Evidence to the Department for Business, Energy and Industrial Strategy, and HM Treasury, on Greenhouse Gas Removals, February 2021

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1. The viability of different GGRs in the UK – including technology readiness, cost, deployment potential, lifecycle emissions, and wider constraints to deployment

The viability of different GGRs in the UK

1.1 The socio-technical readiness, life cycle costs and benefits, and perceived risks and opportunities of each individual GGR can be expected to change continually over the next 30 years. One role of government is to keep a dynamic portfolio of possibilities continually under review, and so resist premature lock-in to one approach. [Question 9]

1.2 The UK would make a contribution to GGR removals under the UNFCCC (and in particular the Paris Agreement) principle of 'common but differentiated responsibilities' – each country maximising its own contribution within its own resources. Most of the options discussed in the Vivid Economics report are consistent with this approach and confined to UK resources, but BECCS is an unexplained exception:

> 'BECCS, which if deployed at scale in the UK, would imply significant biomass imports. The UK would have to work closely with partner countries to ensure these imports are sustainably sourced.'

It is not clear why this exception is allowed (other than that bioenergy is already produced in the UK using imported biomass and the producer has ambition to add CCS). This is not just an issue of sustainable sourcing, since it denies the biomass supplier the opportunity to make use of their own natural resources in GGR, and adds carbon emissions from feedstock transport to the process costs. As the report concedes, there would be an accounting challenge in attributing benefits along the supply chain, which would also require modification of current international accounting conventions. [Questions 5 and 10]

1.3 It might be that given the UK's limited areas for land-based GGRs in relatively high latitudes (and an emerging debate in the literature as to whether afforestation in the northern hemisphere is net negative, when the effects of albedo change are taken into account), the most technologically ready approach - tree planting - may not a be good option. (Bright et al. 2012, Mykeby et al. 2017). However, all land-based options that

claim co-benefits, such as agroforestry, and the use of some soil amendments to both improve soil carbon stocks through enhanced weathering and improved agricultural productivity, need continued rigorous evaluation at near deployment scale, including for MRV.[Question 5].

1.4 Blue carbon (seagrass, mangroves, kelp) is receiving increased international attention, (see for example the new the EU H2020 Project OceanNETs, in which we are participating or the current review of ocean carbon removal and sequestration organised by the National Academies in the U.S.) Comparatively, this area of GGR has received little attention in the UK. (Other than a reference to the possible use of kelp as a feedstock for marine BECCS it did not feature in the RS/RAE Report, for example). Given the significant UK science base in oceanography and marine resource management, and at a time when the UK is reviewing its fisheries policies, this would seem to be a propitious time to assess blue carbon options and their possible contribution to UK carbon removal. [Question 4]

1.5 The same principle applies, indeed, to other forms of ocean-based carbon dioxide removal. Ocean alkalinity enhancement (the focus in the OceanNETs project) would require particular attention, given that it combines significant potential (in terms of scale of CO2 removal and impact on ocean acidification) with significant governance challenges. The UK is, again, well positioned to play a global leading role in the scientific assessment and technical demonstration of these options. [Question 4]

1.6 Given the UK's strong knowledge base, one contribution would be in exploiting its science and industry base by building on the recent UK policy impetus to foster innovation in DACCS, the one GGR which sidesteps potential land-use contestation and where, as the Vivid Economics report acknowledges, there are already claims of significant reductions in removal costs/tonne. Contestation over land-use might be expected to sharpen over time as universalist scientific assessments of what constitutes marginal land suitable for forestry or bioenergy crops conflicts with culturally embedded local uses and priorities. The UK also possesses the potential for the production of relatively large amounts of sustainable and competitively priced energy which would be needed for DACCS, and potential storage sites. [Question 10]

Wider constraints to deployment

Under 'wider constraints to deployment' we understand primarily public and stakeholder acceptability. It might be held to imply that such acceptability needs to be won separately, on its own merits, by each individual GGR technique. By contrast:

1.7 Social and political realism suggests that that "decarbonisation will only be achieved successfully as a benefit contingent upon other goals which are politically attractive and relentlessly pragmatic" (ref). Technologies should not be assessed outside the social and political context of their use. Synergies and trade-offs are an essential part of the calculation. [Question 6]

1.8 Social scientific research suggests that public acceptability of GGR depends on whether the removal option in question can be reasonably perceived as contributing to a broader transition towards a low-carbon, sustainable society – and not to shore up the short-term interests of high-emitters (Cox et al 2020). In addition, our research (e.g. Bellamy et al 2019) suggests that public support for specific GGR options is also contingent on the specific policy instrument used to incentivise it (see 3.2 below). [Questions 5]

1.9 The introduction of GGRs into the climate policy debate alongside emissions reductions and adaptation might be seen as an opportunity to start a debate on alternative broad scenarios of what constitutes sustainable social and economic change, with full attention to uncertainties and risks, and possible winners and losers. Opinion surveys suggest that the public may be ahead of policymakers in their readiness for this (BEIS 2020). [Questions 6 and 9]

1.10 The review of policies for agriculture, forestry and other land use, and fisheries post Brexit make it an opportune time for wider social engagement around the possible contribution of GGRs to climate and other policies. This could raise the level of debate, clarify different positions, and where appropriate, broker negotiation between them. [Questions 6 and 9]

2. The role of government in addressing market barriers and stimulating the development and deployment of GGRs

2.1 Through the GGR Demonstrators and Directorate Hub the UK is already involved in a programme of work on research, development and demonstration of GGRs. This will need to be renewed and strengthened with the aim of testing early-stage new approaches and increasing their integration with existing industrial capabilities. One important aim of this approach will be to foster innovation and learning and avoid premature lock-in, given the rapid pace of innovation across this field. [Questions 8 and 9]

2.2 UK policy towards GGR has a significant international dimension, as the UK has one of the most advanced portfolios of R&D activities, and its choices send significant signals to other countries. The UK should embrace this responsibility. For example, it could see as one of its responsibilities to contribute its expertise to low- and middle-income countries that need to conduct their own assessment of their potential for GGR. Maximising GGRs at the global level requires much more inputs from developing countries, and that in turn depends on those countries having the governance and scientific capacities to know and cost their options in a way compatible with SDGs and more specific local development goals. [Question 6 and 9]

2.3 Problems arise from letting 'market forces … determine the optimal balance between GGR and non-GGR options' within Net Zero frameworks. Such trade-offs run the risk that hard-to-achieve but technically possible emissions reductions will be postponed or abandoned. The extent and usage costs of investment in infrastructure such as carbon pipelines for CCS will of course influence those market decisions and influence GGR

choice. In addition, there is a clear case for policy instruments to effectively limits trade-offs between GGR and non-GGR options, for example, to encourage faster progress towards de-carbonisation of some sector (perhaps through a targeted R&D incentive) or a co-benefit – such as an improvement in urban air quality - to be fully realised. In this regard, it is important to distinguish between 'being technology neutral' and 'maximising policy flexibility and minimising lock-in'. Being technology neutral can be achieved through market forces, but might result in under-development of promising opportunities (creating a lock-in to a narrow set of solutions). Maximising policy flexibility and minimising lock-in requires an active government policy to pursue diversity of solutions ready to scale up as changes in future conditions require. [Question 13]

2.4 If internationally traded offsets are part of this pattern in 4, there is a very high risk that the market power of the higher emitting countries will result in natural resources of lower emitting, poorer countries being lost on potentially unfair terms, to 'solve' a problem which they had no part in making, and with the loss of other local development trajectories. The UK government needs to adopt and internationally promote principles and governance mechanisms to mitigate such outcomes. For these reasons it is advisable to include "Responsiveness to international equity concerns" as one governance principle in the framework for incentivisation of greenhouse gas removals. [Questions 6]

3. Supporting policies needed to enable deployment and scale-up, such as a robust framework for monitoring, reporting and verification of negative emissions

3.1 As the history of REDD+ demonstrates, the maturity of a GGR technology does not automatically imply robust governance mechanisms, or an internationally recognised and widely applied standards of MRV. Rather, there is a danger that the familiarity of forestry as a 'natural' system (Bellamy & Osaka 2019) and the familiarity of BECCS from its role in 'resolving' integrated assessment models may blind us from necessary scrutiny of these approaches. MRV, and its honest application, is a major challenge.[Question 26]

3.2 Our research suggests that policy design influences public acceptability of BECCS, and potentially of other GGR options (Bellamy *et al* 2019). The prospect of a price guarantees for producers selling energy derived from BECCS, for example, was seen to reduce overall support for BECCS as a whole – probably an effect of Hinkley Point C, where this policy instrument was used to promote the development of nuclear power at a perceived high cost for the UK taxpayer. The fundamental point here is that public acceptability is specific to the combination of technology, type of policy incentive, and socio-technical system in question, not just to each individual GGR technology. [Questions 10 and 14]

3.3 As candidate technologies mature, the emphasis of R&D programmes and demonstrators and assessment will need to extend towards:

- Assessing how GGRs will fit into the socioeconomic context of their use, including the local distribution of costs and benefits;
- Practical integration of GGR with existing industrial capabilities and regional development goals;
- Definition of robust MRV arrangements.

The need to establish strong local synergies is likely to blur the lines between traditional mitigation, adaptation and removals, whilst clarity in separating out such measures is key to measuring greenhouse gas capture and secure storage. [Question 25]

3.4 The near future role of industry is crucial. There are a number of GGR technology entrepreneurs, but it is still an open question how larger industrial sectors will realise its increasing numbers of net zero commitments, and link up with entrepreneurs and the financial sector to help scale up GGR approaches. There needs to be some fresh thinking about a suite of policies – including the form of post-Brexit carbon trading or minimum carbon pricing – to test and develop broad commitments and transform scattered activity into a richer ecology of interrelated climate action. High-emitting sectors (e.g. cement or steel production) could play a very significant role in scaling up GGR (for example through the use of industrial waste and by-products), but this will require policy frameworks that continue to incentivise their decarbonisation as GGR options come online. [Question 7]

3.5 The government must maintain a whole system perspective and pursue that the the developments in GGR are appropriately reflected in relevant policy making tool in relevant sector. The Future Energy Scenarios (FES) of the National Grid SO show that the modelling of BECCS, as well as DACCS in their 2021 iteration, have a direct impact over infrastructure choices, and in the assessment of the need for investment on additional electricity generation and transmission capacity. Assumptions about the plausibility of the enabling long-term infrastructure requirements for GGRs must be continuously under scrutiny, to assess the scalability of the solution, as concernes have already been raised for the land available for reforestation and biomass for BECCS (see point 1.3). [Question 14]

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Contributing Research

Further details of the research which contributed to this evidence can be found at:

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