# Independent Review of Greenhouse Gas Removals Annex

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# Contents

# Annex A – Roundtables

As part of the Review process,[1] the Chair undertook extensive engagement with a broad spectrum of GGR stakeholders, including the facilitation of eight thematic roundtables. These sessions focused on key areas across the GGR landscape, covering: Academia, DACCS, BECCS & Biomass, Energy from Waste, Biomethane, Nature-Based Solutions & Non-CCS GGRs, Markets & Investors, and Non-Governmental Organisations (NGOs). The roundtables were designed to reflect the diversity of the GGR sector, but it is important to note that not all aspects were covered in full. Stakeholders who were unable to participate in a roundtable were actively encouraged to contribute through the formal Call for Evidence, ensuring a broad representation and input into the Review. A summary of the themes and key points discussed at the roundtables is outlined in **Table A.1** below.

**Table A.1: Summary of the key themes and key points discussed at the roundtables**

| Roundtable | Discussed Themes |
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| **Academics** | • A systems thinking approach is essential for managing the full supply chain of GGRs, recognising that any interaction or demand within the system generates consequential effects throughout.<br>• DACCS, often regarded as the gold standard of GGRs, should not be perceived as a panacea; nature-based removals offer immediate and tangible benefits and must be taken seriously. Biochar, while not the most potent form of carbon removal, currently accounts for approximately 80% of near-term carbon removal credits and is actively being produced today.<br>• DACCS presents growth opportunities for the UK, positioning it as a potential leader in GGR expertise and contributing to job creation and reskilling within the energy transition.<br>• Synergies across GGR methods such as biochar, EfW and BECCS, particularly in relation to land use decisions and feedstock availability, which remain critical implementation barriers.<br>• GGRs must be implemented in parallel with robust emissions reduction strategies, which remain the most cost-effective climate action.<br>• Considerations of volume, scalability, and cost are critical. The potential for infinite scalability of GGRs risks fostering complacency in emissions control.<br>• A cross-governmental approach is required, as GGRs intersect multiple departmental responsibilities. |

[1] Department for Energy Security and Net Zero (2025) 'Independent Review of GGRs: Terms of Reference'

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| | • The broader climate context must be acknowledged, including implications for food security and societal resilience.<br>• Government leadership is vital in confronting complex issues, and inaction is increasingly viewed as a deliberate choice.<br>• The question of funding GGRs remains open, with debate over the roles of government, consumers, and individuals.<br>• Public perception and trust are pivotal, necessitating transparent and robust MRV frameworks.<br>• Market regulation is essential to prevent reputational damage to GGRs, which are currently perceived as unregulated and environmentally contentious.<br>• A comprehensive communications strategy for CCUS and GGRs is therefore imperative to build societal support and ensure transparency. |
| **DACCS** | • There is a clear and urgent need for the UK Government to provide strong signals and strategic clarity regarding GGRs.<br>• The importance of clarity around future demand and welcomed progress to date, including the UK ETS consultation, the development of GGR business models, and the inclusion of GGRs in the Jet Zero strategy.<br>• Interim milestones and targets are essential to facilitate a smooth transition and foster behavioural change across companies, industries, and the public.<br>• Clear and consistent targets would enhance board-level confidence and stimulate investment.<br>• The SAF mandate was cited as a successful model, with suggestions to adapt it for GGRs by requiring an increasing proportion of emissions to be offset annually, reaching 100% by 2050. Aviation firms should be allowed flexibility in meeting offset requirements, including funding permanent removals, which are more cost-effective than SAF and offer better value for consumers.<br>• Proposed a parallel system for negative credits, to be merged with the UK ETS over time, citing Sweden's dual mechanism as a precedent.<br>• Need for government involvement in the VCM, with calls to include GGRs within the SAF mandate and to unlock additional $CO_2$ storage capacity.<br>• Planning and permitting processes were also highlighted as areas requiring greater clarity due to persistent uncertainties. |

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| | • While the UK might not be the most cost-effective location for deploying DACCS, its abundant geological storage and supportive policy environment make it attractive to investors.<br>• Domestic deployment of GGRs offers economic benefits, including job creation and growth in related industries, as well as increased intellectual property and expertise.<br>• Although short-term employment gains are linked to UK-based deployment, long-term opportunities lie in global project management and technology export. Deploying DACCS abroad may result in higher upstream emissions due to less clean electricity grids, reinforcing the case for domestic investment.<br>• To maximise benefits from international deployment, the Government should explore models such as Japan's GX League, which enables participation in the GGR market despite limited domestic storage.<br>• The UK has the potential to lead globally through its expertise in MRV, international standards, and diplomacy.<br>• Government has a critical role in establishing MRV frameworks, rules, and standards.<br>• Standards are particularly important for overseas deployment, where social acceptability is a key concern. Robust MRV and standards can ensure that international deployment benefits both host countries and the UK.<br>• The VCM is currently fragmented and lacks credibility, deterring participation from major companies. Issues such as fraud, double counting, and poor-quality credits depress the value of legitimate credits.<br>• Long-term cost reductions can be achieved through innovation, modularisation, and practical deployment experience.<br>• Siting decisions are crucial; allowing onshore storage and co-locating plants near storage sites can reduce transport costs and lower $CO_2$ purity requirements.<br>• Harnessing the expertise and infrastructure of legacy industries will be vital to driving down costs.<br>• Continuous innovation is underway, with companies actively developing and testing new technologies. While the DACCS industry is not reliant on just two technologies, firms are eager to deploy at scale and learn through implementation rather than delay progress. |

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| **BECCS & Biomass** | • Preference for retrofitting existing infrastructure over new-build projects, citing lower costs, existing grid connections, and simplified planning processes.<br>• Materials with high biogenic content are particularly attractive for developing a high-quality GGR market.<br>• Importance of adhering to environmental regulations and considering circular economy principles.<br>• Agricultural residues identified as a potential domestic alternative to imported wood pellets, though these are already utilised by other sectors, requiring new infrastructure and posing additional challenges.<br>• Feedstock logistics a critical operational factor, given their geographically dispersed and locally based nature. Road transport is expected to be the primary mode initially, but stakeholders stressed the need to minimise its use due to associated emissions, reliability concerns, and cost implications.<br>• Concerns about the impending termination of existing subsidy support, noting a lack of clarity on future funding mechanisms.<br>• Transitional support to bridge the gap until commercial operation dates are reached and biomass supply contracts are de-risked.<br>• Purpose of power BECCS is shifting from electricity generation to delivering negative emissions.<br>• Need to account for wider co-benefits such as waste management, heat utilisation, and potential applications in data centres or biomethanol production.<br>• Government's role in developing and enabling a carbon dioxide removal market. Revenue certainty is essential for market development and investment.<br>• The current CCUS allocation process places deployment decisions in the hands of Government, which is responsible for creating a project pipeline, providing funding, and exploring NPT options. A cluster-led approach was viewed as more confidence-inspiring by stakeholders. |
| **Energy from Waste** | • Growing optimism regarding the role of EfW in GGR, particularly through the integration of CCUS.<br>• Larger and more advanced EfW operators are leading progress in this area, with one major UK operator highlighting the strategic advantage of using domestically sourced materials. |

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| | • waste management remains a persistent challenge, and the inclusion of EfW in the UK ETS from 2028 will necessitate carbon tax payments, further reinforcing the need for CCS infrastructure.<br>• Infrastructure challenges were discussed, with some EfW plants well-positioned within CCUS clusters, while others require alternative transport solutions such as shipping or rail.<br>• Importance of spatial planning and tailored incentives based on geography, scale, and infrastructure. Underutilised rail infrastructure near EfW sites was identified as a potential asset.<br>• Mapping of EfW fleet access to CCUS infrastructure has already begun, and shipping options are being explored by various organisations.<br>• Clear and positive signals from government are essential to support the sector's ambition, this would help stimulate the development of NPT markets and CCUS deployment.<br>• Progress is hindered by fragmented responsibilities between DEFRA (waste) and DESNZ (CCUS), inconsistent policies, and insufficient planning guidance.<br>• Collaboration between government and industry is critical to align policies, carbon market mechanisms, and monitoring systems. Such alignment would encourage investment in CCUS infrastructure and support long-term revenue models for EfW plants.<br>• Public perception, robust monitoring and reporting, and monetisation of GGRs were also highlighted as key areas requiring joint effort.<br>• A holistic approach to waste management is necessary, recognising the interconnection between recycling, energy production, and CCUS.<br>• Government policies must be aligned to ensure system-wide certainty and efficient resource use.<br>• Clearer priorities and guidelines are needed to advance EfW with CCUS, particularly in relation to SAF and the circular economy.<br>• EfW with CCUS offers significant co-benefits, including the provision of power, heat, and carbon-negative energy.<br>• Revenue stacking, through government support, VCM, and ETS, is essential for project funding.<br>• Long-term contracts are vital for financial stability in the sector.<br>• Modular approaches and lessons from construction could help reduce costs for CCUS retrofits. |

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| | • need for careful oversight of emission control innovations and CCUS integration to avoid unintended environmental consequences. |
| **Anaerobic Digestion** | • Limiting AD feedstocks to conventional waste is neither practical nor sustainable, given its constrained energy output and carbon removal potential.<br>• A broader range of feedstocks, including break crops, cover crops, and diverse waste streams, essential to unlocking the full potential of removals.<br>• Roles of break and cover crops in biomethane production, comparing their suitability for AD and their contributions to sustainable land management.<br>• Feed wheat a potential alternative to break crops, with consideration given to land grade suitability for energy cropping.<br>• Concerns about potential competition between food production and energy crops for biomethane.<br>• Adverse impact on food production would likely provoke strong reactions from farmers, emphasis must be placed on sustainable crop rotation and robust supply chain management.<br>• Lifecycle assessment, AD plant management, and supply chain oversight were identified as critical to ensuring sustainability.<br>• Feedstock availability was not considered a limiting factor, particularly with low-opportunity-cost non-crop options.<br>• AD and bioenergy deployment can scale effectively if feedstock strategies are diversified.<br>• Challenges in the sector include securing long-term contracts for agricultural products and managing energy price volatility, particularly in the context of geopolitical events such as the war in Ukraine.<br>• Concern that current government policy favours waste-based feedstocks, potentially distorting market signals and limiting innovation.<br>• A clearer understanding of the economics across different feedstock pathways was deemed essential to inform future policy and investment decisions.<br>• Misalignment between departments such as DEFRA and DESNZ as a barrier to effective deployment.<br>• Need for timely, coordinated incentives and joined-up policies across agriculture, waste, energy, and nutrient recovery. |

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| | • Balance between compliance and voluntary markets, with a need for improved products and management practices to meet market expectations.<br>• Valuing co-benefits, such as carbon removal, nutrient cycling, and soil health, are essential, alongside mechanisms to reward what is genuinely valuable.<br>• Digestate viewed as both a challenge and an opportunity. Its potential for nutrient recovery, energy generation, and biochar production acknowledged.<br>• Digestate treatment is complex and energy-intensive, with challenges around nutrient separation and disposal.<br>• A holistic, systems-based approach that balances regulatory constraints with practical outcomes and integrates AD more fully into agricultural and waste systems. |
| **Nature-based Solutions & Non-CCS GGRs** | • Co-benefits and synergies vary across GGR technologies, with marine habitat restoration offering flood defence and biodiversity gains despite lower carbon removals.<br>• Food and water security must be considered in GGR strategies, requiring joined-up policy and a focus on delivering multiple public goods rather than pursuing a single agenda.<br>• The current additionality principle in VCMs discourages monetisation of co-benefits by requiring proof that projects are unviable without carbon credits.<br>• Clear understanding of what can and cannot be monetised is essential, and incentives should encourage projects to exceed baseline activities.<br>• Incentives must be provided at local, regional, and national levels to support GGR initiatives.<br>• GGR technologies span multiple departments, and definitional ambiguity can lead to initiatives being lost between departmental silos.<br>• Planning permission in the UK is a significant barrier to scaling projects, with delays and regulatory caution hindering marine technology research and seagrass restoration.<br>• Debate over permanence, with some prioritising durable removals and others advocating for flexibility to encourage innovation and technological development.<br>• MRV is critical but costly, with ocean-based GGRs facing challenges due to dynamic environments and a need for modelling-based approaches. |

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| | • The UK has an opportunity to contribute to the IPCC's MRV methodology and define its own national inventory approach.<br>• R&D is vital for evidence generation, with long-term field sites and demonstrator projects playing a key role.<br>• A catapult model where government funds a central data collection hub that engages private companies.<br>• Social licence is increasingly important, with government playing a key role in shaping public opinion and mitigating reputational risks from poorly executed projects.<br>• Public engagement is essential for projects lacking social licence, and ongoing work is being done on public perception. |
| **Markets & Investors** | • Integration of removals into the ETS is necessary to scale deployment but insufficient on its own to drive investment.<br>• ETS integration is publicly popular, with regulation and mandates preferred over taxes and voluntary markets for driving corporate emissions reductions.<br>• Consensus that woodland credits should not be included in the ETS.<br>• Corporate boards are reluctant to fund removals due to the absence of legal compulsion.<br>• A small mandate applied broadly across emitting firms could be politically feasible and signal future requirements, encouraging early investment.<br>• A mandate must be future proof to ensure corporate confidence while remaining flexible for future strengthening.<br>• Government's GGR Business Model received strong support, though concerns remain about its ability to deliver a diverse technology portfolio.<br>• Early-stage public-private R&D funding is needed to expand the range of viable carbon removal technologies.<br>• Support for a technology-neutral mandate covering both SAF and GGRs, though debate continues over its design.<br>• Integrating SAF and GGRs could lower decarbonisation costs but risks reducing pressure on airlines to improve fuel efficiency.<br>• Mandating international airlines to purchase UK GGRs could replicate past issues seen with EU carbon credit schemes.<br>• Geological net zero was supported in principle, with differing views on how strictly it should be applied in the short-to-medium term. |

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| | • Pragmatic deployment of nature-based removals now, given their readiness and the risks associated with engineered removals.<br>• A framework to balance permanence and technology risks between nature-based and engineered removals was recommended.<br>• Some nature-based removals could be linked to future conversion into geological removals, though reliance on long-term institutional promises was cautioned against. |
| **NGOs** | • Concern over excessive techno-optimism surrounding CCUS, noting a history of overpromising and underdelivering.<br>• Engineered removals are expected to significantly contribute to global targets, but scaling from 41 operational plants to 70–100 annually is required.<br>• Nature-based solutions should be prioritised over engineered removals, aligning with public sentiment from the Climate Assembly.<br>• UK's land use scenarios suggest national targets can be met without engineered removals, supporting increased ambition for nature-based approaches.<br>• Land use strategies should aim to balance multiple ecosystem services and maximise co-benefits.<br>• Concerns about governance and the need for robust standard-setting organisations.<br>• The "polluter pays" principle was supported, referencing the CCC's 2020 report that industries like aviation should fund engineered removals.<br>• Public perception plays a critical role in the success of carbon removal strategies and should be considered going forward.<br>• Government has a key role in enabling deployment, shaping policy, and ensuring cross-departmental coordination of GGRs. |

# Annex B – Call for Evidence

As part of the Review process[2], the Chair undertook extensive engagement with a broad spectrum of GGR stakeholders, including the facilitation of a public Call for Evidence.[3] This gave the general public, developers and other organisations a chance to share their views on the Review. The Call for Evidence ran from the 16 May 2025 to 20 June 2025 and had 143 responses. The Call for Evidence was broken into seven questions to help frame respondents' input. These were:

1. What is the potential scale of GGRs in the UK?
2. What are the co-benefits of GGRs?
3. What are the barriers to and enablers of GGR deployment in the UK?
4. What is the economic cost of deploying GGRs?
5. What approaches are there for transitioning away from public investment and attracting private investment in GGRs?
6. What are the roles and options for all GGRs, domestically and internationally, to balance the UK's residual emissions?
7. How can GGRs contribute to security of supply, with respect to the UK's energy system?

As noted at the outset of the Call for Evidence, there will be no formal response. The Review received a wide range of responses, with the table below outlining the key themes that emerged. This reflects the broad range of perspectives shared by stakeholders. The Review will not detail individual responses. The Review would like to acknowledge the valuable contributions made by all respondents. A summary of the Call for Evidence themes is outlined in **Table B.1** below.

**Table B.1: Summary of the Call for Evidence themes**

| Question | Response Themes |
|---|---|
| **Scale of GGRs in the UK** | • Potential scale of current & future projects<br>• Potential scale of GGR technologies<br>• Assumptions underlying scale & factors<br>• Affecting trajectories including resource availability and suitability<br>• Policy & regulation, infrastructure, MRV and Demand |

[2] Department for Energy Security and Net Zero (2025) 'Independent Review of GGRs: Terms of Reference'
[3] Department for Energy Security and Net Zero (2025) 'Greenhouse gas removals independent review: call for evidence'

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| **Co-benefits** | • Co-products<br>• Environmental benefits<br>• Social & economic benefits<br>• UK leadership<br>• Support for the Growth Mission and Clean Energy Superpower Mission<br>• Technology drawbacks |
| **Barriers and Enablers** | Barriers:<br>• Current policy & regulation<br>• Physical infrastructure<br>• Demand<br>• Commercial<br>• Others, including skills, costs, delays, public perception and legal<br>Enablers included a similar list to barriers as well as:<br>• Scientific evidence base<br>• Standards & MRV |
| **Costs** | • Project level costs<br>• Sector level costs<br>• Factors affecting costs<br>• Cost evolution over time<br>• Avoided costs |
| **Transitioning away from public investment and attracting private investment** | • ETS<br>• VCM<br>• Mandates<br>• Other approaches to reduce public finance<br>• Envisaged funding approaches<br>• International/other sectors' funding mechanisms |

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| **Roles and options for all GGRs, domestically and internationally** | • Role of different types of GGRs, including interaction with SAF<br>• Pro-domestic deployment<br>• Article 6 barriers & opportunities<br>• Potential international deployment opportunities<br>• Deployment strategies |
| **GGRs contribute to security of supply** | • Energy consumption<br>• Contribution to security of supply<br>• Sourcing of biomass and feedstock<br>• Prioritisation of biomass use |
| **Cross-cutting responses** | • GGR need<br>• Public perceptions<br>• Biomass sustainability<br>• Recommendations<br>• Permanence<br>• Moral hazard<br>• End-use hierarchy<br>• Circular economy<br>• Non-CDR GGRs |

# Annex C – Engagement with Government Departments

The Review engaged with a range of government departments on a factual basis periodically throughout the review process. This was to understand complex policy and to ensure the Review was well informed. Information requested from government was gathered in meetings or via a formal commissioning process. This was to ensure the integrity of the independence of the Review.

Work to set Carbon Budget 7 began during the process of the Review. As set out in the Terms of Reference, the Chair engaged with DESNZ throughout, sharing interim findings, as appropriate, to feed into the Carbon Budgets process.

# Annex D – ‘Low regret’ analysis: Process and detailed findings

The Green Book[4] sets out key critical success factors for use in longlist appraisal of policy options. In the context of the Review, a light-touch version of the longlist framework and process has been used to assess validity of our recommendation on ‘low regret’ deployment options. **Table D.1** sets out the chosen criteria and definitions for red, amber, green (RAG) ratings.

Subject matter experts within the Review team assessed each technology against the chosen criteria and filled out **Table D.2** accordingly. The team used findings from the Review, which are mostly based on a wide-ranging literature review and consideration of Call for Evidence and Roundtable stakeholder views. Where evidence is sourced from a specific source, Table D.2 specifies that source. The Review team then ran a variety of workshops to scrutinise each other’s inputs and discuss different entries and ensure consistency. The findings in Table D.2 were also reviewed by technology and policy experts in the Department for Energy Security and Net Zero to ensure accuracy.

[4] HM Treasury (2022) ‘The Green Book’

**Table D.1: 'Low regret' criteria and definitions**

| | | Not 'low regret' | Potential 'low regret' | Definite 'low regret' |
|---|---|---|---|---|
| Strategic fit | Supporting wider government ambitions | Technology negatively affects wider government ambitions/missions. | Technology does not impact other government ambitions/missions. | Technology supports wider government ambitions/missions partially/fully. |
| | Fit within the wider energy system (Security of supply) | Technology uses large amounts of electricity and significantly worsens security of supply (without further build out) | Technology can either improve or worsen security of supply dependent on operating model / conditions | Technology doesn't significantly affect security of supply or improves it |
| | Fit within the wider energy system (Operability) | Technology worsens system flexibility | Technology can either improve or worsen system flexibility dependent on operating model / conditions | Technology doesn't affect system flexibility or improves it |
| | Environmental impacts | Technology has drawbacks for the environment with no mitigations in place. | Technology can have beneficial impacts on the environment, but they are very context and environment dependent. | Technology has beneficial impacts on the environment (irrespective of context and environment) |
| Value for money | Costs (£/t$CO_2$ captured) (2024 prices) | Technology is high cost (above 2050 central appraisal carbon value: £442/t$CO_2$ (2024 prices) | Technology is medium cost or has large cost reduction potential | Technology is low cost (below 2024 central appraisal carbon value: £300/t$CO_2$ (2024 prices) |
| | Non-environmental co-benefits & trade-offs | Technology doesn't benefit other sectors / has large trade-offs | Technology has co-benefits, but they are very context and environment dependent. | Technology benefits other sectors / doesn't create trade-offs |
| Deliverability | TRL | Technology at concept stage, requires laboratory and operational environment testing (1-3) | Technology requires testing in an operational environment & then ready to go (4-6) | Technology is proven and ready to go (7-9) |
| | MRV readiness | Technology does not have regulated MRV in place, neither at national nor at project level | Technology has regulated MRV in place at national but not at project level or is under development | Technology has regulated MRV in place at national and project level |

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| | | (Add asterisk on whether future development is highly complex) | (Add asterisk on whether there is a need to address issues (e.g., MRV on imported feedstocks)) | |
| | **Resource availability and use** | Technology does not have secure domestic sources of input resources, strong competition for resources or need for imports or creation of new supply chains | Technology has domestic sources of input resources and can make use of existing supply chains, but there is competition | Technology has domestic secure sources of input resources, uses waste products and unused/under-utilised feedstocks where possible and resources face no competition or issues |
| **Achievability (enablers & barriers)** | **Public acceptance** | General public is against technology | General public is in favour if certain conditions are met | General public is in favour of technology |
| | **Policy** | Technology requires additional policy to be in place in order to function | Technology requires additional policy to be in place to function more effectively | Technology doesn't require additional policy |
| | **Regulation** | Technology requires additional/amended regulations to be in place in order to be able to function | Technology requires additional/amended regulations to be in place to function more effectively | Technology doesn't require additional regulations |
| | **Physical infrastructure (T&S)** | Technology requires large amounts of $CO_2$ pipeline transport and storage infrastructure, and insufficient amounts are being developed. | Technology requires medium amounts of $CO_2$ pipeline transport and storage infrastructure, but development is in train. | Technology doesn't rely on $CO_2$ pipeline transport and storage infrastructure, or sufficient infrastructure is already in place |
| | **Physical infrastructure (NPT)** | Technology is heavily dependent on NPT | Technology in some instances requires NPT | Technology is not dependent on NPT |

**Note**: The Independent Greenhouse Gas Removals Review notes that there may be other viable criteria, which the Review has not considered.

## Tables D.2: Detailed RAG rating tables by technology with justifications

### Large-scale power BECCS

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| Strategic fit | Supporting wider government ambitions | **Supports wider government ambitions/missions partially/fully.**<br>Large-scale BECCS can contribute to government ambitions. Plants are likely to be retrofit plants therefore supporting the growth mission through maintaining jobs in the North East. Significant electricity generation will support the clean power mission. |
| Strategic fit | Fit within the wider energy system (Security of supply) | **Does not significantly affect security of supply or improves it.**<br>Large electricity generation potential (Large-scale biomass plants that converted from coal contributed 6% of the UK electricity generation in 2024 (DUKES, 2025)). |
| Strategic fit | Fit within the wider energy system (Operability) | **Either improves or worsens system flexibility dependent on operating model/conditions.**<br>Plants would likely operate baseload, therefore displacing renewables. |
| Strategic fit | Environmental Impacts | **Can have beneficial impacts on the environment, but they are very context and environment dependent.**<br>**(-)** Biomass combustion can release pollutants such as particulate matter (PM), nitrogen oxides (NOx), and sulphur oxides (SOx), which may impact air quality. However, the use of existing pollution abatement equipment together with advanced carbon capture technologies, combined with optimal combustion management, can significantly reduce these emissions.<br>**(-)** Existing large scale biomass generators running unabated (that could convert to large scale power BECCS) currently use commercial forestry residues, which is unlikely to have meaningful land use impacts. If woody energy crops become a more prevalent alternative to commercial forestry residues (either due to policy or necessity as a result of increasing demand/competition), there could be more substantive land use impacts.<br>**(-)** Impact on scarce water resources. |
| Value for money | Costs (£/t$CO_2$ captured) | **2030:** no suitable evidence available<br>**2050:** 223-334<br><br>**Source**: CCC (2025) |
| Value for money | Non-environmental co-benefits & trade-offs | **Co-benefits exist, but they are context and environment dependent**<br>**Build/retrofit:** Activity/jobs onsite and in the supply chain (if UK based).<br>**Operation:** Safeguarding jobs onsite and in the supply chain. Competition for biomass feedstocks may be driving up prices / creating incentives for growing feedstock markets. Income for rural communities.<br>**Output:** If the counterfactual is closure or non-existence, then the output co-benefits include the value of electricity generation and other co-products that can be sold to other markets. Also, domestic $CO_2$ production creates increased stability by developing domestic supply chains and |

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| | | less need to rely on global $CO_2$ supply chain (prices fluctuate widely with gas price), leading to reduced fossil fuel imports. Lastly, benefit to the T&S system as steady stream of $CO_2$. |
| Deliverability | **TRL** | 5-7<br>**Source:** CCC (2025) |
| | **MRV readiness** | **Regulated MRV in place at a national level, but not at project level or is under development.**<br>Work is underway through the ongoing development of the Common Biomass Sustainability Framework and GGR Standard to develop MRV requirements. These will build on existing sustainability criteria already in place. |
| | **Resource availability and use** | **Does not have secure domestic sources of input resources, strong competition for resources or need for imports or creation of new supply chains.**<br>Feedstock used is a by-product of commercial forestry operations, imported from abroad. Insufficient domestic feedstock to meet current modelled demand for power BECCS, based on current domestic supply and demand levels. Potential high future competition for biomass feedstocks globally. |
| Achievability (enablers & barriers) | **Public acceptance** | **General public is against GGR solution / General public is in favour if certain conditions are met.**<br>Public concerned that BECCS is not proven at scale and have concerns on the sustainability of the feedstock (as evidenced by some Call for Evidence responses). Public does however understand the need for BECCS in reaching net zero (National Centre for Social Research, 2023). Conditions for public acceptance include trust in institutions and responsible governance (Pidgeon and Spence, 2017; Bellamy, 2022). |
| | **Policy** | **Requires additional policy to be in place to function more effectively.**<br>Plants would likely require business model support. A power BECCS business model, for plants greater than >100 MW is in development. Some plants will require extension of support due to existing subsidy support terminating from 2027. A government response on plants over 100 MW was published in February 2025 illustrating an intention to extend short-term support. |
| | **Regulation** | **Requires additional/amended regulations to be in place to function more effectively.**<br>Continuation of government work on proposed amendments to, and application of, the Carbon Capture Revenue Support (Directions, Eligibility and Counterparty) Regulations 2024 (the “Regulations”) to enable the Greenhouse Gas Removals (GGRs) and Power Bioenergy with Carbon Capture and Storage (Power BECCS) business models. |
| | **Physical infrastructure (T&S)** | **Requires large amounts of $CO_2$ pipeline T&S infrastructure, and insufficient amounts are being developed.**<br>Requires a large amount of storage. |

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| | Physical infrastructure (NPT) | **May in some instances require NPT.**<br>Retrofit plants are likely to be near planned clusters however some projects may require a pipeline or NPT. |

### Small-scale power BECCS

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| Strategic fit | Supporting wider government ambitions | **Supports wider government ambitions/missions partially/fully.**<br>Small-scale power BECCS can contribute to government ambitions. Plants are likely to be retrofit plants therefore supporting the growth mission through maintaining jobs across the country. Plants tend to use waste wood or animal biomass like poultry litter so there is a potential waste management opportunity. |
| | Fit within the wider energy system (Security of supply) | **Does not significantly affect security of supply or improves it.**<br>Electricity generation potential but depending on size this may not be sufficient to meaningfully contribute to clean power but neither will it impact security of supply. |
| | Fit within the wider energy system (Operability) | **Does not affect system flexibility or either improves or worsens system flexibility dependent on operating model/conditions.**<br>For sites that use waste feedstocks, the counterfactual without GGR solutions would still require a type of waste management solution (probably with power output), so a GGR would not affect system flexibility relative to that counterfactual, only if it attracted additional new build sites.<br>For sites that use non-waste feedstocks, the counterfactual is no site once current support ends and no power from these sites. Therefore, if power BECCS plants operate baseload, they would displace renewables. |
| | Environmental Impacts | **Can have beneficial impacts on the environment, but they are very context and environment dependent.**<br>**(-)** Biomass combustion can release pollutants such as particulate matter (PM), nitrogen oxides (NOx), and sulphur oxides (SOx), which may impact air quality. However, the use of existing pollution abatement equipment together with advanced carbon capture technologies, combined with optimal combustion management, can significantly reduce these emissions.<br>**(-)** If woody energy crops become a more prevalent alternative to existing feedstocks (either due to policy or necessity as a result of increasing demand/competition), there could be substantive land use impacts.<br>**(+)** Potential role in waste management and subsequent environmental benefits. |
| Value for money | Costs (£/t$CO_2$ captured) | **2030:** no suitable evidence available<br>**2050:** 223-334<br><br>**Source**: CCC (2025) |

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| Value for money | Non-environmental co-benefits & trade-offs | **Benefits other sectors, but when non-waste feedstocks used co-benefits are dependent on impact of knock-on effects.**<br>**Build/retrofit:** Activity/jobs onsite and in the supply chain (if UK based)<br>**Operation:** Safeguarding jobs onsite and in the supply chain against a counterfactual of closure or minimal impact if other waste management solutions need to be used instead (i.e. some type of plant continues to exist in the counterfactual). Competition for non-waste biomass feedstocks may be driving up prices / creating incentives for growing feedstock markets and income for rural communities by using unused/under-utilised wastes.<br>**Output:** If the counterfactual is closure or non-existence, then the output co-benefits include the value of electricity generation and other co-products that can be sold to other markets. Also, domestic $CO_2$ production creates increased stability by developing domestic supply chains and less need to rely on global $CO_2$ supply chain (prices fluctuate widely with gas price), leading to reduced fossil fuel imports. Lastly, benefit to the T&S system as steady stream of $CO_2$. |
| Deliverability | TRL | 5-7<br>**Source**: CCC (2025) |
| | MRV readiness | **Regulated MRV in place at a national level, but not at project level or is under development.**<br>Work is underway through the ongoing development of the Common Biomass Sustainability Framework and GGR Standard to develop MRV requirements. These will build on existing sustainability criteria already in place. |
| | Resource availability and use | **Domestic secure sources of input resources available, often uses waste products and unused/under-utilised feedstocks where possible but some feedstocks (non-waste) face competition.**<br>Plant feedstock generally waste wood or animal biomass like poultry litter, which are generally domestic resources. Potential high future competition for biomass feedstocks globally. |
| Achievability (enablers & barriers) | Public acceptance | **General public is against GGR solution / General public is in favour if certain conditions are met.**<br>Public concerned that BECCS is not proven at scale and have concerns on the sustainability of the feedstock (as evidenced by some Call for Evidence responses). Public does however understand the need for BECCS in reaching net zero (National Centre for Social Research, 2023). Conditions for public acceptance include trust in institutions and responsible governance (Pidgeon and Spence, 2017; Bellamy, 2022). |
| | Policy | **Requires additional policy to be in place to function more effectively.**<br>Plants would likely require business model support which is currently planned under the GGR business model. |

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| | | A number of plants will require extension of support due to existing support terminating from 2027. Work to date has focussed on plants over 100MW. Due to geographical spread, the majority are likely to require NPT. |
| | **Regulation** | **Requires additional/amended regulations to be in place to function more effectively.** Continuation of government work on proposed amendments to, and application of, the Carbon Capture Revenue Support (Directions, Eligibility and Counterparty) Regulations 2024 (the "Regulations") to enable the Greenhouse Gas Removals (GGRs) and Power Bioenergy with Carbon Capture and Storage (Power BECCS) business models. |
| | **Physical infrastructure (T&S)** | **Requires medium amounts of $CO_2$ pipeline T&S infrastructure, but development is in train.** Small-scale BECCS may make up some of the smaller projects in the CCUS pipeline, thereby requiring less storage. |
| | **Physical infrastructure (NPT)** | **May in some instances requires NPT.** Due to geographical spread, the majority are likely to require NPT. |

## Biomass gasification for hydrogen production

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| Strategic fit | Supporting wider government ambitions | **Supports wider government ambitions/missions partially/fully.**<br>Hydrogen BECCS can contribute to government ambitions. Plants will be new build as this is a nascent sector, therefore supporting the Growth mission through creation of jobs. Deployment of hydrogen could support the wider Hydrogen ambition. |
| | Fit within the wider energy system (Security of supply) | **Does not significantly affect security of supply or improves it.**<br>Would tend to replace the marginal source of hydrogen production (likely to be fossil gas with CCS). |
| | Fit within the wider energy system (Operability) | **Does not affect system flexibility or improves it.**<br>As a storable fuel, hydrogen can be used to enhance the flexibility of the energy system, complementing the roles of wind, solar and nuclear. |
| | Environmental Impacts | **Potential carbon and land use implications depending on expected feedstock.**<br>**(-)** Biomass combustion can release pollutants such as particulate matter (PM), nitrogen oxides (NOx), and sulphur oxides (SOx), which may impact air quality. However, the use of existing pollution abatement equipment together with advanced carbon capture technologies, combined with optimal combustion management, can significantly reduce these emissions.<br>**(-)** If woody energy crops become a more prevalent alternative to existing feedstocks (either due to policy or necessity as a result of increasing demand/competition), there could be substantive land use impacts.<br>**(+)** Potential role in waste management and subsequent environmental benefits. |
| Value for money | Costs (£/t$CO_2$ captured) | No suitable evidence available. |
| | Non-environmental co-benefits & trade-offs | **Co-benefits exist, but they are context and environment dependent.**<br>Supports the development of the hydrogen sector.<br>**Build:** Activity/jobs onsite and in the supply chain (if UK based).<br>**Operation:** Creating jobs onsite and in the supply chain. Competition for biomass feedstocks may be driving up prices / creating incentives for growing feedstock markets. Income for rural communities.<br>**Output:** Value of hydrogen and other co-products that can be sold to other markets. Also, domestic $CO_2$ production creates increased stability by developing domestic supply chains and less need to rely on global $CO_2$ supply chain (prices fluctuate widely with gas price), leading to reduced fossil fuel imports. Lastly, benefit to the T&S system as steady stream of $CO_2$. |

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| Deliverability | TRL | 5-7<br><br>**Source**: IEA (2025) |
| | MRV readiness | **Regulated MRV in place at a national level, but not at project level or is under development.**<br>Work is underway through the ongoing development of the Common Biomass Sustainability Framework and GGR Standard to develop MRV requirements. These will build on existing sustainability criteria already in place. |
| | Resource availability and use | **Does not have secure domestic sources of input resources, strong competition for resources or need for imports or creation of new supply chains.**<br>Feedstocks likely to be woody biomass, meaning there will be competition with other GGRs. Insufficient domestic feedstock to meet potential demand. Potential high future competition for biomass feedstocks globally. |
| Achievability (enablers & barriers) | Public acceptance | **General public is against GGR solution / General public is in favour if certain conditions are met.**<br>Public concerned that BECCS is not proven at scale and have concerns on the sustainability of the feedstock (as evidenced by some Call for Evidence responses). Public does however understand the need for BECCS in reaching net zero (National Centre for Social Research, 2023). Conditions for public acceptance include trust in institutions and responsible governance (Pidgeon and Spence, 2017; Bellamy, 2022). |
| | Policy | **Requires additional policy to be in place to function more effectively.**<br>Plants would likely require business model support which is currently planned under the GGR business model or Hydrogen business model. Requires hydrogen market and offtakers. |
| | Regulation | **Requires additional/amended regulations to be in place to function more effectively.**<br>Continuation of government work on proposed amendments to, and application of, the Carbon Capture Revenue Support (Directions, Eligibility and Counterparty) Regulations 2024 (the "Regulations") to enable the Greenhouse Gas Removals (GGRs) and Power Bioenergy with Carbon Capture and Storage (Power BECCS) business models. |
| | Physical infrastructure (T&S) | **Requires medium amounts of $CO_2$ pipeline T&S infrastructure, but development is in train.**<br>As likely to be newbuilds there are opportunities for location and size. |
| | Physical infrastructure (NPT) | **May in some instances requires NPT.**<br>As likely to be newbuilds there are opportunities for location and size. |

## Fischer-Tropsch SAF with CCS

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| Strategic fit | Supporting wider government ambitions | **Supports wider government ambitions/missions partially/fully.** Fischer-Troph SAF with CCS can contribute to government ambitions. Plants will be new build as this is a nascent sector, therefore supporting the Growth mission through creation of jobs. |
| Strategic fit | Fit within the wider energy system (Security of supply) | **Does not significantly affect security of supply or improves it.** Would reduce reliance on oil, which is likely to be imported at the margin. |
| Strategic fit | Fit within the wider energy system (Operability) | **Does not affect system flexibility.** |
| Strategic fit | Environmental Impacts | **Can have beneficial impacts on the environment, but they are very context and environment dependent.** **(+/-)** SAF may produce lower nitrogen dioxide emissions and less global warming from contrails than kerosene but has impacts on air quality. **(-)** If woody energy crops become a more prevalent alternative to existing feedstocks (either due to policy or necessity as a result of increasing demand/competition), there could be substantive land use impacts. **(+)** Potential role in waste management and subsequent environmental benefits. |
| Value for money | Costs (£/t$CO_2$ captured) | No suitable evidence available. |
| Value for money | Non-environmental co-benefits & trade-offs | **Co-benefits exist, but they are context and environment dependent.** **Build:** Activity/jobs onsite and in the supply chain (if UK based). **Operation:** Creating jobs onsite and in the supply chain. Competition for biomass feedstocks may be driving up prices / creating incentives for growing feedstock markets. Income for rural communities. **Output:** Value of SAF and other co-products that can be sold to other markets. Also, domestic $CO_2$ production creates increased stability by developing domestic supply chains and less need to rely on global $CO_2$ supply chain (prices fluctuate widely with gas price), leading to reduced fossil fuel imports. Lastly, benefit to the T&S system as steady stream of $CO_2$. |
| Deliverability | TRL | 8<br>**Source**: ERM/$CO_2$RE (forthcoming) |
| Deliverability | MRV readiness | **Regulated MRV in place at a national level, but not at project level or is under development.** SAF projects submit LCAs to DfT for review, but alignment with the GGR Standard will be needed |
| Deliverability | Resource availability and use | **Does not have secure domestic sources of input resources, strong competition for resources or need for imports or creation of new supply chains.** |

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| | | Feedstock likely to be wastes and residues, including woody biomass, meaning there will be competition with other GGRs. Potential high future competition for biomass feedstocks globally. |
| Achievability (enablers & barriers) | **Public acceptance** | **General public is against technology / General public is in favour if certain conditions are met.**<br>Public acceptance of SAF may be negatively impacted by perception of it as an 'engineered' GGR that utilises CCS (Call for Evidence responses).<br>Conditions for public acceptance include trust in institutions and responsible governance (Pidgeon and Spence, 2017; Bellamy, 2022). |
| | **Policy** | **Requires additional policy to be in place to function more effectively.**<br>The SAF mandate is in effect, but currently there is not policy requiring SAF plants to apply CCS. |
| | **Regulation** | **Requires additional/amended regulations to be in place to function more effectively.**<br>New SAF pathways must be certified for use in aviation. |
| | **Physical infrastructure (T&S)** | **Requires medium amounts of $CO_2$ pipeline T&S infrastructure, but development is in train.** |
| | **Physical infrastructure (NPT)** | **May in some instances requires NPT.** |

## WECCS

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| Strategic fit | Supporting wider government ambitions | **Does not impact or partially impacts other government ambitions/missions.**<br>WECCS may contribute to government ambitions. Plants are retrofit EfW sites, therefore any impact on the energy superpower or growth mission is minimal as the counterfactual (not being retrofitted as a GGR) means plants will not close down and continue to operate. If GGRs attract new build EfW (which would not have happened in the counterfactual) due to waste market dynamics changing, then can contribute to government ambitions. |
| | Fit within the wider energy system (Security of supply) | **Does not significantly affect security of supply or improves it.**<br>Small reduction in electricity output compared to unabated operation, with minimal effects on security of supply. If GGRs attract new build EfW (which would not have happened in the counterfactual) due to waste market dynamics changing, then can improve security of supply. |
| | Fit within the wider energy system (Operability) | **Does not affect system flexibility or either improves or worsens system flexibility dependent on operating/conditions**<br>EfW sites are designed to operate 24/7 for steady waste throughput. They currently run as baseload operators. If they are not converted into WECCS, they would still continue to operate and provide baseload power, so relative to that operability is unchanged.<br>If GGRs attract new build EfW (which would not have happened in the counterfactual) due to waste market dynamics changing, then if WECCS plants operate baseload, they would displace renewables. |
| | Environmental Impacts | **Can have beneficial impacts on the environment, but they are very context and environment dependent.**<br>**(-)** Relative to the status quo, there are additional environmental impacts from retrofitting CCUS (pollutants, particles, toxic wastes).<br>**(+)/(-)** Could also change waste market dynamics |
| Value for money | Costs (£/t$CO_2$ captured) | **2030**: 221-347 (273)<br>**2050**: 173-298 (223)<br>**Source**: ERM/$CO_2$RE (forthcoming) |
| | Non-environmental co-benefits & trade-offs | **Benefits other sectors, but some co-benefits are dependent on impact of knock-on effects.**<br>**Build/retrofit:** Activity/jobs onsite and in the supply chain (if UK based).<br>**Operation:** No/minimal impact relative to status quo. If GGRs attract new build EfW (which would not have happened in the counterfactual) due to waste market dynamics changing, creating jobs onsite and in the supply chain.<br>**Output:** Relative to the status quo (where EfW continues operating without CCUS), being a GGR could alter waste market dynamics and competition. Beneficial for $CO_2$ T&S operators due to steady $CO_2$ stream. Also, domestic $CO_2$ production creates increased stability by developing domestic supply chains and less need to rely on global $CO_2$ supply chain (prices fluctuate widely with gas price), leading to reduced fossil fuel imports. Lastly, benefit to the T&S system as steady stream of $CO_2$. |

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| Deliverability | **TRL** | 7<br>**Source**: ERM/$CO_2$RE (forthcoming) |
| | **MRV readiness** | **Regulated MRV in place at a national level, but not at project level or is under development.**<br>UK Standard in development |
| | **Resource availability and use** | **Domestic secure sources of input resources available, uses waste products and unused/under-utilised feedstocks where possible, but resources face potential competition.**<br>The EfW plants already exist and have a role as part of the waste hierarchy. The plants have secure supplies of domestic residual municipal solid waste streams. If GGRs attract new build EfW (which would not have happened in the counterfactual) due to waste market dynamics changing, more competition for waste. |
| Achievability (enablers & barriers) | **Public acceptance** | **General public is against technology / General public is in favour if certain conditions are met.**<br>Public acceptance of WECCS is not looked at specifically in the report. Public acceptance of EfW may be negatively impacted by perception of it as an 'engineered' GGR that utilises CCS (Call for Evidence responses). However, WECCS role in waste management may increase public acceptance. Conditions for public acceptance include trust in institutions and responsible governance (Pidgeon and Spence, 2017; Bellamy, 2022).<br>May be increased acceptance due to the role of WECCS in waste management. |
| | **Policy** | **Requires additional policy to be in place to function more effectively.**<br>Currently supported by the ICC business model with an opportunity to reduce the cost to government through sale of credits on the voluntary carbon market, but currently no clear framework for recognising the GGR potential of WECCS. |
| | **Regulation** | **Does not require additional regulations.**<br>WECCS is covered under the ICC regulations. |
| | **Physical infrastructure (T&S)** | **Requires medium amounts of $CO_2$ pipeline T&S infrastructure, but development is in train.** |
| | **Physical infrastructure (NPT)** | **May in some instances requires NPT.**<br>Given wide spread of locations of existing EfW sites, potentially will require NPT for many sites. |

## Anaerobic Digestion

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| Strategic fit | Supporting wider government ambitions | **Supports wider government ambitions/missions partially/fully.**<br>AD can contribute to government ambitions. Energy generation could support the energy superpower mission, with AD also contributing to waste management ambitions and supporting agricultural incomes. |
| | Fit within the wider energy system (Security of supply) | **Does not significantly affect security of supply or improves it.**<br>Biomethane production will reduce fossil gas in both CCS-based and unabated applications; digestate can also displace fossil-based fertiliser. |
| | Fit within the wider energy system (Operability) | **Does not affect system flexibility or improves it.**<br>As a storable fuel, biomethane can be used to enhance the flexibility of the energy system, complementing the roles of wind, solar and nuclear. |
| | Environmental Impacts | **Can have beneficial impacts on the environment, but they are very context and environment dependent.**<br>**(+)** Positive contribution to management of wet wastes, and reduction of on-farm methane emissions, but risk that fugitive methane emissions from AD plants undermine this.<br>**(-)** If purpose-grown energy crops become a more prevalent alternative to existing feedstocks (either due to policy or necessity as a result of increasing demand/competition), there could be substantive land use impacts. |
| Value for money | Costs (£/t$CO_2$ captured) | No suitable evidence available. |
| | Non-environmental co-benefits & trade-offs | **Benefits other sectors / does not create trade-offs.**<br>**Build:** Activity/jobs onsite and in the supply chain (if UK based) for new build AD sites.<br>**Operation:** Creating jobs onsite and in the supply chain. Competition for biomass feedstocks may be driving up prices / creating incentives for growing feedstock market. Income for rural communities<br>**Output:** Supports the agriculture sector and delivers waste management services. Also, domestic $CO_2$ production creates increased stability by developing domestic supply chains and less need to rely on global $CO_2$ supply chain (prices fluctuate widely with gas price), leading to reduced fossil fuel imports. Lastly, benefit to the T&S system as steady stream of $CO_2$. |
| Deliverability | TRL | 9<br>**Source**: BEIS (2021) |
| | MRV readiness | **Regulated MRV in place at a national level, but not at project level or is under development.**<br>Concerns over fugitive methane emissions. |

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| | **Resource availability and use** | **Domestic secure sources of input resources available, uses waste products and unused/under-utilised feedstocks where possible and resources face no competition or issues.** Uses wet waste (domestic supply), but potential to also use crops meaning there may be competition with other GGRs and sectors. |
| **Achievability (enablers & barriers)** | **Public acceptance** | **General public is against technology / General public is in favour if certain conditions are met.** Public acceptance of AD is not looked at specifically in the report. Public acceptance of AD may be negatively impacted by perception of it as an 'engineered' GGR that utilises CCS (Call for Evidence responses). However, AD's role in waste management and potential benefits for farmers may increase public acceptance. Conditions for public acceptance include trust in institutions and responsible governance (Pidgeon and Spence, 2017; Bellamy, 2022). |
| | **Policy** | **Requires additional policy to be in place to function more effectively.** Biomethane is currently supported under the Green Gas Support Scheme, but this is due to expire shortly; Policy does not currently provide a route to reflect the potential value of the digestate or $CO_2$ available to be captured in upgrading. |
| | **Regulation** | **Requires additional/amended regulations to be in place to function more effectively.** Fugitive methane emissions need to be better regulated. |
| | **Physical infrastructure (T&S)** | **Requires medium amounts of $CO_2$ pipeline T&S infrastructure, but development is in train.** Existing gas infrastructure means that biomethane can be utilised within the energy system (eventually with CCS), further opportunity for carbon capture from upgrading requires NPT. |
| | **Physical infrastructure (NPT)** | **Heavily dependent on NPT.** Existing gas infrastructure means that biomethane can be utilised within the energy system (eventually with CCS), further opportunity for carbon capture from upgrading requires NPT. |

**DACCS**

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| Strategic fit | Supporting wider government ambitions | **Supports wider government ambitions/missions partially/fully.**<br>DACCS can contribute to government ambitions. Plants will be new build as this is a nascent sector, therefore supporting the growth mission through creation of jobs. |
| Strategic fit | Fit within the wider energy system (Security of supply) | **Uses large amounts of electricity and significantly worsens security of supply (without further build out).**<br>Flexible DACCS can be added without energy security concerns, but baseload DACCS likely to take supply away from other priorities. |
| Strategic fit | Fit within the wider energy system (Operability) | **Either improves or worsens system flexibility dependent on operating model / conditions.**<br>Flexible DACCS could utilise surplus generation. |
| Strategic fit | Environmental Impacts | **Drawbacks for the environment with no mitigations in place.**<br>**(-)** DACCS uses large amounts of water, construction materials and energy. |
| Value for money | Costs (£/t$CO_2$ captured) | **2030**:<br>Liquid solvent: 325-578 (440)<br>Solid sorbent: 636-842 (735)<br>**2050**:<br>Liquid solvent: 169-405 (284)<br>Solid sorbent: 259-489 (353)<br>**Source**: ERM/$CO_2$RE (forthcoming) |
| Value for money | Non-environmental co-benefits & trade-offs | **Co-benefits exist, but they are context and environment dependent**<br>**Build:** Activity/jobs onsite and in the supply chain (if UK based).<br>**Operation:** Activity/jobs onsite and in the supply chain. Knock-on effects on other sectors, e.g., domestic power supply chain (flexible running can improve renewables business case).<br>**Output:** Benefit to the T&S system as can inject $CO_2$ flexibly. Also, domestic $CO_2$ production creates increased stability by developing domestic supply chains and less need to rely on global $CO_2$ supply chain (prices fluctuate widely with gas price), leading to reduced fossil fuel imports. |

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| Deliverability | TRL | Liquid: 6 / Solid: 7<br>**Source**: ERM/$CO_2$RE (forthcoming) |
| | MRV readiness | **Regulated MRV in place at a national level, but not at project level or is under development.**<br>UK GGR Standard in development. |
| | Resource availability and use | **Domestic sources of input resources available and can make use of existing supply chains, but there is competition.**<br>The resources demanded by DACCS are electricity and water: they can be sourced domestically, but there is competition. |
| Achievability (enablers & barriers) | Public acceptance | **General public is against technology / General public is in favour if certain conditions are met.**<br>Public acceptance of DACCS may be negatively impacted by perception of it as an 'engineered' GGR that utilises CCS (Call for Evidence responses). Conditions for public acceptance include trust in institutions and responsible governance (Pidgeon and Spence, 2017; Bellamy, 2022). |
| | Policy | **Does not require additional policy.**<br>All policy in place, apart from GGR Standard: see MRV column. |
| | Regulation | **Requires additional/amended regulations to be in place to function more effectively.**<br>Continuation of government work on proposed amendments to, and application of, the GGR business model. |
| | Physical infrastructure (T&S) | **Requires medium amounts of CO2 pipeline T&S infrastructure, but development is in train.**<br>DACCS is reliant on the development of T&S clusters, which is in train.<br>Relatively modular nature and flexible siting means it can be accommodated within other T&S plans. |
| | Physical infrastructure (NPT) | **Not dependent on NPT.** |

**ERW**

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| Strategic fit | Supporting wider government ambitions | **Supports wider government ambitions/missions partially/fully.**<br>ERW can contribute to government ambitions. ERW will create new activity and jobs, therefore supporting the growth mission. There may also be positive knock-on effects on the agriculture sector. |
| | Fit within the wider energy system (Security of supply) | **Does not significantly affect security of supply or improves it.**<br>Some energy required to mine and crush additional rocks. |
| | Fit within the wider energy system (Operability) | **Does not affect system flexibility.** |
| | Environmental Impacts | **Can have beneficial impacts on the environment, but they are very context and environment dependent.**<br>**(+/-)** Potential for improvement in soil health, but if wrong application management or other toxins included in ground rock, it can have negative impact on soil health, surface/ ground water and aquatic life. |
| Value for money | Costs (£/tCO2 captured) | **2030**: 350-864(487)<br>**2050**: 262-670 (365)<br>**Source**: ERM/CO2Re (forthcoming) |
| | Non-environmental co-benefits & trade-offs | **Co-benefits exist, but they are context and environment dependent.**<br>**Build:** Activity/jobs onsite (quarries and farms) and in the supply chain (if UK based)<br>**Operation:** Enhanced plant growth and yield and therefore farm productivity. Can also improve other GGRs (e.g. afforestation, reforestation and forest management, biochar, bioenergy feedstock, soil carbon storage).<br>**Impact:** Decreased need for fertilisers and pesticides**.** Potential impacts on human health due to application of rock dust. (Environment Agency, 2025) |
| Deliverability | TRL | 8<br>**Source**: ERM/$CO_2$RE (forthcoming) |
| | MRV readiness | **Does not have regulated MRV in place, neither at national nor at project level.** |
| | Resource availability and use | **Domestic secure sources of input resources available, uses waste products and unused/under-utilised feedstocks where possible and resources face no competition or issues.**<br>Mafic and ultramafic rock in the UK is mainly extracted for construction, with 3.7 Mt/year of basic silicate fines available for early ERW |

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| | | deployment. Extraction will need to be increased to meet the demands required for ERW scale up beyond that, although this is possible with the currently identified basic silicate reserves. (Environment Agency, 2025). |
| Achievability (enablers & barriers) | **Public acceptance** | **General public is in favour if certain conditions are met.**<br>Public acceptance may depend on how ERW presented/perceived, with likely increased acceptance if seen as good for farmers and the environment.<br>More members of the British public support ERW than are opposed to it, but noted the need for conditions such as strict monitoring and small-scale trials (Pidgeon and Spence, 2017). |
| | **Policy** | **Requires additional policy to be in place in order to function.**<br>ERW requires additional policy to be in place, such as development of policy frameworks to support the deployment of ERW, whilst also monitoring ongoing research developments. (Environment Agency, 2025). |
| | **Regulation** | **Requires additional/amended regulations to be in place in order to be able to function.**<br>ERW requires additional regulation to be in place, such as development of regulations for the relationship between mining and the wellbeing of local communities. There also needs to be further policies and regulations surrounding the associated risks globally of deploying ERW. Development of policy frameworks to support the deployment of ERW, whilst also monitoring ongoing research developments. (Environment Agency, 2025) |
| | **Physical infrastructure (T&S)** | N/A |
| | **Physical infrastructure (NPT)** | N/A |

**Afforestation, reforestation and forest management**

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| **Strategic fit** | **Supporting wider government ambitions** | **Supports wider government ambitions/missions partially/fully.**<br>Afforestation can contribute to government ambitions by helping to deliver the legally binding canopy cover target and supports broader environmental targets. |
| | **Fit within the wider energy system (Security of supply)** | N/A |
| | **Fit within the wider energy system (Operability)** | N/A |
| | **Environmental Impacts** | **Can have beneficial impacts on the environment, but they are very context and environment dependent.**<br>**(+)** (If biomass left in place) Changing water quality, soil health, biodiversity, access to green spaces, erosion and flood protection, soil carbon and nutrient recycling.<br>**(-)** Potential negative effects through eutrophication (depending on land use change) and potential local, regional, faraway temperature and precipitation changes. |
| **Value for money** | **Costs (£/t$CO_2$ captured)** | 2-27 (15)<br>**Source**: Element Energy (2021) |
| | **Non-environmental co-benefits & trade-offs** | **Co-benefits exist, but they are context and environment dependent.**<br>**Build/Operation:** Activity and jobs (field operations, monitoring and data management, community and stakeholder engagement), including wage premium for some jobs relative to traditional industries due to higher productivity.<br>**Output:** Increased tourism (including job creation, wider economic activity). Flood protection but flood storage could also reduce in some areas. Sustainably harvested biomass use in other industries. These industries' demands strengthen the market for domestic biomass and if more efficient than alternative use, leads to growth, investment, returns, and jobs in these industries. |
| **Deliverability** | **TRL** | 9<br>**Source**: Element Energy (2021) |
| | **MRV readiness** | **Regulated MRV in place at national and project level.** |

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| | **Resource availability and use** | **Domestic sources of input resources available and can make use of existing supply chains, but there is competition.**<br>There are limits to the amount of land available for woodland creation. Supplies of seeds and saplings is also limited. |
| Achievability (enablers & barriers) | **Public acceptance** | **General public is in favour of technology.**<br>Afforestation was appraised highly by the UK public (Bellamy, 2022) with higher levels of public support (European Scientific Advisory Board on Climate Change, February 2025). |
| | **Policy** | **Does not require additional policy.**<br>Policy support already exists through government funded tree planting programmes (e.g. environmental land management schemes). |
| | **Regulation** | **Does not require additional regulations.** |
| | **Physical infrastructure (T&S)** | N/A |
| | **Physical infrastructure (NPT)** | N/A |

## Biochar

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| Strategic fit | Supporting wider government ambitions | **Supports wider government ambitions/missions partially/fully.**<br>Biochar can contribute to government ambitions. Biochar production with bioenergy offers earlier deployment of carbon reduction strategies at lower carbon prices and provides soil amendment advantages. |
| | Fit within the wider energy system (Security of supply) | **Does not significantly affect security of supply or improves it.**<br>New build pyrolysis plants for biochar production provide heat, syngas, and bio-oil as co-products. Heat can be converted into electrical energy.<br>No/limited electricity demand.<br>Increased heat demand could negatively affect security of supply (unless waste heat is used). |
| | Fit within the wider energy system (Operability) | **Does not affect system flexibility or improves it.**<br>Linked to security of supply implications, no/limited impact. |
| | Environmental Impacts | **Can have beneficial impacts on the environment, but they are very context and environment dependent.**<br>**(-)** Impacts from growing feedstock for biochar include changes in soil health, effects on biodiversity, increased pressure on scarce water resources.<br>**(+)** Positive impacts from application of biochar include reduced chemical inputs from fertilisers and pollutant filtration improving water quality.<br>Negative impacts from incorrect application include pollution of surface/ground water and impacts on aquatic life. (Environment Agency, 2025). |
| Value for money | Costs (£/t$CO_2$ captured) | **2030**: 20-1,171, depending on feedstock<br>**2050**: 5-1,210, depending on feedstock<br>**Source**: ERM/$CO_2$RE (forthcoming) |
| | Non-environmental co-benefits & trade-offs | **Co-benefits exist, but they are context and environment dependent.**<br>**Build/Operation:** Activity/jobs onsite and in the supply chain, including in the set-up of new pyrolysis plants.<br>**Output:** Improved food quality and security and therefore farmer income from improvements in soil health, reduced chemical inputs from fertilisers (resulting in lower input costs) and pollutant filtration improving water quality. Benefits of growth for other sectors including waste treatment, construction, and cement production. (Environment Agency, 2025). |
| Deliverability | TRL | 5-9<br>**Source**: ERM/$CO_2$RE (forthcoming) |
| | MRV readiness | **Does not have regulated MRV in place, neither at national nor at project level.** |

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| | **Resource availability and use** | **Domestic sources of input resources available and can make use of existing supply chains, but there is competition.** Biochar production can use dedicated crops, wood or wastes/residues. Competition for feedstocks with other GGRs and other sectors (e.g. agriculture). |
| Achievability (enablers & barriers) | **Public acceptance** | **General public is in favour if certain conditions are met.** Some concerns over the type of waste being applied to land. Limited studies on public acceptance of biochar, but it was appraised as a middle performing option in mapping appraisals (Lomax C and others, 2025). |
| | **Policy** | **Requires additional policy to be in place to function more effectively.** Requires additional policy to be in place in order to function, including MRV, but biochar is already being produced on small scales. |
| | **Regulation** | **Requires additional/amended regulations to be in place in order to be able to function more effectively.** Biochar should no longer be regulated under the waste regulations and should be included in fertiliser regulations. |
| | **Physical infrastructure (T&S)** | N/A |
| | **Physical infrastructure (NPT)** | N/A |

## Timber in construction

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|---|---|---|
| Strategic fit | Supporting wider government ambitions | **Supports wider government ambitions/missions partially/fully.**<br>Timber in construction can contribute to government ambitions by supporting housebuilding targets and private investment into tree planting. |
| | Fit within the wider energy system (Security of supply) | N/A |
| | Fit within the wider energy system (Operability) | N/A |
| | Environmental Impacts | **Can have beneficial impacts on the environment, but they are very context and environment dependent.**<br>Dependent on sustainable sourcing but can increase funding for tree planting. |
| Value for money | Costs (£/t$CO_2$ captured) | Uncertain (may be zero)<br>**Source**: Element Energy (2021) |
| | Non-environmental co-benefits & trade-offs | **Benefits other sectors / does not create trade-offs.**<br>**Build/operation:** Activity and jobs (operations, monitoring, science, research, community engagement, education), including wage premium relative to traditional industries due to higher productivity.<br>**Output:** Local impacts including income increases and spending growth. Increases private investment into tree planting and forestry sector to secure domestic timber supplies. |
| Deliverability | TRL | 9<br>**Source**: Element Energy (2021) |
| | MRV readiness | **Regulated MRV in place at national and project levels** |
| | Resource availability and use | **Domestic sources of input resources available and can make use of existing supply chains, but there is competition.**<br>There are domestic sources of timber, but these face competition for supply and land constraints. |
| Achievability | Public acceptance | **General public is in favour if certain conditions are met.**<br>Changes to consumer preferences needed to drive higher deployment |

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| | **Policy** | **Requires additional policy to be in place to function more effectively.**<br>Further research and data needed to enable policy support best deployment of timber in construction. |
| | **Regulation** | **Requires additional/amended regulations to be in place to function more effectively.**<br>Further research and data needed to understand future regulatory changes |
| | **Physical infrastructure (T&S)** | Additional sawmills and other processing infrastructure needed if deployed at scale. |
| | **Physical infrastructure (NPT)** | |

## Soil carbon storage

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|---|---|---|
| Strategic fit | Supporting wider government ambitions | **Supports wider government ambitions/missions partially/fully.**<br><br>Creates jobs and activities, supporting the growth mission. |
| | Fit within the wider energy system (Security of supply) | N/A |
| | Fit within the wider energy system (Operability) | N/A |
| | Environmental Impacts | **Beneficial impacts on the environment.**<br>**(+)** Soil health improvements (Call for Evidence). |
| Value for money | Costs (£/t$CO_2$ captured) | 5-23 (c:14)<br>**Source**: Element Energy (2021) |
| | Non-environmental co-benefits & trade-offs | **Benefits other sectors / does not create trade-offs.**<br>**Build/operation:** Activity and jobs (operations, monitoring, science, research, community engagement, education), including wage premium relative to traditional industries due to higher productivity.<br>**Output:** Local impacts including income increases and spending growth. Other industries benefit from increased soil fertility, workability, increased yield & yield stability, and improved water holding capacity, resulting in efficiency improvements, growth, investment, returns and jobs. Health impacts through improved food quality & security. |
| Deliverability | TRL | 8<br>**Source**: Element Energy (2021) |
| | MRV readiness | **Regulated MRV in place at a national level, but not at project level or is under development.**<br>High at national level / Low at project level |

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| | **Resource availability and use** | **Domestic sources of input resources available and can make use of existing supply chains, but there is competition.** Depends on method used and farmer uptake, as different soils have different levels of carbon storage potential. Land availability is a challenge, as land degradation can reduce the soil's ability to store carbon effectively. |
| Achievability (enablers & barriers) | **Public acceptance** | **General public is in favour if certain conditions are met / General public is in favour of technology**. Medium - still some misconceptions and gap in public understand. Acceptance likely high due to perception of 'naturalness' (European Scientific Advisory Board on Climate Change, February 2025). |
| | **Policy** | **Requires additional policy to be in place to function more effectively.** Policy support would need to reflect the range of different soil carbon storage methods. |
| | **Regulation** | **Requires additional/amended regulations to be in place to function more effectively.** Highly dependent on method used. |
| | **Physical infrastructure (T&S)** | N/A |
| | **Physical infrastructure (NPT)** | N/A |

### Peatland restoration

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| Strategic fit | **Supporting wider government ambitions** | **Supports wider government ambitions/missions partially/fully.**<br>Peatland Restoration can contribute to government ambitions by helping to deliver broader environmental targets, such as habitat restoration (Environment Act).<br>Also creates jobs and activities, supporting the growth mission. |
| | **Fit within the wider energy system (Security of supply)** | N/A |
| | **Fit within the wider energy system (Operability)** | N/A |
| | **Environmental Impacts** | **Beneficial impacts on the environment.**<br>**(+)** Peatland restoration offers flood protection and improvements to water quality. |
| Value for money | **Costs (£/t$CO_2$ captured)** | 30-56 (c:40)<br>**Source**: Element Energy (2021) |
| | **Non-environmental co-benefits & trade-offs** | **Benefits other sectors / does not create trade-offs.**<br>**Build/Operation:** Activity and jobs (monitoring and data management, community and stakeholder engagement), including wage premium relative to traditional industries due to higher productivity.<br>**Output:** Local impacts including income increases and spending growth, but economic insecurity for landowners relative to other land uses. Growth, investment, and jobs in improved water management and storage infrastructure in certain landscapes due to increased summer water demand. Spillovers to other sectors. Health impacts through improved biodiversity, water quality and access to green spaces. Reduction in land subsidence, therefore reducing damage in other sectors to e.g., roads, power lines and pipelines. Increased tourism (including job creation, wider economic activity) linked to ecosystem restoration, biodiversity preservation, improved habitat condition and biodiversity. |
| Deliverability | **TRL** | 8-9<br>**Source**: Element Energy (2021) |
| | **MRV readiness** | **Regulated MRV in place at national and project level.** |

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| | **Resource availability and use** | **Domestic secure sources of input resources available, uses waste products and unused/under-utilised feedstocks where possible and resources face no competition or issues.**<br>Entails restoring existing peatland, so there is no constraint on land availability. |
| **Achievability (enablers & barriers)** | **Public acceptance** | **General public is in favour of technology.**<br>Medium - takes land out of food production.<br>Peatland restoration was the most highly appraised option by the public (Lomax C and others, 2025). Acceptance likely high due to perception of 'naturalness' (European Scientific Advisory Board on Climate Change, 2025). |
| | **Policy** | **Does not require additional policy.**<br>Policy support already exists through government funded tree planting programmes (e.g. environmental land management schemes). |
| | **Regulation** | **Does not require additional regulations.** |
| | **Physical infrastructure (T&S)** | N/A |
| | **Physical infrastructure (NPT)** | N/A |

**Saltmarsh restoration**

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|---|---|---|
| Strategic fit | **Supporting wider government ambitions** | **Supports wider government ambitions/missions partially/fully.**<br>Saltmarsh can contribute to government ambitions by helping to deliver broader environmental targets, such as habitat restoration (Environment Act).<br><br>Also creates jobs and activities, supporting the growth mission. |
| | **Fit within the wider energy system (Security of supply)** | N/A |
| | **Fit within the wider energy system (Operability)** | N/A |
| | **Environmental Impacts** | **Beneficial impacts on the environment.**<br>**(+)** Restored saltmarshes act as flood buffers and can improve coastal biodiversity. |
| Value for money | **Costs (£/t$CO_2$ captured)** | 20-41 (c: 28)<br>**Source**: Element Energy (2021) |
| | **Non-environmental co-benefits & trade-offs** | **Benefits other sectors / does not create trade-offs.**<br>**Build/Operation:** Activity and jobs (monitoring and data management, community and stakeholder engagement), including wage premium relative to traditional industries due to higher productivity.<br>**Output:** Flood protection, although flood storage could also reduce in some areas. Impacting adaptation costs via transition from 'hard' to 'soft' coastal defence. No maintenance costs & less vulnerability of inland sea defences to rising sea-levels and storm surges. Local impacts including income increases and spending growth, nut economic insecurity for landowners relative to other land uses. Health impacts through improved biodiversity, water quality and access to green spaces. Beneficial for productivity. Reduction in land subsidence, therefore reducing damage in other sectors to e.g., roads, power lines and pipelines. Increased tourism (including job creation, wider economic activity) linked to ecosystem restoration, biodiversity preservation, improved habitat condition and biodiversity. Also, provision of nursery habitat for commercially important fish species. |
| Deliverability | **TRL** | 9<br>**Source**: Element Energy (2021) |

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|---|---|---|
| | **MRV readiness** | **Regulated MRV in place at a national level, but not at project level or is under development.**<br>High at national level / Low at project level. |
| | **Resource availability and use** | **Domestic sources of input resources available and can make use of existing supply chains, but there is competition.**<br>Restoration success depends on local conditions, such as sediment type or local vegetation. Removal of existing coastal infrastructure for saltmarsh restoration could be required. |
| **Achievability (enablers & barriers)** | **Public acceptance** | **General public is in favour of technology.**<br>Acceptance likely high due to perception of 'naturalness' (European Scientific Advisory Board on Climate Change, 2025). |
| | **Policy** | **Requires additional policy to be in place to function more effectively.**<br>The Environment Agency's Restoring Meadows, Marsh and Reef initiative has a target to restore at least 15% of the current extent of saltmarsh habitats within the next 20 years. The Scottish Government Scottish Marine Environmental Enhancement Fund funds restoration in Scotland. Currently not included in UK's Greenhouse Gas Inventory. |
| | **Regulation** | **Does not require additional regulations.** |
| | **Physical infrastructure (T&S)** | N/A |
| | **Physical infrastructure (NPT)** | N/A |

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