeholders urged the government to outline a clear definition for negative emissions and 'permanent' or 'long-term' storage. A few industry respondents focused on government accreditation of negative emissions from energy-from-waste projects supported by Waste ICC contracts. They argued that this would enable projects to sell negative emissions credits in the market whilst reducing support costs to government.

A number of respondents stressed the importance of early clarity on eligibility criteria, the timing of allocation windows, and the number of contracts likely to be awarded through the GGR business model. A research institute argued that investors and developers would benefit from early clarity from government on the required quantity of removals per annum, demonstrating a clear and credible path to meeting the UK's deployment ambitions. A few stakeholders advocated the inclusion of specific technologies in the business model, most notably biochar and solid carbon as an output of biohydrogen production.

Several respondents discussed the critical importance of CO_2 transport and storage (T&S) infrastructure, with some noting that the GGR business model will not achieve its objectives if T&S networks are not operational or accessible to GGR projects such as DACCS and BECCS. Stakeholders sought clarity on a number of issues in relation to T&S infrastructure, including:

- the design and sizing of T&S networks to accommodate GGRs

- how the business model will manage cross-chain risks such as T&S network delays and outages
- the treatment of T&S fees in the GGR business model, and the extent to which GGR contracts will protect developers against high and variable T&S costs.

One respondent suggested T&S fees may need to be supported as a separate payment through the business model. Addressing the risk of T&S delays and outages, some respondents expressed the view that payments for carbon capture should continue in the event of non-availability of these networks. One developer noted that the Dispatchable Power Agreement business model manages this risk through an Availability Payment, where the project developer still receives some payment to reward performance and availability to operate when the project developer is unable to operate due to problems with T&S networks. For the GGR business model, they suggested the mechanism should be adjusted such that it is paid based on carbon capture capacity (tCO_2/day). A not-for-profit organisation proposed the UK should work to ensure interoperable standards for shipping and pipelines via international partnerships to incentivise closer cooperation with North Sea countries.

Other issues raised by multiple respondents included:

- Speed of policy development: Respondents encouraged government to develop the business model at pace to enable investors and developers to anchor capital and development focus on the UK, particularly in light of the growing attention on the US market following the Inflation Reduction Act.
- Planning consents and permitting: It was argued that the business model should be developed in tandem with progress on the licencing and permitting pathways for GGRs.
- Price indexation: Some respondents noted that GGR projects may be highly exposed to fluctuating energy prices, and proposed that the level of support should be indexed to power prices in order to limit risk to investors. However, one developer did not agree that a GGR contract should include any insulation against opex price variability, and believed this risk should be managed by individual projects.
- Project co-benefits: A few respondents suggested the government should consider the potential for positive social impacts and co-benefits of GGR deployment. A not-for-profit organisation proposed that any recipient of business model support should integrate community benefit plans into their bids, for instance by drawing from local communities for their workforce. A developer suggested the business model should consider potential co-benefits of operating GGR technology such as improvement on local air quality or the regeneration of local infrastructure in deprived areas.
- Innovation: Alongside business model support, stakeholders believed the government should expand its commitment to support GGR R&D. It was argued this would help to improve the technology readiness levels of emerging innovations and bring them closer to market readiness. A developer proposed that the GGR business model should support innovation across all aspects of DACCS technology, and identified carbon capture solvents as a key area where efficiencies may be gained.
- Source of funding: A few stakeholders expressed views on how early GGR projects should be funded. An NGO suggested the aviation sector should make an appropriate contribution to developing engineered GGRs, in line with the ‘polluter pays principle’. A

trade association warned of the risks of significant carbon leakage and policy failure if the GGR business model imposed an excessive financial burden on energy intensive industries. A research institute acknowledged an equitable funding model will be vital to ensure public legitimacy and the feasibility of the policy. It highlighted recent research which concludes that income tax is the most progressive approach for ensuring that the policy costs of GGR deployment are fairly distributed across society.

- Licensing and export potential: Considering the role of the UK in the global GGR industry, a couple of respondents suggested that the greatest value to the UK economy may be in the innovation and licensing of GGR technologies to be deployed in other parts of the world (e.g. countries with lower energy and sequestration costs) and the export of high-quality MRV methodologies, rather than deployment of GGRs in the UK itself. In contrast, a developer believed that carbon credits could become a major export opportunity for the UK in the next few decades, to meet demand from countries that will not be able to build a GGR industry but will still need carbon credits to achieve net zero.

A number of points were raised by individual respondents. An environmental NGO urged government to set separate targets for greenhouse gas reductions and removals in law, maximise the deployment of nature-based solutions ahead of engineered removals, and establish an Office for Carbon Removal to regulate the credibility and integrity of GGRs. A developer argued the government should make explicit reference to the additionality of carbon credit revenues accruing to projects in receipt of business model support. A trade association highlighted poor public perceptions of GGRs as a potential barrier to investment, and called for stronger public engagement and clear communication of the benefits of these technologies.

To support innovation and breakthrough technologies, a developer suggested a portion of available support should be allocated to younger companies or smaller projects. A trade association proposed that business model support should be adapted to the maturity of the technology, with shorter length contracts for pilot scale plants. A developer said the government should consider the design of separate technology pots and how much funding to allocate to each. Another developer argued for flexibility on initial carbon capture rates for GGRs given the challenges associated with FOAK projects, potentially in the form of staggered performance testing over an 18-24 month period. A research institute said that lessons learned from the first GGR projects should be made public, as fully as possible.

Section 3: Building a market for negative emissions

Section 3 of the consultation outlined the reasons why a well-functioning negative emissions market will be essential to leverage private capital and support the Government's objectives for GGR deployment. It explored a range of market options for engineered removals, and invited views from stakeholders on the most appropriate market framework for supporting initial GGR projects over the next decade and how this may evolve over time.

The consultation identified two main approaches available to government for building a market for negative emissions to support GGR projects over the next decade:

- Compliance markets, in which demand for negative emissions is created by the need to comply with a regulatory target or emissions cap.
- Voluntary markets, in which actors choose to purchase negative emissions credits on a non-mandatory basis as part of their efforts to meet corporate net zero targets or other sustainability goals.

Two possible compliance markets for negative emissions were considered: inclusion of negative emissions in the UK ETS, and the creation of a GGR obligation scheme. It also explored two voluntary market approaches: delivering GGRs through existing third-party voluntary market bodies and verifiers, and establishing a central government-designed market for engineered removals.

Questions 15-18 invited views on the development of negative emissions markets to support GGR deployment. Stakeholder responses to these questions covered a number of overlapping and cross-cutting themes. We have therefore grouped the summary of responses to those questions as follows.

Q15: What do you believe is the most appropriate market framework for supporting initial GGR projects over the next decade, and how might this framework evolve over time?

Q16: What steps should the Government take to stimulate voluntary corporate demand for negative emissions credits?

Q17: To maximise voluntary private investment in negative emissions credits, would it be preferable for the Government to (i) establish a regulated market for engineered GGRs or (ii) directly endorse voluntary carbon market bodies that meet high integrity and verification standards? Please outline your view of the main benefits and challenges of each approach.

Q18: Would it be desirable for the Government to establish a regulated market for engineered GGRs to allow for future integration with the UK ETS and/or provide the foundation for a GGR obligation scheme? If so, how could this be achieved?

Number of responses: 40, 40, 37, 38 (respectively)

Overview of responses

There was no clear consensus on the most appropriate market framework to support initial GGR projects over the next decade. The majority of respondents supported the development of a compliance market as a long-term route to supporting GGR deployment, with many directly endorsing the inclusion of GGRs in the UK ETS. However, many respondents also recognised that voluntary markets offer a clear and immediate route to finance over the next decade.

To this end, a number of stakeholders highlighted the advantages of pursuing a combined approach which enables developers to trade in both compliance and voluntary markets. However, there were different views on the appropriate balance between voluntary and compliance markets, and the timing of a transition towards a compliance market.

Of those respondents who favoured the creation of a compliance market, the majority indicated a preference for integrating GGRs into the UK ETS. However, a number of complexities and challenges of this approach were identified – including the risk of market distortions, the treatment of free allowances, managing the volume of negative emissions certificates, and cap adjustments. A small number of respondents preferred other compliance-based mechanisms such as a GGR obligation scheme.

The international nature of voluntary carbon markets was identified as a significant advantage, potentially allowing developers to access a global customer base. Some respondents believed voluntary carbon markets could serve a valuable purpose in the near-term while the challenges of establishing a compliance market are addressed. However, several respondents highlighted concerns around the credibility and integrity of existing voluntary carbon markets, and pointed to the need for government intervention to unlock their full potential.

Options for establishing a compliance market

Most respondents identified the UK ETS as their preferred option for a compliance-based negative emission market, though there were differing views on the most appropriate timing for market integration. Some argued that GGRs should be integrated into the market as soon as is feasible, particularly those who believed voluntary markets already have the necessary rigour to support GGR deployment. However, a number of stakeholders advised caution on transitioning to a compliance market too quickly. These respondents highlighted the need to establish a reliable MRV framework, and to ensure market design does not lead to unintended impacts.

A small number of stakeholders favoured a separate GGR obligation scheme outside of the UK ETS. One respondent believed the government should rapidly develop mandatory corporate demand for negative emission credits, proposing that once price discovery has been achieved it may make sense to migrate to a GGR Obligation Scheme. The Producer Responsibility Obligation was suggested as a potential model for the scheme. They cautioned that any incentive linked to the ETS may be superseded in the coming years by efforts to implement a Carbon Border Adjustment Mechanism (CBAM).

One respondent suggested an obligation scheme would best serve early deployment by allowing the government to set a buy-out price based on the average strike price of GGR projects. Another noted that a standalone carbon takeback obligation scheme would avoid some of the design complexities of reforming the UK ETS to include negative emissions.

However, others were sceptical of the merits of an obligation scheme, particularly due to the challenge of setting a buy-out price given the highly diverse costs of GGR projects. A few stakeholders also noted the risks of unintended consequences such as carbon leakage.

Driving demand and credibility in voluntary markets

A recurring theme among respondents was the limited credibility of voluntary carbon markets, which was considered to limit their investment potential and overall confidence among investors and prospective buyers. The perceived lack of credibility in voluntary markets was widely considered to result from the absence of centralised, government backed standards. Concerns were also raised around the capacity of VCMs to provide sufficient support for the scale of GGRs that are deemed necessary for the UK to meet its deployment ambitions for 2030 and beyond.

Stakeholders shared a number of suggestions on how to address these concerns. Many respondents encouraged the government to establish its own MRV standards for high-integrity removals or to endorse standards developed by third-party organisations. Some stakeholders suggested the government should back initiatives aimed at ensuring that only companies with robust and credible decarbonisation strategies can access carbon credits, for instance the 'Science Based Targets Initiative' (SBTI). This would help to address the risk of 'greenwashing' and over-reliance on GGR credits at the expense of decarbonisation. Some respondents proposed the government could create a 'gold standard' for corporate net zero plans or pursue other routes to regulate corporate claims on the use of offsets.

A few respondents highlighted the need for standards to be consistent across voluntary carbon markets and compliance markets, in order to allow projects to participate in both types of markets most efficiently. One respondent suggested the government could directly purchase VCM credits to stabilise and add provide credibility to such markets.

Views on a government-designed voluntary market

Several respondents supported the creation of a separate, government-designed negative emissions market which could either operate long-term or act as an interim transition between voluntary markets and a compliance market.

It was suggested that this could help with the task of setting MRV standards and drive demand amongst voluntary buyers for credible government-certified removals, eventually facilitating the integration of GGRs in the UK ETS. Some went further and described this as essential to providing project assurance, whereas reliance on third-party platforms would lead to market segmentation and confusion over standards and availability of high-integrity credits.

In contrast, some respondents did not believe that a government-designed interim market would be necessary. The main reasons were that such a market would not have sufficient liquidity and that it would be more desirable for the government to endorse third-party schemes.

Section 4: Accounting and sustainability frameworks

Section 4 of the consultation set out the importance of accounting and sustainability frameworks to ensure that GGR projects deliver verifiable, permanent, and sustainable removals of CO_2 from the atmosphere. It explored key considerations in relation to the monitoring, reporting and verification (MRV) of engineered GGRs, and explored high-level principles that might be applied to ensure their integrity. It also considered some of the challenges and research gaps in this area, as well as the variety of existing standards and initiatives that could potentially support early deployment. We indicated that the government's immediate priority for MRV was to provide a clear definition for negative emissions and to conduct a review of existing market standards to inform decisions on the appropriate role of government in this area.

Q19: Do you agree with the government's immediate priority for MRV, including a review of standards that could underpin business model support for initial GGR projects? Please share any views or suggestions that could help to inform our approach.

Number of responses: 53

Response summary	
Yes	41
No	0
Don't Know	12

The majority of respondents to this question agreed with the government's immediate priorities for GGR MRV. Many respondents stated the establishment of credible and reliable MRV standards is critical to underpin business model support for GGR projects and a future negative emissions market. Responses indicated that a standardised MRV framework will be necessary for the success of a credible long-term negative emissions market, building public trust and preserving the integrity of the market.

Stakeholders suggested a review of existing MRV standards would be a good starting point for government work and it was highlighted that developing MRV policy from scratch, without due regard for existing MRV protocols, would risk unnecessarily complicating the market. Stakeholders emphasised the importance of including a range of standards in scope of any review, including the ISO Standard, the Integrity Council for the Voluntary Carbon Market (IC-VCM), the CCS+ Initiative, and the Oxford Principles for Net Zero Aligned Carbon Offsetting. Stakeholders also suggested that the review of standards should be made publicly available. A trade association agreed that there was a strong rationale for conducting a review of existing standards for MRV across a broad range of GGR technologies and there was recognition that a single standardised MRV protocol would be unlikely to be able to be applied across a diverse suite of GGR technologies.

Some respondents stated that the review of standards ought to consider the international landscape to inform government and market participants on the range and quality of existing standards for MRV that are available. There was a suggestion that for MRV within the UK to remain relevant, it would need to be aligned to the international context. One respondent argued that alignment with international standards would enable international applicability of negative emission credits from UK GGR projects.

A developer called on the government to consider that the review of standards may result in a number of acceptable solutions and not limit the number that may be implemented.

Beyond a review of standards, stakeholders commented more broadly on government's approach to MRV. One stakeholder suggested the government should have a flexible approach to defining standards to ensure the MRV criteria remain fit for purpose as new technologies emerge. They suggested standards need not be overly prescriptive, and that the government could consider outlining a framework that would allow different MRV standards to operate, as long as they are sufficiently robust, to ensure the legitimacy of negative emissions while allowing the industry scope to innovate. A developer cautioned that MRV policy design would benefit from pragmatism as well as being broadly applicable across GGR technologies rather than 'theoretically perfect.'

An academic organisation indicated greater emphasis should be placed on upholding the highest standards of environmental protection and proposed that the government commits to including sustainability frameworks as an immediate priority for MRV. It argued environmental and sustainability criteria should be considered as part of the review of standards alongside other approaches to promoting sustainability such as certification schemes.

Some stakeholders highlighted the importance of ongoing monitoring and auditing to confirm that GGR projects meet standards throughout their lifetime. However, it was also noted that government should consider that any administrative burden is proportionate. It was noted that the risk of non-compliance could be mitigated by minimising reporting burdens on market participants. Simplifying compliance to minimise barriers to entry for smaller scale GGR projects was also suggested. One academic organisation commented that GHG emissions reporting is currently disjointed, and limits the overall transparency of emissions and ability to track progress towards net zero.

Robust MRV was perceived by many stakeholders to be critical to the viability and credibility of any negative emissions markets. Some respondents believed that eventual inclusion of GGRs in the UK ETS is the best path forward, and therefore MRV standards should align with existing UK ETS standards. One stakeholder offered examples of existing regulatory approaches to MRV included in the ETS that contains rules and audit practices for the physical measurement of carbon emissions. Similarly, the Renewable Obligation sets thresholds for greenhouse gas emissions from the biomass supply chain and any supported biomass must meet land-based sustainability criteria.

Q20: Beyond ensuring the legitimacy of initial projects, what is the appropriate role for the government in developing a robust and enduring framework for negative emissions MRV, compared to the role of other bodies such as those outlined in Figure 1?

Number of responses: 39

In response to this question, the majority of respondents indicated that the government has an important role in developing a robust and enduring framework for negative emissions MRV. However, there were mixed views as to how the government should achieve this, with stakeholders highlighting three leading options in their responses.

First, some stakeholders proposed that government should develop its own standards and MRV protocols from scratch. These stakeholders argued that a single government standard would simplify the MRV landscape for potential purchasers and developers by creating a single standard that all projects must meet. They also suggested that a government designed standard would ensure a high level of transparency and integrity in the market, as it would be separated from commercial interests. A few respondents proposed that while the government should set its own MRV standards, it should rely on approved third party bodies to carry out independent validation and verification.

Second, another option put forward was that government should approve or endorse existing third-party voluntary market standards that meet a certain quality threshold. These stakeholders argued that this approach would prevent overcomplication of the market and duplication of work already undertaken in the voluntary sector. One stakeholder suggested that approved standards should be accepted unless there are inconsistencies in the methodologies and/or outcomes of the standards, with a responsibility for government to ensure standards are appropriate. Advocates of this approach believed that using existing standards had the potential to minimise reporting burden on market participants and simplifying compliance. There was a suggestion that government endorsement of standards could help to develop consistency across the voluntary market and act as a market signal to non-expert buyers of negative emissions credits.

Third, some stakeholders suggested a hybrid approach whereby government should initially adopt voluntary market standards in the short term, whilst developing its own standards in the longer term. The rationale given for this approach was that, over time, a single government standard would provide greater clarity for market participants and foster consistency between voluntary carbon market bodies. Governance and the potential for conflicts of interest was raised as a risk for voluntary markets, and respondents suggested that government-led standards would help to ensure a high level of transparency and integrity in the GGR projects supported.

There were other variations of the hybrid approach proposed, including that academics should lead on MRV, adding that they should agree an approved 'gold standard' which would be reviewed and monitored by the government and be the required baseline for compliance with existing regulatory policies. Alternatively, one respondent suggested that government should ‘rubber stamp’ MRV for specific projects without endorsing or creating a wider MRV framework. One stakeholder suggested that government should establish a set of overarching

principles for early GGR projects to meet, and then perform due diligence on these standards to ensure they are sufficiently robust, rather than creating a detailed MRV framework for early projects. One stakeholder suggested an independent public body should aim to set standards, designate approved removals and where necessary help address outstanding scientific questions.

Other wider points related to MRV were also raised, including:

- Some respondents made reference to the MRV Task and Finish Group report, encouraging the government to act on the recommendations from the report, particularly the implementation of an oversight body.
- Some responses requested external expertise to be sought in the development of the MRV standards as GGRs create a wide range of societal impacts and external expertise can help weigh up the trade-offs between those impacts and the benefits derived from them.

Q21: Do you agree with our proposed principles for negative emissions legitimacy?
Number of responses:45

Response summary	
Yes	30
No	1
Don't Know	14

Most stakeholders that responded to this question agreed with the proposed set of principles for determining the legitimacy of a negative emission, which drew on the MRV Task and Finish Group's advice. Respondents endorsed the principle-based approach, while recognising that different technologies are likely to achieve these principles through different methods.

There was broad agreement with the proposed definitions of GGR legitimacy, although one respondent added these should be underpinned by assessment criteria. Many of the respondents who agreed with the principles, suggested slight modifications and/or additions.

In response to the definition of CO_2 source, a few respondents suggested capture from seawater should also be considered a negative emission. One stakeholder stated that they agreed CO_2 should be atmospherically sourced whilst another suggested that the government removes "directly, or via biological means" to reflect other options for delivering negative emissions. A developer stated the definition of CO_2 source is useful as it allows for a variety of solutions and differentiates from emissions captured from an emitting source.

For the definition of net negativity, stakeholders raised different ways this could be considered. One stakeholder concluded lifecycle GHG emissions must be lower than the total GHG

removals over the lifetime of the GGR project's operation. Another stated that supply chain CO_2 emissions must be lower than the total amount of stored carbon, regardless of the size of supply chain emissions. A third stakeholder agreed that government should apply a threshold for supply chains emissions, which could decrease over time, but argued this should be applied to gross CO_2 removals.

In respect of the definition of permanence and usage, one respondent disagreed it should be a criteria for negative emissions and instead suggested that a discounted rate should be applied to carbon credits to reflect the durability of storage as assessed by government. Another stakeholder expressed concerns that geological storage was the only method recognised by the criteria and suggested it should be widened to include other forms of storage (e.g., concrete).

One respondent believed additionality could be introduced as a fourth definition for determining the legitimacy of a negative emission, i.e., proof that the carbon removal activity is additional to what would have otherwise occurred in the absence of the GGR intervention.

Section 5: Applicability across different GGR technologies

Section 5 considered the applicability of the proposed Greenhouse Gas Removal (GGR) business model across different technologies, and how it might interact with other policies and business models under development.

Q22: Are there specific policy requirements for initial DACCS projects that the Government should take into consideration? Please provide arguments to support your view.

Number of responses: 28

Overview of responses

Respondents expressed a range of views relating to the characteristics and policy requirements of DACCS, and the extent to which it is appropriate or desirable to tailor policy support for specific technologies. A number of respondents argued that DACCS could play an important role in addressing emissions from hard-to-abate sectors and may require additional or adapted policy support in order to address particular technology risks. Some of those respondents agreed with the policy considerations listed in the consultation and suggested these should be explored further as the GGR business model is developed. However, others argued that the same type and level of support should be available to all technologies, and some expressed concern over the high energy-intensity of DACCS.

Stakeholder views on DACCS policy requirements

Several respondents stated that GGR policy should be tailored to reflect the needs of different technologies and highlighted specific risks of DACCS technology that should be addressed in policy design. Respondents generally focused on the technology's high capital costs, lack of co-product revenue, and sensitivity to energy prices. Some industry stakeholders argued that separate technology pots and bilateral negotiations will be required to ensure DACCS projects receive an appropriate strike price and are not automatically disadvantaged compared to lower-cost technologies. It was also suggested that the government could introduce capital support instruments such as grant funding or loan guarantees to assist with high capital costs.

Respondents put forward a number of proposals to mitigate the risk of high or uncertain energy prices for DACCS projects, include strike price indexation, energy price caps, and limited reopeners to ensure correct pricing for power. One trade association said that any such measures should also be applied to other carbon capture projects to ensure equal treatment. A developer highlighted that low-carbon heat from nuclear can play a positive role in enabling and enhancing DAC processes and lowering costs. On a similar note, a research institute shared a study showing that intelligent deployment via siting and energy source selection is critical to deliver DACCS cost reductions.

Further suggestions for policy support for DACCS included streamlined planning permissions for projects that deliver co-benefits (e.g. improvement of local air quality or the regeneration of

local infrastructure), and frontloading capex repayments (to reduce the cost of finance over the project lifetime and unlock private investment at best value for money).

Two developers pointed out that ocean carbon capture (via absorption) is an equivalent process that shares many of the same risks and challenges identified for DACCS, and should therefore benefit from the same policy support.

Concerns relating to policy support for DACCS

Some respondents argued that the same level of policy support should be applied to all technologies, and cautioned that neither DACCS nor any other technology should receive a different level of support simply due to its cost or other characteristics. One developer stated that many BECCS projects have similar risk profiles to DACCS as well as comparable potential for technological and cost improvement. A not-for-profit organisation believed that instead of adjusting support for DACCS specifically, policy should follow a general principle of making adjustments to support all early-stage GGR methods and their unique barriers.

Several respondents raised concerns over the high energy requirements of DACCS, noting that its ability to deliver negative emissions depends on a supply of low-carbon energy. Some said that the operation of DACCS facilities should not divert renewable energy away from other decarbonisation priorities, such as electrification of transport and heat. An NGO believed DACCS deployment should be tied to the additional deployment of renewable energy required to power the installation, while an environmental consultancy argued that DACCS projects should be required to show that their operations are not leading to additional fossil fuels use. A developer said there must be safeguards against a scenario in which CO_2 is emitted to the atmosphere at a relatively high partial pressure through power generation in order to capture CO_2 from the atmosphere at a low partial pressure.

Individual respondents highlighted the carbon footprint and environmental impacts of constructing DACCS facilities, as well as the impacts on land availability. A trade union believed that CO_2 captured from DAC should be utilised for the production of Sustainable Aviation Fuels (SAF) rather than storage.

Q23: Do you have views on the applicability of the GGR business model to BECCS projects that are not eligible for the Industrial Carbon Capture or power BECCS business models?

Number of responses: 33

Overview of responses

A large majority of respondents to this question believed that the GGR business model could play an important role in supporting BECCS projects that require policy support for negative emissions but are not eligible for the Industrial Carbon Capture (ICC) and power BECCS business models. There was general agreement that the GGR business model should have wide applicability to a range of BECCS technologies, with some suggesting that it should serve

as the “umbrella mechanism” for negative emissions projects that are not supported under existing policies. Several respondents encouraged the government to clarify eligibility criteria, allocation timings, and project maturity criteria as soon as possible in order to give certainty to industry on whether projects will be eligible for support.

Many respondents focused on specific technologies and their interactions with the GGR business model. In their answers, however, a number of respondents also raised wider considerations in relation to GGR policy and its applicability to BECCS. These largely focused on the importance of sustainable biomass feedstocks and a rigorous lifecycle assessment to ensure BECCS projects deliver their intended environmental benefits. A few respondents said that future policy on BECCS should be informed by the forthcoming Biomass Strategy, while two suggested the government should prioritise BECCS projects using waste biomass streams rather than virgin biomass. Some respondents recommended that sustainability criteria and MRV/LCA standards should be applied consistently across BECCS technologies regardless of which business model they are supported under.

A few respondents stressed the importance of avoiding double-subsidisation for any BECCS projects that are receiving policy support for multiple services (e.g. negative emissions and low-carbon energy). A not-for-profit organisation suggested a reorientation away from the term ‘BECCS’ towards a more inclusive term that encompasses non-energy-generating biogenic carbon capture and storage solutions that can deliver negative emissions. It argued that the GGR business model should be open to both BECCS and non-energy biogenic GGR projects that are not eligible for other business model support.

Stakeholder commentary relating to specific types of BECCS are summarised below.

Industry BECCS

Respondents acknowledged that the Industrial Carbon Capture (ICC) business model provides support for deploying CCS in industrial facilities. However, a trade association raised concern that this does not provide an incentive to switch from fossil fuels to waste biomass in cement and lime production sites. It suggested that industrial CCS projects should be able to participate in negative emissions markets to ensure that the capture of biogenic CO_2 attracts an additional benefit.

Waste BECCS

Two trade associations commented that the Waste ICC business model is the correct mechanism to support investment in CCS in the waste sector, and no support is therefore required through the GGR business model. However, respondents argued that government endorsement of negative emissions from Waste ICC projects will strengthen voluntary demand for those negative emissions and accelerate the implementation of CCS across the waste sector.

Power BECCS

A number of respondents referred to the eligibility criteria set out in the power BECCS project submission guidance, published in August 2022. Some recommended that the eligibility thresholds set out in the guidance should be amended, while others suggested that the GGR business model should be applicable to projects that do not meet these criteria. Two respondents disagreed with the creation of a bespoke business model for power BECCS projects and argued that this is inconsistent with a technology-neutral approach to GGR deployment.

Hydrogen BECCS

Multiple respondents discussed the interaction of the Hydrogen business model and GGR business model in relation to hydrogen BECCS technologies. It was acknowledged that support for hydrogen BECCS can deliver negative emissions and accelerate the deployment of low-cost hydrogen. Most of these stakeholders, including developers and trade associations, proposed that the two policies could be used in combination to incentivise different parts of the process, with the Hydrogen business model rewarding hydrogen production and the GGR business model rewarding negative emissions. It was noted that the Hydrogen business model aims to stimulate investment in low-carbon hydrogen products through price and volume support for producers, but does not provide any incremental value for emissions reductions beyond the 'low carbon hydrogen standard' threshold and does not reward negative emissions.

There was general agreement on the merits of providing separate support mechanisms for each output. One developer argued that this would allow re-balancing between support mechanisms for the separate outputs as the respective markets for these develop in the future. Another developer agreed that, in the long-term, the value of both elements will be set by the markets for low-carbon fuels and negative emissions, and government policy should therefore attempt to "track the market" as far as possible. It proposed that support for low-carbon fuels should be set at the same level as support for low-carbon fuels produced without carbon sequestration, while support for negative emissions should be set at a similar level to other comparable GGR projects.

Anaerobic Digestion/Biomethane BECCS

Several respondents believed it is vital that the Anaerobic Digestion (AD) industry is appropriately recognised within the GGR business model. Respondents highlighted that while policy support is in place for the production of biomethane, such as the Green Gas Support Scheme, this does not incentivise the installation of capture plants. They proposed that the GGR business model could be used to support the installation of CCS and unlock the potential for negative emissions from AD plants.

Some respondents suggested that BECCS AD and Biomethane represents one of the most cost-effective technologies capable of delivering negative emissions, and at its full potential the AD industry could generate over 8 million tonnes of bio-CO_2 for storage by 2030. It was noted that AD plants are not currently eligible for the ICC, Waste ICC or power BECCS business models.

However, a trade association cautioned that GGR contracts must not undermine other forms of policy support for decarbonising the waste and resources sector. It said that the relationship between these different forms of support is complex and should warrant further investigation to avoid any potential unintended consequences.

Biofuels BECCS

Stakeholders expressed a range of views on the most appropriate way to support negative emissions from biofuel projects. It was noted that biofuel projects will not be eligible for the ICC business models if they are outside a cluster, while existing support schemes such as the Renewable Transport Fuels Obligation (RTFO) and Green Gas Support Scheme (GGSS) are not designed to provide support for negative emissions and future schemes such as the Sustainable Aviation Fuel (SAF) mandate have not confirmed how negative emissions will be treated.

Two developers argued that negative emissions from biofuel projects should be supported via the GGR business model. They noted that existing biofuel support schemes (e.g. RTFO, GGSS) vary significantly in terms of the level of support offered to different fuels/end-use sectors and the way they are implemented, and therefore incentivising negative emissions through these schemes would require significant changes. One believed that providing negative emissions support through the GGR business model would “create a level playing field” for projects across different end-use sectors.

A trade association agreed that the RTFO should not be altered to cater for negative emissions, and proposed that RTFC-earning projects should be eligible for the GGR business model. With respect to SAF, however, it recommended allowing the SAF producer to choose between having their project value the negative emissions via the SAF mandate or a GGR business model.

For SAF projects that deliver negative emissions, a developer suggested that the simplest approach would be to recognise the full benefit of the negative emissions in SAF mandate certificates. While noting that this would not align with the approach for other transport policies that do not recognise negative emissions (e.g. RTFO), it believed that an integrated approach would be preferable to a split revenue model in which negative emissions are rewarded under a GGR business model while emissions savings (excluding sequestration) are rewarded under the SAF mandate. It raised concerns that rewarding these benefits separately would fail to recognise that the benefits provided by a SAF project with CCS are “uniquely integrated” – combining decarbonisation of a hard-to-abate sector with waste treatment and carbon sequestration – and could leave SAF projects competing for GGR contracts on an unequal basis with other projects which do not offer the same benefits.

Various respondents noted that a number of existing and planned biofuel projects are located outside of the CCUS clusters, and called for non-pipeline transportation to enable these projects to realise the benefits of carbon sequestration and negative emissions.

Q24: Do you have views on the applicability of the GGR business model to novel technologies excluding DACCS and BECCS? Please outline any specific policy requirements or other considerations we should take into account.

Number of responses: 30

There was strong agreement among stakeholders that the GGR business model should have the flexibility to support a broad range of novel and evolving technologies. It was argued that this would encourage innovation, promote diverse negative emissions markets, and enhance UK leadership in the GGR sector.

Several respondents advised that GGR policy should be outcome-led rather than technology-focused. It was widely suggested that the GGR business model should be underpinned by clear government-defined standards and definitions for 'negative emissions', based on a robust MRV framework and guidelines on storage permanence. Novel technologies could be eligible for the GGR business model as long as they achieve negative emissions that meet those government-defined criteria.

Multiple respondents argued that the GGR business model should be open to different forms of carbon sequestration and should not be limited to processes that involve geological storage. In particular, a considerable number of respondents argued that biochar should be within scope of the policy. Some agreed with the government's stated intention to develop an improved evidence base to better understand the benefits and risks of biochar, and encouraged the government to set out a clear timetable for this work. A few said that the government should explicitly aim to include biochar at a later stage.

In addition to biochar, multiple stakeholders supported the inclusion of other GGR methods such as enhanced weathering, ocean carbon capture, and mineral carbon storage in cement or concrete. A few noted that there are already projects underway in other countries using these types of technology. Other technologies for consideration included bio-oil for geologic sequestration, solid carbon from the production of biohydrogen, and mineralisation of wastes such as alkaline slag and mine tailings. A not-for-profit organisation advised that the primary inclusion criteria for the GGR business model should be the achievement of safe and long-term carbon storage that is "highly durable with a vanishingly low reversal risk". It believed this definition would include many methods that store carbon in above-ground mineral forms, long-lived building materials, ocean sediments, geological reservoirs, disused gas and oil wells, and other locations.

One respondent expressed concern that support for novel technologies may distract from the deployment of more proven and established technologies. Wider policy suggestions included protection from high CO_2 transport and storage costs for smaller project developers, and streamlined permitting processes to ease the regulatory burden on businesses and accelerate GGR rollout.

Endnotes

1. IPCC (2022), 'Summary for Policymakers' in Climate Change 2022: Mitigation of Climate Change, Contribution of Working Group III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change, https://www.ipcc.ch/report/sixth-assessment-report-working-group-3/
2. HM Government (2023), 'Mission Zero: Independent Review of Net Zero', https://www.gov.uk/government/publications/review-of-net-zero
3. National Infrastructure Commission (2021), 'Engineered greenhouse gas removals', https://nic.org.uk/studies-reports/greenhouse-gas-removals/
4. HM Government (2021), 'Net Zero Strategy: Build Back Greener', https://www.gov.uk/government/publications/net-zero-strategy
5. Department for Business, Energy and Industrial Strategy (2022), 'Business models for engineered greenhouse gas removals: accelerating investment in engineered carbon removals', https://www.gov.uk/government/consultations/greenhouse-gas-removals-ggr-business-models
6. HM Government (2022), 'Powering up Britain: Net Zero Growth Plan', https://www.gov.uk/government/publications/powering-up-britain/powering-up-britain-net-zero-growth-plan
7. UK ETS Authority (2022), 'Developing the UK Emissions Trading Scheme (UK ETS)', https://www.gov.uk/government/consultations/developing-the-uk-emissions-trading-scheme-uk-ets
8. Department for Business, Energy and Industrial Strategy (2022), 'Business model for power bioenergy with carbon capture and storage (Power BECCS)', https://www.gov.uk/government/consultations/business-model-for-power-bioenergy-with-carbon-capture-and-storage-power-beccs
9. Department for Energy Security and Net Zero (2023), 'Power bioenergy carbon capture and storage consultation: government response', https://www.gov.uk/government/consultations/business-model-for-power-bioenergy-with-carbon-capture-and-storage-power-beccs
10. The State of Carbon Dioxide Removal (2023), 'A global independent scientific assessment of Carbon Dioxide Removal 1st Edition', https://www.stateofcdr.org/
11. Direct Air Capture and other Greenhouse Gas Removal technologies competition, https://www.gov.uk/government/publications/direct-air-capture-and-other-greenhouse-gas-removal-technologies-competition
12. UK Infrastructure Bank (2022) Strategic Plan, www.ukib.org.uk/strategic-plan
13. Frontier Climate, https://frontierclimate.com/
14. Microsoft, www.microsoft.com/en-us/corporate-responsibility/sustainability/carbon-removal-program
15. Swiss Re, www.swissre.com/media/press-release/nr-20210825-swiss-re-climeworks-partnership.html
16. JPMorgan Chase, www.jpmorganchase.com/news-stories/jpmorgan-chase-seeks-to-scale-investment-in-emerging-carbon-removal-technologies
17. HM Government (2023), 'Mobilising green investment: 2023 green finance strategy', https://www.gov.uk/government/publications/green-finance-strategy

18. Integrity Council for the Voluntary Carbon Market (IC-VCM), www.icvcm.org/the-core-carbon-principles/
19. Voluntary Carbon Markets Integrity Initiative (VCMI), https://vcmintegrity.org/
20. Transition Plan Taskforce, https://transitiontaskforce.net/
21. Department for Energy Security and Net Zero (2023) Cluster sequencing for carbon capture, usage and storage (CCUS): Track-2, www.gov.uk/government/publications/cluster-sequencing-for-carbon-capture-usage-and-storage-ccus-track-2
22. Department for Business, Energy and Industrial Strategy (2021), 'MRV Task and Finish Group: Monitoring, reporting and verification of greenhouse gas removals' , https://www.gov.uk/government/publications/monitoring-reporting-and-verification-of-ggrs-task-and-finish-group-report

List of sources – Table 1: Alternative CO_2 storage options for non-CCUS projects

Babiker, M. et al. (2022), Cross-sectoral perspectives. In IPCC, 2022: Climate Change 2022: Mitigation of Climate Change. Contribution of Working Group III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change

Beerling et al. (2020) Potential for large-scale CO2 removal via enhanced rock weathering with croplands, Nature, https://www.nature.com/articles/s41586-020-2448-9

Buckingham et al. (2022) Soil core study indicates limited CO2 removal by enhanced weathering in dry croplands in the UK, Applied Geochemistry, Volume 147, 105482, https://doi.org/10.1016/j.apgeochem.2022.105482

Campbell et al. (2022) Geochemical Negative Emissions Technologies: Part I. Review, Frontiers in Climate, https://doi.org/10.3389/fclim.2022.879133

Chiquier et al. (2022) A comparative analysis of the efficiency, timing, and permanence of CO2 removal pathways, Energy Environ. Sci., https://pubs.rsc.org/en/content/articlelanding/2022/ee/d2ee01021f

Crequtzig, F. et al. (2022), Demand, services and social aspects of mitigation. In IPCC, 2022: Climate Change 2022: Mitigation of Climate Change. Contribution of Working Group III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change.

Fawzy et al. (2021) Industrial biochar systems for atmospheric carbon removal: a review, Environmental Chemistry Letters volume 19, pages 3023–3055, https://link.springer.com/article/10.1007/s10311-021-01210-1#Tab2

Fuss et al. (2018) Fuss et al. (2018) Negative emissions—Part 2: Costs, potentials and side effects, Environ. Res. Lett. 13 063002; https://iopscience.iop.org/article/10.1088/1748-9326/aabf9f/meta

Hepburn et al. (2019) The technological and economic prospects for CO2 utilization and removal, Nature volume 575, pages 87–97, https://www.nature.com/articles/s41586-019-1681-6

Hills et al. (2020) Mineralization Technology for Carbon Capture, Utilization, and Storage, Front. Energy Res., https://doi.org/10.3389/fenrg.2020.00142

Hoglund, R. (2022) Carbon can be temporarily stored for a long time, Illumenim voice, https://illuminem.com/illuminemvoices/8203562b-c83d-47b7-b316-6da2d26efe9a

Jeswani et al. (2022) Environmental sustainability of negative emissions technologies: A review, Sustainable Production and Consumption, Volume 33, Pages 608-635, https://doi.org/10.1016/j.spc.2022.06.028

Kelemen et al. (2020) Engineered carbon mineralization in ultramafic rocks for CO2 removal from air: Review and new insights, Chemical Geology, Volume 550, 119628, https://doi.org/10.1016/j.chemgeo.2020.119628

The Royal Society and Royal Academy of Engineering (2018) Greenhouse Gas Removal, https://royalsociety.org/topics-policy/projects/greenhouse-gas-removal/

Schmidt HP., et al. (2022) Permanence of soil applied biochar, the Biochar Journal, Arbaz, Switzerland. ISSN 2297-1114 www.biochar-journal.org/en/ct/109

Verra (2021) Methodology for biochar utilization in soil and non-soil applications, https://verra.org/methodologies/methodology-for-biochar-utilization-in-soil-and-non-soil-applications/

Woolf et al. (2021) Greenhouse Gas Inventory Model for Biochar Additions to Soil, Environ. Sci. Technol. 2021, 55, 21, 14795–14805, https://doi.org/10.1021/acs.est.1c02425

This publication is available from: www.gov.uk/government/consultations/greenhouse-gas-removals-ggr-business-models

If you need a version of this document in a more accessible format, please email alt.formats@beis.gov.uk. Please tell us what format you need. It will help us if you say what assistive technology you use.