THE BARTLETT
INSTITUTE FOR SUSTAINABLE RESOURCES

CO_2RE CONSORTIUM
RESEARCHERS FROM THE UNIVERSITY OF SOUTHAMPTON

Business model for power bioenergy with carbon capture and storage consultation

Response from UCL Institute for Sustainable Resources, the CO_2RE consortium, and researchers at the University of Southampton

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Section 1: Rationale for developing a power BECCS business model

Q1: Have we identified the most important challenges in considering the development of power BECCS projects?

No

The Institute for Sustainable Resources has previously responded to a BEIS consultation on the Role of biomass in achieving net zero.[1] Where appropriate, we will refer to specific points made there as they are relevant to this consultation. More broadly, the issues of equity and justice, and the wider environmental impacts of biomass are well covered in the previous response.

The call has identified a series of challenges which may affect the scale up of power BECCS, mainly related to market barriers. We believe that the following challenges have been overlooked:

Availability of biomass feedstock.

There is potentially limited scale up opportunity due to the availability of sustainable biomass feedstock on the domestic and international markets. Here we highlight two key competitions which the UK faces: (1) competition on the international markets for sustainable biomass feedstock, and (2) competition on the domestic markets for land-use (with food, regeneration, other land-based GGRs) and biomass feedstock (for aviation fuels, green hydrogen, construction, furniture, paper).

a) The sustainability criteria for biomass, still to be fully defined by the Biomass Strategy, will considerably influence the amount of feedstock available. Comparing the environmental impacts of domestic versus international biomass supply chains will also strongly influence the availability of sustainable biomass. Ensuring that markets exist for sustainable biomass feedstock will be critical to the scale up of BECCS. If the market incentives for bioenergy feedstock are based solely on greenhouse gas emissions they will overlook the wider environmental impacts that biomass can have. These broader impacts are discussed in detail in question 4 of the previous consultation response, linked above.
b) In the context of perennial bioenergy crops, the spatial context of the conversion of land to biomass will impact the provision of ecosystem services. There is the possibility for both beneficial and adverse impacts on greenhouse gas emissions, biodiversity, and other ecosystem services.[2] For example, compared with natural forest or grasslands, biodiversity is unlikely to thrive in areas of monoculture biomass production. In these cases, therefore, the benefits derived from biodiversity, such as pollination, pest regulation, and human enjoyment of nature, would be lower. When choosing whether to dedicate land to biomass plantations, an assessment is therefore needed of whether the value of the biomass

[1] https://www.ucl.ac.uk/bartlett/sustainable/sites/bartlett/files/ucl_isr_response_to_beis_biomass_consultation_2021.pdf
[2] https://onlinelibrary.wiley.com/doi/full/10.1111/gcbb.12695

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produced outweighs the value potentially lost by changing the goods that can be derived from that natural capital through other ecosystem services.

c) Limited scale up opportunity for domestic feedstock must also recognise poor track record in terms of planting rates in the UK. The UK has had longstanding targets for tree planting in relation to afforestation which have systematically been missed.[3] National statistics highlight that we have in fact gone backwards. Planting track record for energy crops show stagnating levels and low output yields.[4] Future energy systems with high reliance on BECCS for power would require significant planting ramp up and this implies changes to current practices which are not trivial.
d) This ramp up of domestic production would also require ramping up the supply chains and building the skills related to processing, transporting, delivering, and storing the biomass to the power BECCS facility.
e) There is also potential for concern around energy security. The current large-scale generation of power from biomass uses exclusively imported biomass, mainly from North America. The Russian invasion of Ukraine showed how disruptive an external event can be for securing imports of energy feedstock. Although the scale and type of risks are different, biomass feedstock imports could present similar challenge of continuity, especially in the light of China pursuing conversion of their coal-power plants to co-generation with biomass.[5]
f) Unfair competition with other BECCS options and land-based GGRs. Power BECCS relies on sustainable biomass feedstock, which in turn relies on available land and/or available residual biomass from agriculture and forestry. However, this land and biomass feedstock could also be used for other types of BECCS (also offering high-value co-products, e.g. aviation fuels, hydrogen) and land-based GGRs (e.g. biochar, also offering soil stability and nutrient value; reforestation, also providing local cooling, flood protection, biodiversity enhancement, etc.). By stimulating only power BECCS at this point in time, there is a risk that other uses of land and/or biomass feedstock are disadvantaged.

The broader electricity system.

g) Providing support to power BECCS may lead to unfair competition with other renewable electricity providers, in particular wind and solar. These currently represent the cheapest options for generating electricity in the UK and can also be built and connected to the energy system in the shortest time. This unfair competition has several characteristics:
    i. Scaling up power BECCS beyond the bioenergy power plants which are currently operating in the UK has the potential to lead to positive GHG emissions overall, hence there is the risk of ending up with very expensive mitigation, not removal. Some evidence suggests a high uncertainty of emissions/removal from power BECCS due to supply chain configuration, source of biomass feedstock, and agricultural practice. In comparison, currently in the UK both solar and wind are known to provide low-cost electricity at low carbon footprints.
    ii. There is also a risk in supporting BECCS in ways that do not take into consideration the feasible technological alternatives that can be achieved on a system level. It is important that BECCS is compared to, or contrasted with, other potential supply chains or systems for negative emissions, and not solely other single technologies that provide negative emissions i.e. ensuring we get the best value over the whole system by avoiding supporting one option disproportionately when other combinations of options also work.
    A conceptual example could be the combination of variable renewable energy (vRES) and with Direct Air Carbon Capture and Storage (DACCS), where negative emissions could be achieved without adding the significant costs that BECCS may bring to the power system when contracting all its capacity under CfD. However DACCS is currently still a costly option, although, depending on the rate of deployment, those costs could fall significantly.[6]
    In other words, the technological differences not only of GGRs but of bundles of comparable solutions should be identified for securing fairness and supporting the realisation of the full value and potential of alternatives.

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[3] https://researchbriefings.files.parliament.uk/documents/CBP-9084/CBP-9084.pdf
[4] https://www.gov.uk/government/statistics/area-of-crops-grown-for-bioenergy-in-england-and-the-uk-2008-2020/section-2-plant-biomass-miscanthus-short-rotation-coppice-and-straw
[5] https://www.nature.com/articles/s41467-021-23282-x
[6] https://www.wri.org/insights/direct-air-capture-resource-considerations-and-costs-carbon-removal#:~:text=The%20range%20of%20costs%20for,less%20than%20%2450%2Ftonne.

h) This call suggests that it expects BECCS to provide baseload power. It is first important to acknowledge that the concept of baseload as it is traditionally defined is out of date; in the 21st century the power system needs flexibility to balance a range of sources and demand, not baseload. This consultation defines the notion of “baseload” as “generating constantly” by opposition to “flexible” generation implying a level of responsive generation. This notion is however confusing in the context of BECCS because it is important to clarify what the BECCS facility is “generating” - e.g. is it designed for power generation or for carbon capture. Several studies have indeed shown that there are trade-offs between high power output and maximum capture rate at the BECCS facility. This “parasitic load” that the addition of carbon capture to the power plant represents is referenced elsewhere in the BEIS call for evidence. It means that maximising carbon capture may produce very limited or no electricity.[7] The BECCS facility then is designed for a particular purpose that cannot be easily changed. If carbon capture is the objective, then the facility will need to be run as often as possible and will not offer flexibility. This then outlines a different concept, one which could be termed “baseload carbon”, by opposition to what baseload power has meant to date and which is increasingly being described as outdated. With the increased availability of ever cheaper renewables and smarter “connected” energy technologies, we are starting to consider a move away from a large centralised power system with baseload-power physical assets with investment cycles of several decades. With increased electrification, there is an increasing need for flexibility. This is being provided in more innovative ways including dynamic, agile, decentralised, and smart systems, as well as dynamic sector coupling – where consumers play an increasingly active role. Elements of the existing system could remain here with a role for low Capital Expenditure (CAPEX) turbine systems (e.g. hydrogen based) to provide more dispatchable ancillary services and flexibility. In such a system, however, the notion of a fixed demand that needs to be met and that is known with clarity ahead of time is outdated and cannot be used to justify investment in e.g. large power BECCS.

Other concerns.

i) Decarbonising the power sector is an essential part of decarbonising the whole UK energy system. This is particularly true as plans to address emissions in downstream sectors rely on electrification and will therefore imply a power sector that is two to three times the size of the one we know today.[8] As highlighted above and in the main consultation document, sustainable biomass feedstocks are and will be in limited supply with significant supply-chain risks. Combining this risk with the upward pressure expected on the power sector with a strategy that relies heavily on power BECCS for decarbonisation then highlights the potential for designing a vulnerable system. Strategies therefore that reduce the size of the overall energy system by rationalising, shifting, and reducing demands – for energy, materials, and specific transport modes – should be pursued in order to reduce the carbon pressure on the energy system and thus the pressure on biomass supply options.

j) Another concern is the consistency of the make-up of biomass feedstock, which could be a risk in retrofitted plants, while newer plants may be innovating past this. Varying quality and composition can be a problem for power plant operation, and a risk when combined with potential supply chain issues as mentioned above. It is important to be able to guarantee that the composition of the biomass supplied to largescale power facilities is constant over time to avoid significant issues with the power plant. There is some ongoing research which could be reducing this issue somewhat, but it will not disappear entirely.

Q2: Are there any other market barriers in addition to those identified?

Yes

Wholesale electricity price volatility is a known issue in the existing system. More broadly, and looking to the long term, it is clear that there is still significant uncertainty in the future system that power BECCS would fit in to, and challenges as to how these assets will be operated.

For instance, there may be the potential for double counting, and therefore a duplication within the incentive structure when looking at the interconnection between the power plant infrastructure, and the sequestration infrastructure. Clarity is needed on how the business cases for transport and storage (T&S) will be arranged.

[7] https://www.researchgate.net/publication/330774659_BECCS-deployment-_a-reality-check; https://doi.org/10.1039/c7ee03610h; https://doi.org/10.1016/j.apenergy.2017.03.063

[8] https://www.theccc.org.uk/wp-content/uploads/2020/12/Sector-summary-Electricity-generation.pdf

Q3: Are there any other power BECCS-specific risks that need to be considered? If so, what are your proposals for mitigating them?

Our response to question 1 highlighted many challenges that will affect power BECCS and that need to be considered in addition to those identified by previous BEIS research. All these risks, including some of the risks BEIS has also identified, should be mitigated by limiting government support to power BECCS to conservative levels in a first phase of technology development. This might for example limit support to already operating or approved to operate biomass power generation. This approach would (1) send out a clear signal of government support for scaling up the removals markets in the UK, whilst (2) recognising that the GGR evidence base is increasing fast and the composition of the most suitable combination of GGR and other system changes that support reaching the net zero UK targets is still to be determined; and (3) sending out clear messages to international players that the UK is fully aware of the risks associated with imported biomass feedstocks, and it is taking a precautionary approach to scaling up power BECCS to avoid any unwanted consequences of scale up.

It is also worth recognising that BECCS is not yet deployed at scale anywhere for power generation, and an incremental scale up will allow for 'learning by doing' and sharing best practise for future plants on the likely technical, economic, and other challenges which will arise.

Point (3) is particularly relevant. It is fully expected that other countries will pursue similar solutions to the UK. While the UN Framework Convention on Climate Change accounting rules remain applicable to these new supply chains, it is also the case that impacts in producing countries remain unknown and highly variable. These can include creating high levels of carbon debt, causing significant biodiversity loss due to increased harvest of forests for energy, land use change leading to forests loss, soil degradation or water scarcity; but also deep social and justice implications of bringing into production land areas that are currently part of complex and diverse ownership structures. These risks have been discussed in detail in the response that the ISR gave to the consultation on the "Role of biomass in achieving net zero" - referenced above.

There are many alternative uses of sustainable biomass feedstock. These could include the production of hydrogen, use of more wood in construction, the development of sustainable platform chemicals, its use in industrial heat (with or without CCS), or the production of sustainable liquid fuels. There is currently no other consensus on the best use of sustainable biomass, beyond widespread agreement that its use in hard to decarbonise sectors that have no other decarbonisation options is a low regret application. BECCS for power is not one of these options – a focus on developing this option over others is making a choice to allocate scarce sustainable biomass resources away from other applications that might otherwise benefit from it.

Finally, expanding on the "Broader electricity system" points made under question 1, it is important to recognise that, as with any first of a kind (FOAK) plant, there is a risk of stranded assets, poor performance, or early retirement. Again, there is currently a lack of previous experience with deploying BECCS at scale for power generation. This is particularly significant for BECCS power facilities for several reasons: (1) expecting large thermal power plants to run as baseload in a system that will increasingly value agility and flexibility may be unreasonable, (2) sustainable supply chain issues may significantly limit availability of imported feedstock, and domestic supply will be limited, for facilities that will consume vast amounts of biomass, (3) we have not demonstrated emissions sequestration over the full life cycle of these facilities and if it fails then their primary purpose is defeated.

Section 2: The business model proposal and options considered

Q4: Do you agree with the overarching objectives of our policy framework for power BECCS?

As referenced in previous questions, there is currently no consensus that the power sector represents the best use of scarce biomass resources – even if BECCS is involved. There are ready, low-to-zero carbon, alternatives for power generation. Other sectors are not currently so lucky and alternatives there will be more difficult to deploy. The use of biomass, and, by extension, of BECCS, should arguably be prioritised in these areas.

Q5: Do you agree with the minded-to position of a combined CfD for electricity generation (£/MWh) and a CfD for Carbon (£/tCO2) under a CfD contract framework? If not, please provide rationale for why not?

Don't know

The decision to apply both a CfDe and a CfDc to BECCS for power facilities seems dependent on the design of the rest of the future energy system and responding a priori is not an easy task.

On the one hand, applying both would provide consistency with government's proposed carbon CfD business model for other GGRs.[9]

This could allow the facility more flexibility to balance electricity and carbon output and design a FOAK BECCS facility that delivers what benefits it can without fitting with our current expectation of what the plant should deliver. While this could help to develop the technology and establish the concept, it could also create perverse incentives to e.g. change outputs from the power plant in response to changing circumstances not previously foreseen, affecting the provision of planned removals for example.

Conversely however, this approach also carries significant risk for a first of a kind (FOAK) plant since CfD approaches will require plants to actually perform i.e. capture emissions and/or generate electricity. In this instance, where BECCS has never been demonstrated at scale for power production, this may lead to investors needing a very high strike price to take on large construction risks they face for FOAK plant.

A combined CfDe and a CfDc relies on ensuring that the corresponding support mechanisms for other GGR and vRE projects are designed so as to maintain a level playing field for the provision of electricity and carbon sequestration. If other GGR projects provide useful co-products, will they then be allowed to combine such a carbon CfD with other support mechanisms for these useful outputs (e.g. energy or materials)? In addition, electricity generation can be provided by increasingly cheap and technologically advanced variable renewables, questioning then the focus on remunerating a costly service from a facility optimised to sequester carbon. Notwithstanding, the question of how to supply power during periods of low vRE output in highly renewable systems remains debated. Future systems may reach levels of integration, flexibility and storage that allow them to cope – but equally having some sort of (relatively expensive) dispatchable low-carbon generation that reduces energy system exposure could help. Of course, the limited capacity of carbon focussed BECCS (which here are supported First-Of-A-Kind) will not provide a full solution here, their contribution may justify CfDe remuneration.

Equally, what will the support mechanisms look like for the T&S systems that provide the actual sequestration service: will their business model also include remuneration for carbon sequestration and how do we ensure that there is no "double paying" for the service of removing carbon from the atmosphere between the BECCS facility CfDc and the T&S supplier?

Finally, it is important to note that any response to this question should be subject to revision as the market develops, to fully understand the areas where any level playing field or double pay issues may come into play.

Q6: Should the power BECCS project be incentivised to run as baseload or flexibly? Please provide rationale for your answer.

As noted in question 1 section h, the concept of baseload power is outdated and the future energy system will be significantly different and have a much greater need for flexibility. This consultation defines the notion of "baseload" as "generating constantly" by opposition to "flexible" generation implying a level of responsive generation. Here, we also differentiate between "baseload carbon" and "baseload power". As noted in question 1, the former makes sense in the context of carbon removal from the atmosphere - i.e. optimising the BECCS facility for its CCS contribution. By contrast, "baseload power" is a term that has described power plants run at high capacity factor to generate as much electricity as possible. This approach has typically helped to recover the high capital expenditure involved in building power plants with low flexibility levels and low running costs. It has also been associated with a particular view of electricity demand as predictable, and

[9] https://www.gov.uk/government/consultations/greenhouse-gas-removals-ggr-business-models

inflexible. This reality however belongs squarely in the 20th century and is unlikely to have a role in the future energy system of the UK.

In the context of BECCS for power, it is therefore important to consider the following when discussing the provision of “baseload" vs. “flexibility”. First, understanding whether the BECCS facility is being designed and built with the objective of maximising carbon capture or maximising electricity output will define what baseload means. While baseload power generation is considered outdated, given the transition to a more decentralised and demand driven paradigm, the continuous operation of BECCS for carbon removal is more appropriate. Considering that it would be incentivised as a removal option, then it needs to be run at full nameplate capacity. As well as maximising carbon dioxide removal through CCS, this will also minimise biomass storage pre-power generation, which is known to be a significant GHG emission hotspot, due to decomposition of biomass in storage, and facilitate upstream supply chain management.

Second, flexibility in this consultation is described as providing “some level of responsiveness” that is useful to the power system. In the case where the BECCS facility is designed for carbon sequestration, power becomes a secondary output from the facility. While providing remuneration for this provides a potentially important revenue stream for recovering high CAPEX costs and keeps the facility linked to the power system, it is noteworthy that the “baseload carbon” approach for maximising carbon takedown will not leave headroom to ramp the power plant and provide "flexibility” as defined here. In addition, alternative existing technologies (e.g. open or closed cycle gas turbines) can be designed to run with clean fuels (e.g. hydrogen or biomethane) to provide ancillary services and flexibility in a similar fashion to existing gas turbines.

Third, it is important to consider BECCS power facilities as part of the wider energy system and the need to design a future that provides resilience and relies on cross-sectoral integration. As end use sectors decarbonise it is expected that levels of electrification will increase, and that current notions of flexibility and baseload-power will evolve. Using holistic whole-system analysis to ensure that the role of these new power-carbon facilities is in line with the needs that arise on this new distributed, decarbonised, electrified (and multi-fuel vector) system will be essential to avoiding e.g. stranded assets.

Q8: Are there any risks or concerns around setting the CfDe strike price that have not been mentioned here?

Research shows that the policy instruments used to incentivise BECCS can significantly change the way the public see BECCS.[10] In particular, people are very wary of a price guarantee scheme – where government would guarantee a higher price for producers selling electricity derived from BECCS. BECCS incentivised in this way led to a significant drop in support for BECCS by participants, owing to concerns about such schemes transferring excessive costs to taxpayers and energy consumers. By contrast, they are very supportive of fixed payments, whereby government would pay a fixed amount to operators of BECCS based on how much carbon they remove from the atmosphere.

Q9: The CPI indexed strike price option requires the project to bear the risk of biomass costs and is the option in current contracts. Is this an appropriate allocation of risk? Please provide rationale and evidence for your answer.

The main aim of a CfD supporting scheme should be to remove the cost recovery risks in a supplementary to the market participation way. Although cost recovery, as one of the desirable economic properties of market mechanisms, refers mostly to the operational costs, in the context of incentivising a FOAK BECCS, securing both the capital expenditure (CAPEX) and operating expenses (OPEX) recovery becomes the objective. Taking into consideration the time value of money through the CPI in setting the price of a supporting scheme that spans at least until the breakeven time is totally acceptable.

On the other hand, the strong dependency of the operation and maintenance (O&M) costs to the prices of inputs (fuel, labour, materials, buildings, equipment, etc.) constitutes another risk that it is not necessary to be removed through the supporting scheme. Beyond the technical difficulty on identifying an appropriate index to follow for the biomass price, this is mainly because there are ways that investors could use to

[10] https://www.nature.com/articles/s41467-019-08592-5

mitigate such risks and more specifically hedge the risk of biomass stock price, with forward contracts, purchase agreements and vertical integration being indicative examples. To that extend this risk can be considered and mitigated by the investor during and project appraisal and funding process.

Q13: Do you agree with a proposed contract length of 10-15 years? If not, why not?

Yes
The GGR market is growing fast, and we are seeing other removal methods with less contentious supply chains coming up fast, e.g. DACCS. In parallel, robust, science based criteria for appraising different GGR options and moving away from unsustainable GGR supply chains are being developed.[11]

Most current CfDs are 15 years, and in the case of power BECCS this should be the maximum length to allow for reassessment after this period.

This contract length may help businesses plan appropriately (e.g., resource generation and allocation (financial and employee), research and development, innovation) and generate insights into potential return on investment of new technologies and revenue streams. I.e., give them some stability and sense that the rules of engagement will not be changed in a year or two making any time spent on the strategic planning less worthwhile.

A contract would also enforce some legal mechanism that is useful for setting a minimum standard. Therefore, careful consideration to the wording of the contract is essential. For example, this would define what the potential repercussions of not achieving a standard compliance level would be, or clarify what the benefits are for.

Q14: What are your views on the suggested options? [biomass feedstock costs]

In principle, the price is an important indicator of the sustainability of biomass feedstocks, encapsulating the availability/scarcity levels.

Sustainable biomass is not an infinite resource. It is not reasonable to expect scarcity to improve over time as demand increases as a result of low-carbon actions around the world. The price of biomass will therefore likely go up in a successfully-mitigating future. The price signal may then be an important indicator to the market that certain biomass feedstocks are approaching supply limits, and an incentive for projects to innovative towards other, more sustainable feedstocks or approaches.

Therefore, generic protection from biomass prices is not recommended. While it is recognised that protection policies help to support FOAK technologies, applying these to fuel prices will have distorting effects in the biomass commodity market, and will transfer significant risk directly to the taxpayer. This seems unreasonable.

Q18: Should the plant run unabated during periods of T&S unavailability, such as temporary outages?

The underlying reasons for the approach to T&S unavailability that is suggested are well understood, but the suggestion that the BECCS facility would be allowed to run unabated requires much more detail.

Research has shown that the unabated substitution of wood for coal in power generation could lead to net increases in atmospheric CO_2 and therefore in climate forcing.[12]

While existing arrangements for temporary changes to operations currently exist in the energy sector in relation to e.g. gas flaring from oil and gas fields, they offer high levels of flexibility to producers and lead to many fields having very high carbon intensities.

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[11] https://co2re.org/ggr-evaluation/
[12] https://iopscience.iop.org/article/10.1088/1748-9326/aaa512

It is difficult to state support for this arrangement without additional detail that specifies how this would work. Clear definitions of “temporary” and “unavailability" are missing. Additionally, understanding what the contractual arrangements between the BECCS facility and the T&S supplier would look like would help to clarify how these “outage” situations would be regulated. Simply offering the BECCS facility a “get out of jail free card” to continue producing unabated power is inappropriate and defeats the object of building the facility in the first place.

Section 3: Sustainability and negative emissions

Q21: Do you agree that a power BECCS project should report against a suitable threshold to ensure that we achieve a minimum level of net-negativity from any power BECCS project is achieved?

Yes

A heavily qualified yes. One key characteristic of power BECCS options is that they should remove carbon dioxide from the atmosphere. The supply chains involved are long, complex, involve technical and natural systems, spread over large geographies and assessed over long timeframes.

It is therefore essential that all projects meet a minimum standard of net-negativity over their entire lifecycle. Fundamentally, this should be measured against the most probable baseline, i.e. the one describing what would have happened to the biomass in the absence of the project. It should not be measured against a corresponding fossil baseline. In addition, projects should be incentivised to go further than the minimum standard in sequestration terms where possible: any support mechanism must actively incentivise against a race to the bottom. This would be aided by the carbon CfD, if and only if this is set on a full lifecycle basis.

Note that the terms outlined above for this minimum standard of net-negativity (i.e. full life cycles of BECCS, measured over appropriate/long time frames and appropriate geographies, using the most probable alternative baseline in biomass use terms) make it significantly different from the current threshold approach imposed by the Renewables Obligation (RO) and Contracts for Difference (CfD) Schemes. These currently require that the supply chain GHG emissions from biomass-generated electricity does not exceed a set GHG threshold, target or ceiling. The ceiling is currently set as 50% reduction as compared to a fossil alternative. This is not appropriate. The comparator should instead refer to a baseline within which the most probable use of the biomass, should power BECCS not occur, be considered.

In addition, the current RO and CfD projects make significant distinctions as to the boundaries of the Life Cycle Assessment (LCA) calculations for different supply commodities by setting different boundaries for the upstream system depending on whether wastes or cultivated biomass are considered. These boundaries should be expanded for the wastes option to ensure they capture all relevant emissions of the BECCS for Power scenario when compared to the most probable alternative future over the duration of the analysis (for example, the impact of extracting waste from forest eco-systems on e.g. soil carbon balances).

Q22: Do you have any evidence to share that could support the determination of a suitable supply chain GHG emission threshold for power BECCS, including by how much they could be strengthened?

Useful estimates for some example supply chains here:
https://www.sciencedirect.com/science/article/pii/S0961953421002002, ECF BECCS final report (https://www.ucl.ac.uk/bartlett/sustainable/sites/bartlett/files/ecf_beccs_final_report.pdf)

Q23: Out of the three options, which option do you prefer for assessing power BECCS? Do you have any other recommendations on an alternative suitable method?

Option 3: Combined option.
Power BECCS will provide electricity and potentially removals, hence targeting on the supply chain emissions per unit of electricity is in line with the consideration of both bases, i.e. electricity and carbon, which are acknowledge by the support. We understand that similar supply chain targeting approaches would be applied at a later date to other GGR options according to applicability, e.g. those which are currently being

demonstrated under the GGR-D programme (GGR projects - CO_2RE - The Greenhouse Gas Removal Hub (co2re.org) https://co2re.org/ggr-projects/ and BEIS phase II DACS https://www.gov.uk/government/publications/direct-air-capture-and-other-greenhouse-gas-removal-technologies-competition/projects-selected-for-phase-2-of-the-direct-air-capture-and-greenhouse-gas-removal-programme).

Q24: Of the two options considered (net and gross), which do you think is most appropriate for the reward of power BECCS through an appropriate carbon market?

Net is essential.
As discussed in previous questions this would ensure that carbon accounting along the entire supply chain through to final sequestration is accounted for thus demonstrating actual removal.
In addition, this would provide an incentive for projects to further improve their lifecycle GHG balance over time, rather than simply meet the minimum threshold and then cease to innovate towards better outcomes.