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Foreword

Since 1990 the UK has almost halved our greenhouse gas emissions.¹ Thanks to the efforts of successive governments, we are almost half-way to ending the UK's domestic contribution to man-made climate change, and in 2019 the UK became the first major economy in the world to legislate to finish the job with a binding target to reach net zero emissions by 2050.

Our Net Zero Strategy² set out the next steps we will take to cut our emissions, seize green economic opportunities, and leverage further private investment into net zero. The primary method of achieving net zero is to take ambitious decarbonisation measures across society. However, we acknowledge that sectors such as industry, agriculture and aviation will be difficult to decarbonise completely by 2050. Greenhouse gas removals (GGR) are therefore essential to compensate for the residual emissions arising from the most difficult activities to reduce or eliminate from within polluting sectors.

The UK is well-placed to take a leading role in GGR policy development and deployment. We have world-leading academic and industry expertise in relevant sectors, as well as a rapidly developing carbon capture usage and storage (CCUS) sector and access to large volumes of quality geological CO2 storage.

Across government, we are investing £100 million in the research, development, and demonstration of GGRs. This includes the Direct Air Capture and other GGR innovation competition which will support the construction of pilot plants for a range of promising technologies to help them achieve commercial realisation.

Enabling GGR deployment will not only help us achieve net zero but will also maximise the economic and regional development opportunities of developing the low carbon economy in our industrial heartlands. Economic benefits include creating new, highly skilled jobs in our industrial heartlands and safeguarding those existing in adjacent sectors with the potential to be adversely affected by the transition to net zero, as well as supply chains.

In the Net Zero Strategy, we announced a number of key commitments on GGRs:

- Set the ambition of deploying at least 5 MtCO2/year of engineered removals by 2030, in line with Climate Change Committee and National Infrastructure Commission assessments.
- Deliver £100 million innovation funding for Direct Air Carbon Capture and Storage (DACCS) and other GGRs.
- Develop markets and incentives for investment in greenhouse gas removal methods, by consulting on our preferred business models to incentivise early investment in GGRs.

¹ <u>https://www.gov.uk/government/statistics/final-uk-greenhouse-gas-emissions-national-statistics-1990-to-2020</u>

² <u>https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1033990/net-zero-strategy-beis.pdf</u>

- Working in partnership with the Devolved Administrations, we conducted a call for evidence exploring the role of the UK ETS as a potential long-term market for GGRs, as part of our consultation on the UK ETS.
- Explore options for regulatory oversight to provide robust monitoring, reporting and verification (MRV) of GGRs, following the recommendations of the BEIS-led MRV Task & Finish Group involving experts from industry and academia.
- Seek an amendment to the Climate Change Act to enable engineered removals to contribute to UK carbon budgets.

The government is grateful to the National Infrastructure Commission (NIC) for their comprehensive work on this important issue and looks forward to working with the NIC as it continues further work in this area.

Engineered Greenhouse Gas Removals

The government welcomes the National Infrastructure Commission's (NIC) report 'Engineered Greenhouse Gas Removals'.

The NIC made the following eight recommendations:

- 1. Government must make a clear commitment to deploy a range of different engineered removals at megatonne scale in the UK no later than 2030 and must publish a detailed plan to deliver this by the end of 2022. This should form the basis for an enduring policy regime which will maximise the likelihood of the UK playing a leading role in the development of engineered removals.
- 2. Action on deploying engineered removals must not reduce effort from emissions reduction, which should be used to cut most of the country's emissions. Government's net zero strategy should set this out clearly.
- 3. By 2024, and before any engineered removals are deployed at scale in the UK, government must put in a place an independent monitoring regime. This must:
- be robust, transparent and instil public and investor confidence
- ensure that any removals are genuine and verifiable, including putting in place a monitoring, reporting and verification regime
- account for the full lifecycle emissions of technologies, regardless of whether those emissions occurred inside or outside the UK
- be consistent with the principles to protect the natural environment set out in the Environment Bill.
- 4. A market for engineered removals, whereby government support can gradually fall away, should be created by obligating polluting sectors to offset their emissions. Obligations on polluting sectors should cover a growing proportion of emissions over time, reaching 100 per cent no later than 2050.
- 5. Government should support a portfolio of engineered removals and deploy a range of first-of-a kind plants at scale no later than 2030. To support deployment, government should use a combination of:
- staged competitions, focused on pulling through early-stage technologies to commercial readiness
- direct investment, with the option for the involvement of the UK Infrastructure Bank
- contracts for revenue with government using competitive auctions where possible, and consider the feasibility of linking the contracts to a market-based mechanism, such as the newly established UK Emission Trading Scheme.

- 6. Government should aim to have polluting sectors pay for removals they need to reach carbon targets. Sectors that do not require removals to achieve net zero should not be obligated to pay for them. However, in some instances there may be adverse consequences that require intervention. To account for this, by 2024, government must:
- undertake and publish detailed analysis on the range of adverse distributional consequences that could occur from the proposed policy approach
- set out which sectors it is open to providing subsidy for removals to
- consider the risks of offshoring emitting activities to other countries, and how these can be mitigated.
- 7. Government and regulators, in particular Ofgem for electricity and Ofwat and the Environment Agency for water, must work with operators of infrastructure networks to ensure any demands from engineered removals are planned for from the late 2020s.
- 8. Government must ensure that the required carbon transport and storage infrastructure is delivered and that additional demand from engineered removals deployment is accounted for in its plans. To do this government must:
- finalise its regulatory regime and policy frameworks for carbon transport and storage and deliver on its ambition to deploy at scale over the 2020s
- consider how engineered removals in dispersed locations not near the UK's industrial clusters, for example small energy from waste or biomass plants with carbon capture and storage, can be integrated into carbon transport and storage networks over the next decade
- ensure adequate carbon dioxide storage capacity is explored and characterised in time to deploy engineered removals.

The following report will address each recommendation in turn. The government either fully or partially accepts all of the recommendations.

Government Response to the recommendations

Recommendation 1

Government must make a clear commitment to deploy a range of different engineered removals at megatonne scale in the UK no later than 2030 and must publish a detailed plan to deliver this by the end of 2022. This should form the basis for an enduring policy regime which will maximise the likelihood of the UK playing a leading role in the development of engineered removals.

The government accepts this recommendation.

The primary method of achieving net zero is to take ambitious decarbonisation measures across society. However, we must also acknowledge that sectors such as industry, agriculture and aviation will be difficult to decarbonise completely by 2050. Greenhouse gas removals (GGR) are therefore essential to compensate for the residual emissions arising from the most difficult activities to reduce or eliminate from within polluting sectors.

Both nature-based and engineered removal methods will be necessary. Nature-based removals are already a mature approach for capturing and storing carbon and, especially in the case of tree-planting, codes already exist to allow trading on the voluntary carbon market. While nature-based removals are likely to be available at scale earlier than engineered removals, their contribution will be limited by dependency on land availability. Therefore, developing and deploying engineered approaches will also be critical to 2050 and beyond, and we have committed to deploying at least 5 MtCO2/year by 2030 in the Net Zero Strategy.

Evidence around scale-up potential of engineered removal solutions in the UK is rapidly evolving, alongside innovation in the sector. This evidence suggests that the next decade will be critical and several GGR solutions, such as Direct Air Capture, will have to be developed or scaled-up significantly during the late 2020s and early 2030s to contribute effectively to later carbon budgets and our net zero target, as well as to build our evidence and experience in the sector.

For engineered removals, a portfolio approach, supporting innovation, demonstration, and commercialisation of a wide range of removal solutions in the 2020s, is needed to ensure GGRs can contribute effectively to meet our Nationally Determined Contribution (NDC) and Carbon Budget 6. The government's current suite of innovation programmes for DACCS and other GGRs will help ensure we continually target efficiency improvements, cost reductions and novel GGR technologies to inform our approach over the coming decades.

Based on the current evidence base and projects in the pipeline, our analysis indicates that engineered removals would be expected to deploy from 0 MtCO2 today to at least 5 MtCO2 by

2030 and to around 23 MtCO2 by 2035, with higher and lower deployment possible depending on sector-specific and wider economy developments.

By 2030 we envisage significant deployment of mature BECCS technologies and commercial scale deployment of DACCS. BECCS technologies will include retrofit applications in the power and industry sectors. BECCS applications in the power sector could be deployed by the late 2020s, and potentially achieve ambitious contributions to our NDC target by 2030. Engineered removals are likely to be located within or near industrial clusters, benefitting from access to CO2 transport and storage infrastructure, essential to support delivery of net-negative emissions.

By the early 2030s the portfolio of GGRs deployed at scale in the UK will expand as technologies mature and demand from end-use sectors increases. Beyond the contribution of power BECCS to the electricity grid, production of hydrogen, biogas/biomethane fuels with BECCS could also support the decarbonisation of transport, industry and potentially power and heat in buildings. By 2050, deployment of engineered removals at large scale, between 75 and 81 MtCO2 per year, will be needed to help compensate residual emissions. This is expected to be equivalent to around 45-80% of total emissions captured across the UK economy and will see predominantly the scale up of DACCS and BECCS with gasification technologies.

The UK is well placed to take a leading role in GGR policy development and deployment. We have world-leading academic and industry expertise in relevant sectors, as well as a rapidly developing carbon capture usage and storage (CCUS) sector and access to large volumes of quality geological CO2 storage. Enabling GGR deployment will not only help us hit net zero but can support the UK's ability to export skills and expertise to other nations with comparable ambitions for the sector.

Recommendation 2

Action on deploying engineered removals must not reduce effort from emissions reduction, which should be used to cut most of the country's emissions. Government's net zero strategy should set this out clearly.

The government accepts this recommendation.

In October 2021 we published the Net Zero Strategy, setting out the action we will take to keep us on track for the UK's carbon budgets and 2030 NDC and establish our longer-term pathway towards net zero by 2050. It provides a comprehensive set of measures to reduce emissions across the UK economy.

The Strategy is clear that the purpose of engineered greenhouse gas removals is to balance residual emissions from sectors unlikely to achieve full decarbonisation by 2050. They must not be pursued as a substitute for ambitious and decisive action across the economy to reduce emissions, referred to as 'mitigation deterrence'.

Recommendation 3

By 2024, and before any engineered removals are deployed at scale in the UK, government must put in a place an independent monitoring regime. This must:

- be robust, transparent and instil public and investor confidence
- ensure that any removals are genuine and verifiable, including putting in place a monitoring, reporting and verification regime
- account for the full lifecycle emissions of technologies, regardless of whether those emissions occurred inside or outside the UK
- be consistent with the principles to protect the natural environment set out in the Environment Bill.

The government partially accepts this recommendation.

Government acknowledges the crucial role of establishing a robust Monitoring, Reporting and Verification (MRV) regime in delivering engineered removals at scale in the UK. Ensuring the amount and permanence of removals can independently be quantified robustly and transparently is essential to give confidence that removals are genuine and verifiable.

In 2021, we established a GGR MRV Task and Finish Group, comprised of experts across government, industry, academia, and regulatory services. The role of the group was to provide advice and guidance on the development of a MRV policy approach for GGRs. A recommendation made by the group was the need for an independent function to be responsible for a monitoring, reporting and verification regime. The permanent removal of greenhouse gas from the atmosphere is key to reaching net zero. For a GGR approach to be credibly 'net-negative' it must permanently remove more greenhouse gas from the atmosphere than it creates.

Accounting for emissions associated with international supply chains presents a challenge for GGR carbon accounting, and we will engage with our international counterparts to ensure best practice is achieved. Accounting for possible re-emissions, e.g. of CO2 captured internationally but stored in the UK may be a particular challenge. We commit to collaborating with international partners to ensure alignment on any future MRV framework.

Our core principles on MRV, such as the relationship between any near-term support that may be applied to 'at scale' GGRs and any existing MRV standards already in use in the private voluntary sectors, is explored in our consultation on Business Models for Engineered Removals. Therefore, we commit to the importance of a robust monitoring regime but will consider the approach we take as part of our response to this consultation.

Recommendation 4

A market for engineered removals, whereby government support can gradually fall away, should be created by obligating polluting sectors to offset their emissions. Obligations on polluting sectors should cover a growing proportion of emissions over time, reaching 100 per cent no later than 2050.

The government partially accepts this recommendation.

The Net Zero Strategy set out the government's long-term vision to establish a liquid market for carbon removals in which polluters are incentivised or obligated to invest in GGRs in order to balance their remaining emissions. The integration of negative emissions in the UK Emissions Trading Scheme (ETS) was identified as a possible route to achieving a single, integrated compliance market for carbon. Depending on scheme design, the inclusion of negative emissions credits in the UK ETS would allow participants to offset a portion of their emissions by purchasing negative emissions credits as the ETS allowance cap falls over time and conventional abatement options are exhausted.

We agree with the principle that polluting sectors have a responsibility to invest in offsetting emissions, including removals, and that markets like the Emissions Trading System are mechanisms which may enable this principle to be enacted.

The UK ETS Authority has recently conducted a call for evidence on the expansion of the ETS to include a range of new polluting sectors, as well as the role the UK ETS could have as a long-term market for both engineered and nature-based GGRs. This call for evidence explores different eligibility criteria for participation in the ETS, different types of market designs and phasing, and timings for inclusion. We will consider the polluter pays principle further in light of the submissions to our call for evidence, which will be important in refining government's approach. We will formally respond to our call for evidence in due course.

The UK Government agrees with the NIC that a market for GGRs will take time to establish and may not be sufficient to enable initial large-scale projects to deploy over the coming decade. The government's stakeholder engagement to date, including the Call for Evidence on Greenhouse Gas Removals, has highlighted that technology developers face major challenges to financing GGR projects due to high capital and operational costs, coupled with the absence of a stable revenue stream for the provision of negative emissions. In the near-term, nascent voluntary markets are unlikely to provide the predictable revenue streams required to justify investment decisions on large-scale projects; and as such, there is likely to be a greater role for government in providing bespoke support to unlock private capital.

Alongside this response, we have published a consultation on the business models needed to accelerate investment in engineered GGRs. This has set out details of our preferred mechanisms to stimulate the GGRs sector in the UK and deliver the government's ambition to deploy at least 5 MtCO2 per year of engineered removals by 2030. While acknowledging the role of government in the early stages of deployment, we will seek to ensure that early support instruments leverage private sector investment as far as possible while minimising the impact

on the taxpayer. In line with the NIC's advice and the 'polluter pays' principle, we anticipate that any government support will be phased out as the market develops.

Recommendation 5

Government should support a portfolio of engineered removals and deploy a range of first-of-a kind plants at scale no later than 2030. To support deployment, government should use a combination of:

- staged competitions, focused on pulling through early-stage technologies to commercial readiness
- direct investment, with the option for the involvement of the UK Infrastructure Bank
- contracts for revenue with government using competitive auctions where possible, and consider the feasibility of linking the contracts to a market-based mechanism, such as the newly established UK Emission Trading Scheme.

The government partially accepts this recommendation.

The government has committed to pursuing a portfolio approach to GGR deployment which enables the development and commercialisation of a mix of different technologies. This reflects the evidential uncertainty around the scale-up potential and future costs of individual GGR options, and our view that a range of GGR solutions will need to be deployed at scale in order to meet our climate targets.

Furthermore, we accept the NIC and the Climate Change Committee's advice that government should develop policy mechanisms to deploy engineered GGRs at scale from the late 2020s, and we have set an ambition of deploying at least 5 MtCO2/year of engineered removals by 2030. In doing so, we will aim to position the UK as a world-leader in the adoption of GGR technologies while reducing technology costs, generating technical improvements, and developing supply chains to enable scaling-up through the 2030s and 2040s.

We partially accept this recommendation noting that we agree with the portfolio approach. We are currently consulting on Business Models for engineered removals, which examines a range of policy levers that could potentially accelerate investment in GGRs including competitions, capital support and contract mechanisms. Building on this consultation, we will continue to engage with the NIC as we develop our policy proposals.

The recently launched consultation on business models sets out details of how we intend to support early deployment of GGR technologies. Our proposals have been informed by a study conducted for BEIS by Element Energy, as well as our ongoing engagement with key stakeholders such as the NIC.

The consultation builds on our commitment to invest up to £100 million in innovation, research and development for GGR technologies. This includes BEIS' Direct Air Capture and Greenhouse Gas Removal Programme, which is supporting the construction of pilot plants for a range of promising technologies to help them achieve commercial realisation. Furthermore, the UK ETS Authority has recently conducted a call for evidence exploring the role of the UK ETS as a potential long-term market for both engineered and nature-based GGRs. This call for evidence explored different eligibility criteria for participation in the ETS, potential market

designs, and phasing and timing for inclusion. It also took into account the wider GGR policy landscape in UK Government and the Devolved Administrations.

Recommendation 6

3

Government should aim to have polluting sectors pay for removals they need to reach carbon targets. Sectors that do not require removals to achieve net zero should not be obligated to pay for them. However, in some instances there may be adverse consequences that require intervention. To account for this, by 2024, government must:

- undertake and publish detailed analysis on the range of adverse distributional consequences that could occur from the proposed policy approach
- set out which sectors it is open to providing subsidy for removals to
- consider the risks of offshoring emitting activities to other countries, and how these can be mitigated.

The government partially accepts this recommendation.

In the Net Zero Strategy, the government committed to developing markets and incentives for investment in greenhouse gas removal (GGR) technologies including Direct Air Carbon Capture and Storage (DACCS). We are currently consulting on business models to incentivise deployment of GGRs in the next decade.

As set out in response to Recommendation 4, we agree with the principle that the cost of deploying GGR technologies should be borne by hard-to-abate sectors that require carbon removals to balance their remaining emissions.

In the shorter-term, we recognise that both public and private investment will be crucial for any path to net zero. While we expect most investment needed to reach net zero to come from the private sector, market failures mean the private sector alone will not deliver emissions reductions and innovation at the pace required. Our 2019 Green Finance Strategy³ demonstrated how the strategic use of public funds, long-term policy frameworks, and signalling can leverage private investment into the technologies and infrastructure that will be needed to deliver net zero. Each technology and sector will present its own challenges, and government support for a large pipeline of projects will be needed. Potential inclusion of GGRs into a compliance market, such as the UK ETS, is one option for ensuring polluting sectors pay for reductions, as it would allow sectors covered by the scheme to meet their obligations through the purchase of GGR credits alongside conventional abatement options. The UK ETS as a long-term market for GGRs, but we recognise that such an approach does raise questions about the impact on sectors, and their consumers, and careful consideration would be required to mitigate any potential adverse consequences.

https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/820284/190716 BEIS Green Finance Strategy Accessible Final.pdf

Likewise, as we transition to net zero, it is important we ensure that our ambitious climate policy interventions do not lead to carbon leakage. As discussed in the final report of the Net Zero Review and Industrial Decarbonisation Strategy⁴, a range of approaches could potentially help to address this.

We fully recognise the issues raised in this recommendation, but we consider that they are most relevant to the long-term policy approach for removals, and the design of the ultimate mechanism to deliver a market for removals. There are many considerations and uncertainties to address before we are able to propose what this longer-term solution should be, and it will be subject to the outcomes of research, learnings from earlier policy interventions, and further consultations. We do not consider therefore that it is feasible or practicable at this stage to carry out detailed assessment of the distributional or other impacts of this longer-term intervention. However, we are fully committed to carrying out such assessments as we develop policy. We therefore accept the principles behind the recommendation, but not the proposed timeframe.

To progress our shorter-term policy interventions, we are currently consulting on business models to incentivise investment in GGRs. As set out in the consultation, the Government will consider further how GGR business models will be funded. This will take into account the impact on the fiscal position, affordability for businesses and developers, as well as ensuring a fair distribution of costs.

https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/970229/Industri al_Decarbonisation_Strategy_March_2021.pdf

Recommendation 7

Government and regulators, in particular Ofgem for electricity and Ofwat and the Environment Agency for water, must work with operators of infrastructure networks to ensure any demands from engineered removals are planned for from the late 2020s.

The government accepts this recommendation.

Government recognises the importance of working with both regulators and infrastructure operators, to ensure a coordinated approach to meeting future demand from engineered removals. We are clear that early engagement will be key to effective long-term planning and delivery.

Regulators are currently working on net zero innovations and collaborating with both government and operators on approaches to better utilise existing systems and infrastructure. Government and regulators will continue to work closely with operators to support the deployment of engineered removals, in conjunction with fulfilling their statutory duties. With local place-making and industrial regulation expertise, regulators will help industry to ensure engineered GGR projects are designed and shaped to be sustainable and resilient in a changing climate.

Recommendation 8

5

Government must ensure that the required carbon transport and storage infrastructure is delivered and that additional demand from engineered removals deployment is accounted for in its plans. To do this government must:

- finalise its regulatory regime and policy frameworks for carbon transport and storage and deliver on its ambition to deploy at scale over the 2020s
- consider how engineered removals in dispersed locations not near the UK's industrial clusters, for example small energy from waste or biomass plants with carbon capture and storage, can be integrated into carbon transport and storage networks over the next decade
- ensure adequate carbon dioxide storage capacity is explored and characterised in time to deploy engineered removals.

The government accepts this recommendation.

The government agrees with the Commission that the deployment of CO2 transport and storage (T&S) infrastructure is essential for the production of negative emissions using engineered removals.

Since we last published our ambition for carbon capture, usage and storage (CCUS) in the Prime Minister's Ten Point Plan for a Green Industrial Revolution⁵ and the aim to capture and store 10 MtCO2 a year by 2030 from four industrial clusters, we have announced more ambitious UK carbon reduction targets through our 2030 Nationally Determined Contribution (NDC) and sixth carbon budget and have provided further clarity in our Net Zero Strategy.

Our updated ambition to capture and store 20-30MtCO2 per year by 2030 is in line with wholeeconomy targets and would account for between 20-30% of the emissions reduction requirements to meet our NDC in 2030.

CCUS will play a crucial role in industrial decarbonisation, in the generation of low carbon power, for engineered greenhouse gas removal technologies and in delivering our 5GW by 2030 low carbon hydrogen production ambition. The timely development of CO2 transport and storage networks across the UK will be important in supporting this deployment.

Geological GGR projects will need to be located in areas of the UK where it is feasible to gain access to a T&S network, which is likely to require close proximity to a CCUS cluster. This will facilitate the construction of new-build GGR projects as well as retrofitting existing plants to enable the production of negative emissions. We are exploring how early GGR projects could be supported through the CCUS cluster sequencing programme, and we will publish further information in due course.

https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/936567/10_PO INT_PLAN_BOOKLET.pdf

The Government also recognises the importance of remote projects in dispersed sites being able to access CO2 transport and storage networks. We consider that the capacity for T&S networks to be able to accept CO2 from dispersed sites and international sources, either transported by ship, road or rail (non-pipeline transport), will be vital for achieving our carbon budgets and net zero. We are continuing to develop the licence conditions and business model arrangements so that non-piped sources of CO2 can be accommodated by the Transport and Storage Regulatory Investment (TRI) model.

We are also working closely with key CCUS regulators to ensure that alongside the commercial framework, we have a robust regulatory regime in place which can support the deployment of CCUS at scale over the 2020s and put us on a firm pathway to achieving our net zero ambitions. The government also recognises the need to ensure that there is adequate carbon dioxide storage capacity in the UK continental shelf and that these stores are suitably appraised and can support the volumes of CO2 likely to be being captured from both power generation and industrial processes, including engineered removals in the 2020s and beyond.

This publication is available from: <u>https://www.gov.uk/government/publications/national-</u> infrastructure-commission-report-on-greenhouse-gas-removals-ggrs-government-response

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