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# REA POSITION PAPER

## GOING NEGATIVE:
### Policy Proposals for UK Bioenergy with Carbon Capture and Storage (BECCS)

RENEWABLE ENERGY ASSOCIATION

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## SUMMARY

Bioenergy paired with Carbon Capture and Storage (BECCS) technologies has the potential to play a critical role in meeting the UK's net zero ambitions, but achieving this potential involves immediate action at a number of scales.

The REA recommends increasing the UK total carbon price to around £50t/ $CO_2$ from 2020 with a clear trajectory to at least 2035 in order to promote rapid emission reductions.

The UK should also explore a mechanism which rewards negative emissions, such as tradeable negative emissions allowances under a domestic emissions trading scheme.

Finally, the UK should incentivise the deployment of demonstration projects at several scales that prioritise the use of lowest carbon feedstocks whilst making BECCS plant eligible for support under existing UK policy, such as the Contracts for Difference (CfD) mechanism.

## KEY MESSAGES

**1**

**BECCS has the potential to play a critical role in meeting the UK's net zero ambitions.** According to the Committee on Climate Change (CCC), the UK will require Carbon Capture and Storage (CCS) at scale in order to achieve net zero by 2050[i]. BECCS could play an important role in doing this cost-effectively whilst providing wider co-benefits, with the potential to abate around 51 $MtCO_2yr^1$ of the projected 90 - 130 $MtCO_2yr^{-1}$ residual emissions in 2050 from difficult to decarbonise sectors such as agriculture, aviation and industry[ii, iii]. The scale-up of both domestic and international sustainable biomass can facilitate this shift with potential economic and environmental benefits across the agricultural and forestry sectors, including rural development[iv]. Recent modelling suggests that BECCS could reduce annual $CO_2$ emissions in the UK by ~6%, whilst also providing low carbon power, heat and additional co-benefits[v]. Developing CCUS technology, expertise, and transport and storage in the UK brings further economic opportunities.

**2**

**Scaling up and deploying UK BECCS is complex and will require significant investment and policy change.** Whilst the UK has a strong bioenergy sector, accounting for 7.4% of primary energy supply, it does not have an established CCS industry[vi]. Policy will need to shift in order to correctly price carbon, offer long-term support to bioenergy and incentivise CCUS technologies, infrastructures and business models, alongside negative emissions from BECCS. Scaling up either domestic biomass production or imports to match the levels required (51 $MtCO_2yr^{-1}$) demands a coordinated and robust approach which ensures rigorous carbon accounting throughout feedstock supply chains. Whether international or domestic, supply chains used for BECCS should be the lowest carbon option available.

**3**

**A number of actions can be taken now which utilise the existing policy trajectory and expedite BECCS deployment and the delivery of a net zero society.** As part of a portfolio of renewable energy and clean technology deployment, Greenhouse Gas Removal (GGR) strategies and immediate mitigation efforts, we recommend i) increasing the UK total carbon price to around £50t/$CO_2$ with a clear trajectory between at least 2020 - 2035; ii) creating a mechanism to reward negative emissions (e.g. tradeable Negative Emissions Allowances under a UK emissions trading scheme); iii) modifying existing UK supportive policy, such as the Contracts for Difference mechanism (CfD) to support BECCS at scale; iv) developing BECCS demonstration projects at a number of scales that make use of lowest carbon feedstocks; and v) stimulating increased research into a variety of potential feedstock genotypes to improve bioenergy yields and sustainably meet requisite feedstock demand.

## What is BECCS?

Bioenergy with Carbon Capture and Storage (BECCS) is a way of capturing and permanently storing $CO_2$ released by bioenergy processes. Bioenergy is the energy generated from the conversion of solid, liquid and gaseous products derived from renewable organic biomass such as wood, agricultural crops, and various kinds of waste. Biomass can be burned directly or processed into biofuels such as ethanol and methane. In the case of combustion, as in biomass power, heat or energy from waste, compounds are used to separate and capture $CO_2$ from the flue gases. Pre-combustion capture is also possible on specially designed plants[vii]. In the case of biofuel production, $CO_2$ is captured directly from processes like fermentation as an off-gas; whereas in anaerobic digestion $CO_2$ is separated from biogas in the process of upgrading it to biomethane.

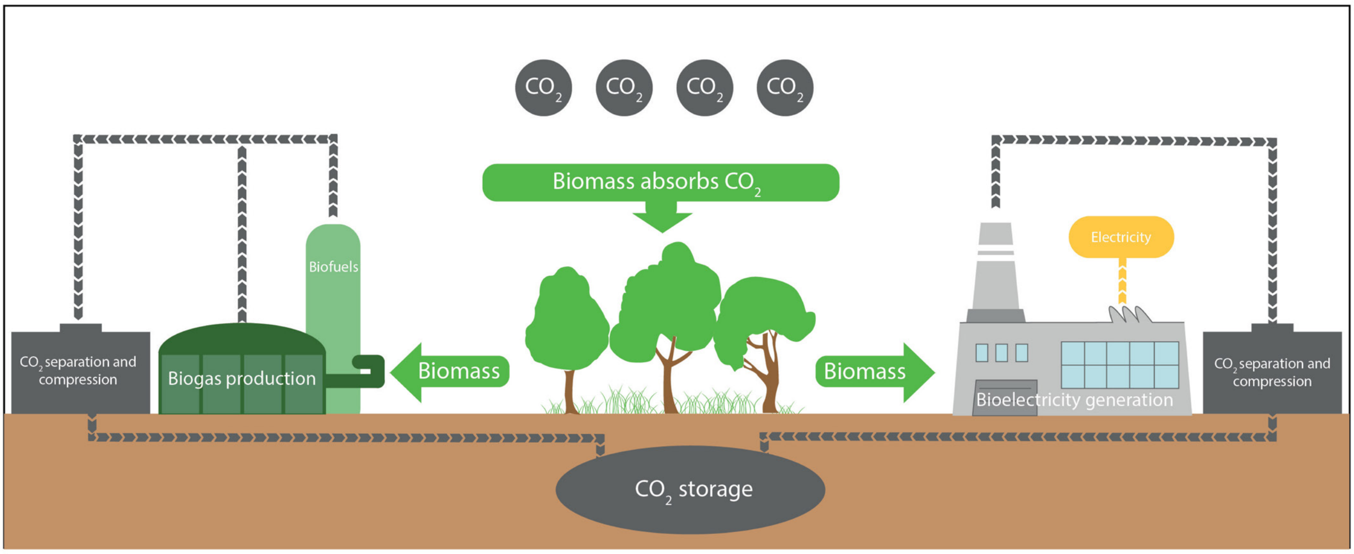


**Figure 1 (above)**: Diagram showing three BECCS pathways, biogas-CCS, biofuel-CCS and bioelectricity-CCS © REA 2019[viii].

BECCS features prominently in the climate debate because of its potential to deliver negative emissions - removing more $CO_2$ from the atmosphere than is released via the bioenergy process (combustion, fermentation or digestion). This is possible because the biomass used as fuel fixes $CO_2$ from the atmosphere during growth. When it is then processed this same $CO_2$ is released but rather than being returned to the atmosphere, it is captured and permanently stored. Captured carbon may also be used as a feedstock in chemical and industrial processes, for example in the manufacture of bio-based carbon products such as building materials, and in the production of synthetic transport fuels; hence Carbon Capture Usage and Storage, or CCUS.

## Is BECCS a single technology?

BECCS is not a single technology. Rather, CCUS is compatible across a range of bioenergy configurations including: Biofuels (biochemical and thermo-chemical); Anaerobic Digestion (AD); Energy from Waste (EfW) and Biomass (heat and power)[ix, x, xi]. Despite its theoretical versatility, however, BECCS is still firmly in the developmental stages with a mixture of small-scale demonstrational projects primarily concentrated in CCU and CCS with biofuel production (particularly in the United States)[xii], CCU and CCS with EfW (Netherlands and Japan)[xiii, xiv], and CCS with biomass power (UK)[xv].

## Is BECCS necessary to meet climate targets?

Achieving net zero is not possible without a portfolio of GGR strategies, most likely including BECCS at between 24 - 51 $MtCO_2yr^{-1}$ [xvi]. This is because there will be an estimated 'residual' of emissions (90 - 130 $MtCO_2yr^{-1}$) in 2050, even with maximum reduction efforts in all areas, due to those hard to decarbonise sectors such as aviation, shipping, and industry that have no, or only very high cost, options to fully decarbonise. CCS currently presents the cheapest or only option to decarbonise many industrial applications[xvii]. Developing BECCS will capture $CO_2$ and deliver negative emissions which expedite the route to net zero whilst also compensating for residual emissions, thereby significantly reducing the cost of UK decarbonisation. This being said, pursuing BECCS need not preclude vigorous economy-wide mitigation efforts and the rapid deployment of renewable and clean technologies.

## How much will BECCS cost?

The Committee on Climate Change's 'Net Zero' report estimates that the assumed abatement cost for BECCS is between £125 - 300/$tCO_2$[1], depending on whether imported or domestic biomass is used and the demand for BECCS in other countries as a mitigation technology[xviii]. Elsewhere, analyses of UK BECCS costs are limited to configurations such as biomass power with CCS, and conclude that it will be more expensive overall than its coal- and gas-fired comparators, at between £170 - 204 /MWh[xix]. In this analysis, the biomass cases with a 90% carbon capture efficiency are more expensive because they pay the cost of $CO_2$ transport and storage as well as a $CO_2$ emissions charge (despite their use of biogenic fuel) which applies to the residual 10% not captured[2]. They must also pay the price of a more expensive feedstock and different load factors (versus a Combined Cycle Gas Turbine, for example). Whilst early BECCS configurations are likely to be more expensive than fossil fuel-CCS, cost reductions are expected as the supply chains, system and technology efficiencies improve[xx]. Equally, as the storage and transport infrastructure develops, associated costs are expected to fall[xxi].

In addition to the above, neither of the given cost estimates considers the possible value awarded to BECCS for generating negative emissions. A future mechanism which appropriately prices carbon economy-wide and rewards negative emission will bring down the operational costs of BECCS and drive demand in carbon dioxide removals.

Overall, it is likely that a significant proportion of the cost of BECCS can be managed through well-designed domestic policy. For example, if the UK were to take the carbon price charged for every tonne of fossil $CO_2$ emitted and change this to a payment for every tonne of biogenic $CO_2$ captured, in other words from a penalty to an incentive, then the case for biomass with CCS looks very different. Here, BECCS cases become competitive at between £53.1 - 112.8 /MWh[xxii, 3].

## How should UK BECCS be deployed?

To expedite BECCS deployment the UK should initially focus on delivering 'anchor' projects in at least three CCUS clusters, as recommended by the BEIS Select Committee inquiry into CCUS deployment[xxiii]. The most suitable technology for this at present is large-scale bioelectricity, either from biomass power or EfW. This approach takes advantage of the existing policy trajectory alongside sustainable, mature and rigorously audited bioenergy supply chains[xxiv]. It also allows the necessary technologies, transport and storage infrastructure to develop, laying the groundwork for exploring future BECCS at different scales.

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1 CCC assumes that £300/tCO2 estimate becomes global trading price for GGRs, based on the cost of Direct Air Capture and Storage (DACS), rather than BECCS.

2 Biomass power currently does not pay the CO2 emissions charge, so its inclusion here skews the cost comparison. It is unclear why the addition of CCS would require biomass to pay this charge in the future.

3 Whilst this should be explored by Government, it is not a policy proposal of this paper. Rather, it indicates that slightly modifying just one aspect of current UK policy can make BECCS considerably more competitive. As noted later on, it is likely that several complimentary policies will be needed to support UK BECCS.

Following this, the UK can investigate the potential for small- to medium- scale BECCS - for example, the capture of $CO_2$ from AD plants which is then either utilised in the wider bioeconomy (CCU) or compressed and transferred for injection in nearby transport and storage infrastructure (CCS).

## How can the sustainability of UK BECCS be ensured?

The sustainability and negative emissions delivered by BECCS will depend on the scale at which it is deployed[xxv]. At the small- to medium-scale, BECCS is likely to be most sustainable when plants are dispersed across the UK and supplied with local agricultural, forestry and municipal residues to produce heat at high efficiencies[xxvi, xxvii]. Separately, large-scale BECCS, such as biomass power, is likely to be fuelled by sustainably expanding feedstock imports[xxviii]. This is because both the lifecycle carbon and cost are much lower from long-distance haulage via ship or rail than using road transport to supply domestic resource at a handful of large-scale plants. This being said, BECCS at any scale should be fuelled using the lowest carbon feedstock available[4].

The UK currently has the most stringent biomass sustainability criteria in the world and is therefore well placed to manage the development of BECCS. These criteria manage imported biomass resource by stipulating a minimum carbon efficiency of 47 - 60% compared to the carbon intensity of European biopower (~79g $CO_2$/MJe)[xxix]. In the context of large-scale bioelectricity projects, initially utilising existing, mature and low carbon bioenergy supply chains will ensure the sustainability of BECCS.

As noted, utilising small-to-medium-scale BECCS may also offer the UK significant economic and environmental benefits. A decentralised approach to BECCS using small scale combined heat and power (CHP) projects and a distributed supply of sustainable domestic bioenergy crop production has the potential to contribute significantly (~20 $MtCO_2 yr^{-1}$) to 2050 BECCS targets (50 $MtCO_2 yr^{-1}$), whilst providing wider environmental benefits and having little impact on food production[xxx]. The overall GHG emissions from BECCS under such a scenario have been modelled at well below the UK's Renewables Obligation (RO) sustainability threshold (30 - 50g $CO_2$/MJ compared to 79g $CO_2$/MJ) and indicate that, in addition to the delivery of negative emissions, air and water quality might also be improved[xxxi]. BECCS of this kind which utilises sustainable domestic biomass resource has the potential to reduce annual $CO_2$ emissions by up to ~6%, whilst also providing low carbon power and heat[xxxii].

At all scales there is a clear potential for the sustainable growth of domestic and international bioenergy resource which utilises residues, wastes and perennial bioenergy crops[xxxiii]. There is also the potential to build on existing sustainability criteria, with the European RED II Directive stipulating that large scale heat and biomass power plant must demonstrate an 80% emissions reduction against a fossil fuel comparator, including land-use change emissions.

The UK will need to consider its position regarding the implementation of RED II and how this compares to its own sustainability criteria. It should also review recommendations made by the CCC, such as embedding sustainability criteria into procurement and financing rules to regulate biomass outside of support mechanisms like the Contracts for Difference (CfD), Renewable Heat Incentive (RHI) or RO[xxxiv]. In any case, sustainability is imperative to BECCS and so the onus must be on ensuring best possible practice and regulation. Negative emissions rely on the efficacy of these measures.

## Does BECCS present an economic opportunity to the UK?

Biomass produced domestically in the UK has the potential to significantly increase the current bioenergy market. The CCC has estimated that domestic biomass could contribute between 5-10% of the UK's total energy demand by 2050, and that UK forest cover should increase to between 17-19% by the same date[xxxv, xxxvi]. BECCS development would therefore establish positive climate and economic synergies

[4] Lowest carbon feedstock refers here to supply chain emissions. However, it is possible that in the future it will be desirable to use the highest possible carbon feedstocks, so as to maximise carbon sequestration.

between the agricultural, forestry and energy sectors.

As the BEIS Select Committee concluded in a recent report, CCUS deployment should be prioritised because it presents an opportunity to reduce the overall cost of meeting the UK's emissions reduction targets[xxxvii]. For the UK, one of the main economic benefits of BECCS will likely be significantly lowering the costs of domestic decarbonisation, particularly for the agricultural industry and energy sectors[5]. Mobilising local resources would also stimulate feedstock supply chains to domestic BECCS configurations (e.g. AD or CHP) and contribute to the rural economy[xxxviii, xxxix]. These benefits can be explored and better understood through appropriately scaled demonstration projects in the late 2020s.

For CCUS more broadly, there are significant potential economic opportunities in developing strong UK-based technological innovation, expertise and storage infrastructure, which could service international markets. Additionally, there are synergies between BECCS and the decarbonisation of hard to abate sectors, such as transport. $CO_2$ captured from BECCS can be combined with renewable hydrogen via electrolysis to produce synthetic fuels, particularly for use in aviation, shipping and heavy haulage. As the CCC has noted, at least one of the early CCUS regional clusters should involve the significant production of low-carbon hydrogen by 2030 to achieve net zero[xl]. BECCS configurations situated at such clusters are therefore well placed to facilitate this pathway to decarbonised transport fuels.

BECCS also has a place in the wider bioeconomy where long-lived products can be made from bio-based carbon, such as buildings, civil engineering, as well as structural components of consumer durables. Examples of materials include bio-based carbon fibre and bio-based resins as well as engineered wood.

Finally, the CCC argues that imported biomass alone has the potential to meet around 5% of UK energy demand by 2050. As such, international biomass supply chain development, of which the UK is a global leader, has the additional co-benefit of exporting proven sustainability criteria that stimulate sustainable forestry and economic development in parts of North America, Europe, the Baltics and beyond. The importation of international resource also provides investment in domestic port, rail and logistics infrastructure.

## How could BECCS be incentivised?

There are several possible options for incentivising UK BECCS. One approach, explored below, requires three significant changes to policy:

i) a marked increase in, and expansion of the UK carbon price;

ii) the implementation of a mechanism to reward negative emissions;

iii) the adaptation of existing supportive UK policy to include BECCS.

### *Carbon pricing*

The UK currently has a total carbon price of around £42/$tCO_2$, comprised of the European Emissions Trading Scheme (EU ETS) element at £24/$tCO_2$ and the domestic Carbon Price Support (CPS) at £18/$tCO_2$[6]. The domestic element of this total price, which currently only applies to large-scale power generation, will need to be significantly increased in order to incentivise the capture and long-term usage or storage of carbon[7].

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[5] It is also the case that CCS costs must be compared against the cost of avoided $CO_2$ (see Roussanaly, S. [2019] 'Calculating $CO_2$ avoidance costs of Carbon Capture and Storage from industry. *Carbon Management,* 1- 8)

[6] Figures correct as at 10.06.19 – CPS currently frozen at 18/tCO2 until 2021.

[7] Any changes should also be accompanied by supportive policies to protect the fuel poor, such as increased funding for energy efficiency.

The level of increase to the CPS required depends on a number of factors, such as policies augmenting the instrument to create a UK total carbon price; and our future participation in the EU ETS[8]. In any case, an economy-wide price on carbon will likely be needed to generate demand for negative emissions from BECCS. This would make unabated (without CCS) fossil fuel generation and industrial processes uneconomic, thereby driving adaptation into emissions reductions and removals.

Recent analysis from the Grantham Research Institute on Climate Change and the Environment suggests that, in order for the UK to reach net zero by 2050, the UK will need a shadow carbon price[9] of around £50/t$CO_2$ from 2020 with a range of £40 - 100t$CO_2$e depending on the sector in which it is applied[xli]. The authors suggest that in order to incentivise negative emission technologies like BECCS, this price will need to reach around £75 in 2030 and £160 per t$CO_2$ in 2050.

### *A UK ETS*

A significantly raised, gradually expanding and progressively increased UK carbon price is a fundamental precondition to BECCS, but alone it cannot fund negative emissions[xlii].

To do this, the UK could create a domestic emissions trading scheme (ETS) where actors can purchase Negative Emissions Allowances (NEAs). These allowances permit participants to offset unabated emissions and remunerate negative emissions technologies, such as BECCS[10]. The UK's future relationship with the European Union would dictate whether this is also linked to a negative emissions market in the EU ETS, although it suggested here that linking the two would be beneficial. A linked market would increase liquidity, reduce market volatility and maximise opportunities for negative emissions. In addition, it would allow the UK to service international markets, capitalising on its extensive geological storage capacity.

Such a scheme could be administered by the Department for Business, Energy and Industrial Strategy (BEIS), as is currently the case under EU ETS arrangements. This being said, it should be noted that an EU ETS-linked UK ETS with a facility for negative emissions will create additional complexities and therefore require a review of the current accounting methodology.

Alternatively, negative emissions could be funded by revenue generated from a gradually increasing, economy-wide carbon tax. However, others have noted that this would require a carbon price of between £125 - 300t/$CO_2$ in 2050[xliii]. As such, it is likely that additional technology support will be required for BECCS whilst the carbon price, and therefore the cost of securing negative emissions, increases over time. Possible options are explored in the following section.

In any case, it is clear that a specific mechanism will be needed to go beyond 'positive' emissions reductions and drive negative emissions[11]. This is because hard to abate sectors such as aviation, agriculture and industrial sub-sectors will still have significant residual emissions by 2050, even after the implementation of strong domestic policies such as an elevated and expanded carbon price[xliv]. Achieving net zero across the UK will therefore require offsetting these emissions with greenhouse gas removals from technologies such as BECCS.

[8] Government has expressed a preference for an EU ETS-linked UK ETS following its departure from the UK, but a domestic Carbon Emissions Tax has also been proposed.

[9] The price used by Government to guide public investment decisions

[10] Other Negative Emission Technologies (NETs) could also be utilised, but are not considered here.

[11] The options outlined above are not mutually exclusive, but Government should explore the best sequence of implementation and how this might interact with additional policies.

### *Technology-specific support*

A suitable incentive for BECCS depends on both the scale and technological configuration.

For medium- to large-scale plant generating renewable electricity, such as biomass- or EfW-CCS pathways, both the power and negative emissions will require support. For the electricity generation, utilising existing UK policy such as the Contracts for Difference (CfD) mechanism could provide funding on either an auction or bilateral negotiation basis. The CfD is a Government support mechanism wherein a generator of renewable electricity is paid the difference between the 'strike price' - a price for electricity reflecting the cost of investing in a particular low carbon technology - and the 'reference price'- a measure of the average market price for electricity in the GB market[xlv]. At present, bilateral negotiation is the means through which nuclear CfDs are awarded; however, given nuclear's waning capacity, medium- and large-scale configurations of bioelectricity-CCS could offer a tenable replacement[12]. Alternatively, bioelectricity-CCS could be included under the CfD on an auction basis either by stipulating a minimum capacity of CCS-enabled generation (e.g. 300MW), or by creating a separate CCS technology Pot[13].

Government should consult on whether BECCS configurations under the CfD are rewarded for their power generation and negative emissions separately, so as to allow other CCS technologies, like Direct Air Capture (DAC), to compete. However, rewarding only the negative emissions from BECCS would disregard its wider benefits to the energy system. Beyond the CfD, NEAs awarded under a UK ETS could provide support for BECCS, but the scale of this support would depend on the demand for negative emissions.

For small-to-medium plant, such as a distributed network of AD or biomass CHP units with CCS, payments could be received in the form of NEAs for the demonstrable capture and storage (or use) of $CO_2$. The value of the allowances could be tiered depending on whether the $CO_2$ is stored or used, and the carbon benefits afforded. A similar approach is taken in the United States under '45Q', a tax credit scheme which remunerates the capture or long-term use of $CO_2$ at \$50 and \$30/tonne, respectively[xlvi]. For the capture and storage of $CO_2$ from UK BECCS, rather than requiring dedicated transport and storage infrastructure which extends to smaller plant, NEAs could be awarded at the point of injection into a shared network. In addition to rewarding negative emissions, an appropriate mechanism should also be available to support the generation of renewable heat from bioenergy[14].

For biofuel-CCS configurations or biogas-CCS with a pathway to biomethane in transport, the UK should look to its Greenhouse Gas (GHG) Regulations under the European Fuel Quality Directive[xlvii]. The GHG Regulations set an obligation on fuel suppliers to reduce GHG emissions from their fuel by 4% in 2019 and 6% in 2020. One GHG credit is awarded for every kilogram of $CO_2e$ mitigated under the fossil baseline (94.1 $gCO_2e/MJ$). The GHG Regulations are suited to the use of CCS in the production of transport fuels because they reward those fuels with the lowest carbon intensities. Unfortunately, the GHG Regulations are set to end in 2020. Extending this policy would encourage the application of BECCS to reduce the carbon intensity of transport fuels.

Alternatively, the UK could adapt its Renewable Transport Fuel Obligation (RTFO), which currently places an obligation on fuel suppliers to source a proportion of their fuel from renewable sources, by shifting it

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[12] Government has already made provision under the CfD for bilaterally negotiated CCS contracts, but there are currently no precedents https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/233004/EMR__Contract_for_Difference__Contract_and_Allocation_Overview_Final_28_August.pdf

[13] 300 MW is considered the minimum capacity needed for BECCS power generation at a reasonable cost (Brown, 2019 REA Bioenergy Strategy – Phase 2: A Vision to 2032 and Beyond).

[14] The need for this would depend on a number of factors, including how high the price of carbon is set. A high carbon price would improve the case for biomethane from AD and biomass heat against the comparators of fossil gas and oil, but a low carbon price might require additional support such as an obligation on gas suppliers to provide a proportion of green gas or a steadily increasing duty on fossil fuel use in heating.

it from a volumetric to a GHG basis. However, Government should consult carefully on such a change so as to minimise any unintended consequences[15]. Beyond these options, biofuel-CCS or biogas-CCS configurations could also be eligible for NEAs under a UK ETS, providing further support.

Finally, providing a time-limited classification of BECCS projects as 'emerging technologies' would allow for the receipt of multiple support options under State Aid regulations, thereby expediting development and deployment.

### *Incentivising BECCS feedstocks*

Although the UK will likely need to mobilise a significant volume of sustainable domestic resource, (estimated at 5.7 - 7.3 Mt $yr^{-1}$ in 2050) imported biomass will still be necessary[xlviii]. Incentives for the production of local, innovative and sustainable feedstock supplies which do not adversely impact food systems or biodiversity could promote the development of BECCS as well as bioenergy more broadly. The UK currently imports over one-quarter of its bioenergy feedstock and it is projected that this could sustainably increase to meet ~5% of the UK's energy demand by 2050[xlvx]. Thus, scaling international feedstock supply will be central to securing BECCS at the required scale.

Increasing domestic production could be achieved through payments for suitable crops on marginal land and wastes as well as R&D Tax Credits for research into widening the range of potential feedstocks. International feedstock supply can be increased by exporting the UK's world leading sustainability criteria to low-risk areas, thereby expanding the available resource pool. Again, this should be carefully managed by embedding the UK's sustainability criteria into financing and procurement rules. The efficacy of UK BECCS depends on the success of these efforts as without a combination of sufficient and genuinely sustainable domestic and international resource, the UK cannot achieve the necessary levels of either bioenergy or negative emissions to reach net zero by 2050.

### *$CO_2$ transport and storage infrastructure*

$CO_2$ transport and storage (T&S) infrastructure is a precondition for BECCS. Although such infrastructure is not the focus of this paper, it is worth outlining current thinking.

The UK's CCUS Action Plan currently states that deployment at scale should only be supported if 'sufficient' cost reductions are achieved[l]. This language fails to give certainty to investors and therefore impedes the development of infrastructure required for BECCS. It also runs counter to the CCC's view that the earlier $CO_2$ infrastructure is deployed at scale, the earlier CCS can be deployed cost effectively[li]. This paper supports the BEIS Select Committee's recommendation that Government should adopt a clear strategy for the scale and timing of CCUS deployment which is consistent with a target of capturing 10 Mt $CO_2$ per annum in 2030 rising to 20 Mt $CO_2$ per annum in 2035. We add further that this should prioritise BECCS to secure maximal negative emissions. Government should also aim to establish BECCS-enabled T&S infrastructure in at least three storage regions of the UK by the 2020s in order to facilitate negative emissions.

In terms of funding, models for carbon capture should be kept separate from those of transport and storage[lii, liii]. Government will consult on funding $CO_2$ T&S infrastructure in 2019, where the REA encourages the exploration of a Regulated Asset Base (RAB) model to initially develop BECCS at the UK's proposed industrial clusters.

The UK should also utilise existing policy through the *Industrial Strategy* and *CCUS Action Plan* to establish at least one commercial large-scale BECCS project and several smaller demonstration scale BECCS projects by the late 2020s.

[15] Changing from a volumetric to GHG basis under the RTFO might encourage high volumes of crop-based biodiesel in the UK which could impact food production and have wider environmental impacts.

This approach will expedite the technological developments and cost reductions required to roll out BECCS more widely, delivering the negative emissions needed to reach net zero.

## SUMMARY OF POLICY PROPOSALS

### Biomass sustainability

- **The UK currently has the world's most stringent sustainability criteria, but will need to consider its position regarding the implementation of RED II and how this compares to its own policies. It should also review recommendations made by the CCC, such as embedding sustainability criteria into procurement and financing rules to regulate biomass outside of support mechanisms like the CfD, RHI and RO.**
- **BECCS should make best use of the lowest carbon feedstocks and existing sustainable supply chains.**

### CCUS

- **Government should adopt a clear strategy for the scale and timing of CCUS deployment which is consistent with a target of capturing 10 Mt $CO_2$ per annum in 2030 rising to 20 Mt $CO_2$ per annum in 2035. Priority should be given to BECCS in order to maximise negative emissions.**
- **Government should seek to establish BECCS-enabled transport and storage infrastructure in at least three cluster regions of the UK by the 2020s to allow all industrial clusters to access negative emissions.**
- **Government should increase low-carbon cluster funding from £170m overall to £100m per low carbon cluster hub as part of the upcoming Spending Review, with the aim of developing at least 3 hubs by the mid-2020s.**
- **Government has committed to consult on $CO_2$ transport and storage infrastructure in 2019 and should consider within this the most effective model for funding (e.g. Regulated Asset Base).**
- **Government should consult on the option of enabling technologies with CCUS from 2030 as part of the UK's *CCUS Action Plan*. All $CO_2$ point sources above a certain threshold should be CCUS-enabled by 2030.**

### Carbon pricing

- **The UK carbon price should be gradually expanded economy-wide to accurately reflect the true cost of carbon and promote renewable and clean technologies. Any changes should also be accompanied by supportive policies to protect the fuel poor, such as increased funding for energy efficiency.**
- **A proportion of proceeds from either an emissions trading scheme or economy-wide carbon tax could be used to fund CCUS projects (including BECCS), expediting development and deployment whilst remaining near cost-neutral to Treasury.**
- **Government should increase the current UK total carbon price to around £50t/$CO_2$ from 2020. A clear trajectory should be given until at least 2035, when prices should be around £80t/$CO_2$. The Government should also consider the creation of an an EU ETS-linked UK ETS with a facility for negative emissions. Taken together these mechanisms will drastically reduce domestic emissions, create demand for negative emissions and provide a revenue stream for negative emissions technologies such as BECCS.**

## Incentivising BECCS technologies

- Government should consult on options for incentivising negative emissions from BECCS configurations. These could include: modifying the CfD to provide support for large-scale bioelectricity-CCS; using Negative Emission Allowances (NEAs) as part of a UK ETS in order to reward BECCS across heat and transport; and extending the GHG Regulations to provide credits for biofuel (including biomethane) production with CCUS.

- Government should consider additional policies which support the bioenergy technologies underpinning BECCS (Anaerobic Digestion, Energy from Waste, Biomass Power, Biomass Heat and Biofuel production).

- Government could include BECCS under the State Aid exemption category for emerging technologies in order to allow multiple support instruments for its development and deployment.

- Government should establish at least one commercial large-scale BECCS project and several smaller demonstration scale BECCS projects by the late 2020s.

# FOOTNOTES AND REFERENCES


[i] Committee on Climate Change (2019) 'Net Zero: The UK's contribution to stopping global warming', pg. 23 https://www.theccc.org.uk/wp-content/uploads/2019/05/Net-Zero-The-UKs-contribution-to-stopping-global-warming.pdf
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