

## **Whitehead review call to evidence questions**

### **1. What is your name?**

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### **3. What is your organisation (if applicable)?**

Aviation Environment Federation (AEF) campaigns on aviation for people and the environment. Our focus is on aviation policy, relating primarily to climate change, noise and air pollution, and we participate in several Government engagement groups including having a seat on the Jet Zero Council. Internationally, we are a lead member and representative of the NGO grouping ICASA (the International Coalition for Sustainable Aviation), which has observer status to the UN's International Civil Aviation Organisation (ICAO).

### **4. Disclaimer on data sharing: We may publish a summary of all responses. Would you be happy for your response to be published in full? (Options: Yes; Yes, but without identifying information; No, I want my response to be treated as confidential).**

**Yes**

### **Opening statement**

Greenhouse gas removals (GGR) play a role in almost every pathway to reaching Net Zero by 2050, but to date the amount of commercially available engineered removals is tiny. In order to scale up the removals industry, we understand the government is exploring a number of ways to stimulate the market, including considering supply side measures, such as a selection of business models, and demand-side measures such as possible inclusion in the UK ETS.

As the UK approaches 2050, there is likely to be fierce competition from a range of sectors for access to scarce removals. This is particularly true for sectors which are currently considered difficult to decarbonise, and which are yet to make significant progress in reducing in-sector emissions (such as aviation or agriculture). This means that a primarily market-based approach to removals with little government direction, presents uncertainties and risks as we transition our economy towards Net Zero. There is a risk of banking everything on technologies

which are still in their infancy, and may not deliver at scale, or seeing removal credits bought only by those sectors with the highest ability to pay. There is also a risk that industries such as aviation will use the future promise of removals as a “Plan B” decarbonisation strategy if “sustainable” aviation fuels (SAF) do not pay off, rather than making serious efforts to reduce in-sector emissions today.

Could a whole government approach be considered to provide arbitration in a sector which may be viewed as a public good? There is a philosophical argument that CO<sub>2</sub> removals could be viewed as a **waste disposal problem**, paid for by the industries that pollute our shared atmosphere - this would ensure that the negative externalities of aviation for example are adequately priced, reflecting the “polluter pays” principle. Discussions could involve the government deciding what removals projects are the most reliable (and we would strongly recommend not including Nature Based solutions in that), and which sectors qualify for access. The Climate Change Committee seems to be beginning to advocate such an approach by arguing that aviation should pay for the development of around 60% of removals as that is the share the sector will need in the future. By targeting sectors such as aviation, which is primarily consumed by higher income groups for discretionary leisure spending, this would mean the societal costs of scaling up removals is paid for by higher income groups.

Alternatively, if certain sectors do fall behind in the move to decarbonise, yet are able to access the first tranche of removals, this will slow in-sector decarbonisation. This in turn means locking in reliance on removals and that the UK will continually have to generate more removals, at great cost, to abate rising CO<sub>2</sub> emissions. To avoid this problem, these industries could be denied early access to removals if they fail to make meaningful progress towards decarbonisation.

At the same time, there are questions about competing pathways for renewable energy production and supply of feedstocks – for example, should CO<sub>2</sub> removed by DAC be stored under the seabed as a permanent removal, or used to produce green hydrogen for synthetic fuels? It has been estimated that putting together captured carbon using DAC with green hydrogen provides only half the climate benefit of sequestering it under the sea. No clear “best-end use hierarchy” has yet to be carried out for carbon from CCUS, CCS, DACCS and BECCS. A purely market-based approach means that the most well-resourced sectors will access the technology (and indeed we have seen some evidence of this from tech firms forward purchasing credits) and resources first, possibly leading to perverse outcomes in decarbonisation progress.

## **Review of GGRs questions**

### **5. What is the potential scale of GGRs in the UK?**

We do not have specific new information on this question

## 6. What are the co-benefits of GGRs?

Supporting the development of DAC technologies, could also produce captured carbon that when combined with green hydrogen, could be used to create synthetic or e-fuels for aviation and shipping. Building on the UK's expertise in refining, pipelines and fuel production in key industrial clusters such as Teesside, Humberside and Grangemouth, the government could consider promoting the development of the UK as a leading e-fuels production site.

Domestic production of PtL fuels for aviation represents a significant economic opportunity, not only by creating direct revenue and employment in the UK, but also by reducing national expenditure on imported fossil fuels. Supporting PtL SAF facilities could lead to further investment in renewable electricity generation, carbon capture and pipeline infrastructure. Furthermore, it enhances the UK's energy security and supports the Government's clean energy mission by enabling aviation to be powered by homegrown renewables, instead of relying on imported fossil fuels.

However, a number of key challenges and constraints need to be addressed. The most significant challenge is scaling the nascent PtL industry to produce the levels needed to provide meaningful decarbonisation. The Committee on Climate Change advice on the [Seventh Carbon Budget](#) stated that 13 TWh of synthetic fuels need to be produced by 2040 in order to achieve a Balanced Pathway in line with the UK's Net Zero commitment (roughly equivalent to ~550,000 tonnes per year for aviation). Currently, the biggest e-fuel plant operating in the whole of Europe, in Frankfurt, has just announced it will be producing just 2,500 tonnes of e-fuel per year. That's equivalent to the fuel required by a Boeing 787 to make 35 single flights between London and New York. In the UK, there are two projects in more advanced stages of development which will use biogenic CO<sub>2</sub> and green hydrogen to make fuel. However, neither of these have yet reached FID, and will only produce 95,000 tonnes between them. It would require more than five times the output of these projects per year to produce the required amount of e-fuel needed to meet the projections in the CCC's Balanced Pathway.

The UK government has been supportive of the development of a UK SAF industry, pushing through the SAF mandate which began in January 2025, and tabling a Revenue Certainty Mechanism bill to support producers with a guaranteed strike price in June 2025. The SAF mandate has a PtL component - by 2030 0.5% of aviation fuel must be PtL (out of a total 10% requirement

from all SAF pathways which will largely be met by HEFA), and by 2040, the mandate requires that at least 3.5% of total fuel supplied in the UK to be PtL. Clearly, given the enormous price differentials (e-fuels are estimated to be around five times more expensive than SAFs from waste feedstocks), the government needs to put in place significant further policy support to develop this industry in the UK. The Government's recent consultation on the SAF Revenue Certainty Mechanism<sup>1</sup> acknowledged the problem, stating that 'UK PtL could face significant challenges to produce in the UK'. A number of airlines wrote to the EU earlier in 2025 asking for the stringent Refuel EU mandate to be revised because they did not believe sufficient SAF would be available.<sup>2</sup>

Another challenge to the scaling of a domestic PtL industry is the availability of surplus renewable electricity and the UK's particularly high electricity prices compared to other countries in Europe such as France and Norway. Green hydrogen production is extremely energy intensive, and diverting renewable energy to e-fuel production would be in direct competition with the government's Clean Power Mission to provide 95% of electricity in the UK from renewable sources by 2030. Renewable electricity will also be required to power the DAC plants - it has been estimated that the only existing DAC plant in Iceland has so far not captured enough emissions to even offset its own operations<sup>3</sup> The energy requirements are huge - in its Net Zero Carbon Road Map, the Sustainable Aviation group estimate that the sector will require an additional 147TWh of additional renewable energy to achieve its contribution to net zero by 2050 (that is roughly half the entire UK's current electricity consumption<sup>4</sup>. .

One recent academic study concluded that more than double the climate impact can be achieved by using CO2 and green power separately for other climate purposes instead of combining them for e-fuels<sup>5</sup>.

AEF believes that the UK should aim to carry out a systematic review of the most climate-efficient use and economy-wide benefit of the enormous increase in renewable energy being planned over the next 5 years, and indeed the captured carbon (a "best end-use hierarchy"), before committing large amounts of public money to one pathway which is likely to benefit

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<https://www.gov.uk/government/consultations/saf-revenue-certainty-mechanism-approach-to-industry-funding/outcome/saf-revenue-certainty-mechanism-approach-to-industry-funding-government-response>

2

<https://www.ebaa.org/press/ebaa-and-industry-partners-call-on-the-european-commission-to-enable-saf-market-efficiency-with-book-and-claim/#:~:text=Brussels%2C%2017%20February%202025%20E2%80%93%20EBA,flexibilities%20to%20the%20ReFuelEU%20Aviation>

<sup>3</sup> <https://heimildin.is/grein/24581/>

<sup>4</sup> <https://www.aerosociety.com/news/scaling-up-saf/>

<sup>5</sup> <https://concito.dk/en/news/e-fuels-aviation-could-be-an-expensive-and-inefficient-dead>

wealthier households consuming aviation for largely discretionary leisure purposes.

## **7. What are the barriers to and enablers of GGR deployment in the UK?**

There are currently significant barriers to the deployment of engineered removals in the UK. These can be divided into demand-side constraints, and supply-side constraints. We believe that the biggest barrier to deployment at scale is the prohibitive cost of engineered GGRs and the fact that there is currently no compliance mechanism making it a requirement for hard-to-abate industries to invest in buying GGR credits. While GGR projects could be eligible under ICAO's CORSIA offsetting scheme, they are effectively competing alongside the availability of offset projects with significantly lower costs. Given that CORSIA compliance doesn't differentiate between the higher environmental integrity of GGR credits and offset credits, there is no incentive for airlines to purchase them. This means that despite ambitious companies pushing to develop the technology at scale, if there is no buyer for the product it is highly unlikely that investors will invest.

For example, at present, there are almost no engineered removal credits available on voluntary carbon markets. If these did start to become available in the next few years, the price would be so disproportionately high (around £250/tonne for DAC compared to about £2 per tonne for forestry offset credits), that it's unlikely any business would buy the credits other than to make a one-off demonstration of willingness to support the industry.

Supportive policy to stimulate demand for GGRs in the UK is limited to a provisional suggestion of a GGR business model, promoted by the previous government in late 2023, but yet to be implemented. A consultation on integrating GGRs into the UK ETS closed in August 2024 but has yet to be followed up on, and looks likely to be delayed while the mechanics of the UK/EU ETS "linking", announced at the EU/UK summit in May 2025, are worked out. If the UK is forced to accept all of the EU rules in terms of what is included in the EU ETS, then there will likely be further delay as the EU will not decide until at least July 2026 if removals should be included or not<sup>6</sup>.

Some voluntary commitments to buy a portfolio of innovative GGR credits have been made by airlines, aircraft OEMs and airports in the last year<sup>7</sup>, but the volumes are very small (BA paid around £9m for 33,000 tonnes of COs = ~£270 per tonne). Some of the credits which were purchased are future

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<sup>6</sup> <https://www.sustainableviews.com/carbon-markets-experts-grapple-with-role-of-removals-in-ets-7c557238/>

<sup>7</sup>

<https://mediacentre.britishairways.com/pressrelease/details/20828#:~:text=British%20Airways%20joined%20forces%20with,and%20advance%20this%20critical%20sector.>

commitments for credits which do not actually exist yet, and it seems highly unlikely that at such elevated prices the aviation industry will be willing to stump up further cash for credits which they are under no obligation to buy.

## **Public perceptions**

There are signs that the British public is uncomfortable with the concept of engineered removals<sup>8</sup>. The CCC provided an illuminating portfolio of evidence from its citizens assemblies which were held to test opinion on the acceptability of various decarbonisation policies as part of the CB7 advice. This revealed that participants were less familiar with removals technologies and some expressed concern with their safety and effectiveness. Participants did not feel that removals policies should be the primary or sole way in which emissions from flying were addressed. They felt it should supplement managing demand, if used at all. At the same time there are important distributional impact questions to be raised if there were any decision in future to use public spending to support a GGR market or to facilitate direct procurement. Research has suggested that funding removals through income tax could be the most progressive way, whereas a direct levy on household bills the most regressive - as discussed elsewhere in this document, another method is to ensure that it is the people who do the polluting who pay for the cost of cleaning up the environmental damage.

Aviation industry insiders are already looking into the possibility of positively influencing the public narrative on GGRs, however it's important that the true picture of what they can and can't deliver is communicated clearly. Recent analysis suggests that the only functional DAC plant in the world - Climeworks in Iceland - has only been able to capture a 1000th of the CO2 it promised to capture - equivalent to the yearly emissions of just a handful of trucks<sup>9</sup>. The British public would be right to be skeptical that a miracle technology can be scaled from such a tiny position today, while at the same time global emissions continue to rise.

## **8. What is the economic cost of deploying GGRs?**

We are neither a project developer nor buyer so we won't comment on this

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<sup>8</sup>

<https://www.theccc.org.uk/wp-content/uploads/2025/02/Citizens-Panel-for-an-accessible-and-affordable-household-vision-of-Net-Zero-IPSOS-1.pdf>

<sup>9</sup>

<https://cleantechnica.com/2025/05/15/climeworks-dac-fiscal-collapse-the-brutal-reality-of-pulling-carbon-from-the-sky/>

## **9. What approaches are there for transitioning away from public investment and attracting private investment in GGRs?**

So far there is very little evidence suggesting that a market in engineered removals can be stimulated without significant government intervention. Looking at the current state of the voluntary carbon markets (VCMs) in terms of offset and avoidance credits shows that it is highly unlikely to lead to an effective market in removals. In recent years VCMs have come under intense scrutiny as it's begun to emerge that credits often do not deliver on the promise of emissions reductions<sup>10</sup>. Businesses will naturally look to the cheapest cost option to offset their Scope 3 emissions, so it is simply naive to believe that any serious progress can be made in scaling expensive engineered removals credits via VCMs alone.

Developing further policy support is crucial, especially as the previous government's Jet Zero strategy sees removals as one of the major pillars for aviation to reach net zero, with around 19Mt required per annum by 2050 just to balance residual emissions from the sector (i.e. ignoring any additional need for DAC to supply PtL). Despite this reliance there is no current comprehensive policy package, and key questions - such as whether there is a case for direct procurement from the government to help stimulate the market? - remain unexplored.

There could be some scope to consider including removals in the SAF mandate (or by a mechanism which credited the removed carbon in the production of e-fuels). The advantage to this is that it is an existing compliance scheme that would possibly need less redesigning to incorporate removal credits. There is evidence that airlines could find this an attractive alternative to SAF prices on the SAF market which are currently higher than removals prices. At least one international DAC producer has expressed an interest in this option.

### **Inclusion in the ETS**

AEF responded to the government's 2024 consultation on whether GGRs should be included in the UK ETS. Our full response can be read here<sup>11</sup>, but the main points are as follows:

“While it is important to progress work on GGRs, AEF believes there is a case for proceeding cautiously. In particular, a decision that the UK ETS provides

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<sup>10</sup>

<https://www.energymonitor.ai/carbon-markets/energy-transition-impact-of-cookstove-carbon-credits-worthless-rating/>

<sup>11</sup> <https://www.aef.org.uk/2024/08/27/aef-urges-caution-over-greenhouse-gas-removals/>

the best way of supporting removals is premature, and that alternative approaches should be explored before any final decisions are made.

**Specifically for aviation**, we are concerned about the development of an overreliance on removals and subsequent mitigation deterrence due to the hard-to-abate nature, and associated high abatement costs, of the sector. We would support additional measures being put in place to manage this.

Our main concern is that removals are not fungible with emissions reductions. Removing a tonne of CO<sub>2</sub> from the atmosphere is not equivalent to an emissions reduction that avoids the tonne of CO<sub>2</sub> being released in the first place. Placing the two in the same system implies equivalency. The climate impact of the two therefore cannot be compared accurately. Considering the two to be equal encourages mitigation deterrence as polluters can support removals instead of reducing emissions wherever possible. Additionally, inclusion in the ETS could incentivise cheap, less sustainable nature-based removals over investment in higher quality reductions from longer-term technology improvements and innovation. While inclusion in the ETS may help with scaling sustainable removals, it could limit the potential environmental benefits on the scheme overall.

We would recommend taking a step back, and take the opportunity to examine whether including removals at all in an ETS is the correct approach at this stage. In its response to the consultation, Carbon Market Watch warns against inclusion, especially for nature-based solutions due to the unpredictability of ensuring that the removal is permanent. We would like further clarity on whether the primary aim of this consultation is to look for ways to stimulate supply of GGRs by giving some kind of revenue certainty to producers, or whether it is primarily a tool to actually reduce emissions. If it is to stimulate supply, there are other ways of stimulating investment and that should be explored, for example, by taking the revenues from the ETS and setting up an engineered removals fund, or introducing a mandate or revenue certainty mechanism. If the issuing of including GGR allowances in the ETS is done prematurely, there is a risk that they could quickly become the preferred compliance pathway for hard to abate sectors and therefore emissions reductions would stall, compromising the overall aim of the ETS. This is particularly relevant for aviation which faces high mitigation costs for deploying alternative fuels and investing in new technology. Given that aviation also has significant net climate warming impacts (such as those from contrails and NO<sub>x</sub> emissions) that are not covered by existing climate targets and policies, there is a strong rationale for focusing aviation efforts on in-sector measures that reduce climate impacts overall rather than relying on CO<sub>2</sub> removals only. The primary function of the ETS is to reduce emissions over time, therefore it is essential that the incentive to decarbonise remains above all the other principles. For the same reasons, the environmental integrity of any removals is also crucial.

We are uncomfortable with the idea that removals are being pushed forward so quickly to be potentially offered as compliance credits in the ETS at this point. This seems premature and at odds with the need to deliver actual emissions reductions in the hard-to-abate sectors. If GGRs are integrated into the UK ETS, we believe there is a strong argument for delaying access to aircraft operators. Careful consideration is needed to consider whether aviation climate policy supports DAC for e-fuel production, DACCS as removal, or both.”

## **The UN’s compliance scheme CORSIA**

It is unlikely that significant progress will be made in the short term in the only other existing compliance market for international aviation, the UN/ICAOs “CORSIA” scheme for airlines. While CORSIA’s MRV and project and fuels eligibility criteria provide a solid foundation, it is currently very unambitious, only requiring offsetting above an 85% baseline of 2019 emissions, which is clearly not Paris or net zero compliant. And due to the Covid pandemic, so far no offsetting has taken place although this is likely to change in 2025. Again due to the comparative cost differential of forestry offset credits and expected engineered GGR units, it seems unlikely that any airline would voluntarily purchase an engineered GGR credit in the existing scheme, unless they are forced to. To move CORSIA to a GGR-only market would require a consensus amongst ICAO’s 193 member states. Given that this is not even on the current agenda, and that CORSIA reviews take place every three years, it is unlikely that any progress will be made before 2028, and in the most likely scenario, not until 2035 when CORSIA is set to end and ICAO will need to consider its future.

## **10. What are the roles and options for all GGRs, domestically and internationally, to balance the UK’s residual emissions?**

At present, there is a long way to go before engineered removal projects such as DACCS or BECCS begin production in the UK. Although there are some advantages to developing the industry in the UK (well-developed pipeline infrastructures, skilled workforce and ample geological storage under the North Sea), the policy support does not seem to be as attractive as in the US under the Inflation Reduction Act (at least until the end of 2024) and Canada<sup>12</sup>, and the barrier of high electricity costs is significant. The most likely scenario in the next few years looks likely to be a number of DAC credits from projects in the US and Canada becoming available for purchase.

That being said, there is a lack of clarity on how international removals can be used to balance the UK’s residual emissions within the accounting framework.

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<sup>12</sup>

<https://natural-resources.canada.ca/energy-sources/carbon-management/carbon-capture-utilization-storage-british-columbia>

Currently the guidance for emissions reductions claimed from SAF feedstocks in other countries is not clear -The CCC has previously said "In practice, future SAF production and supply is likely to operate in an international market. IPCC inventory guidelines will need to be clarified to allow for imported synthetic fuels to contribute to UK territorial emissions savings." We need to consider whether similar issues will apply to the use of international GGR credits for emissions reductions. International accounting rules have meant that (non-GGR) CORSIA eligible credits have been slow to come to market - there is no shortage of eligible projects, but states need to "attest" that they won't use the credits for their own inventories to prevent double claiming. This is an important mechanism to prevent double-claiming, but the market claims it is a slow process that can create delays.

These lessons highlight that before moving towards international crediting of GGRs, clarity is needed on the status of a credit for CO<sub>2</sub> removed in a DAC plant in, for example, the US, and whether that can be counted towards balancing residual emissions in the UK. Frameworks being established for the future trading of international credits under Article 6 of the Paris Agreement will likely answer this question, but it would likely mean a corresponding adjustment on the inventories of the host country. While Article 6 rules on accounting and avoiding double claiming are likely to be stringent, they could take some time to develop and GGR policy needs to factor this in.

## **11. How can GGRs contribute to security of supply, with respect to the UK's energy system?**

We welcome this opportunity to provide evidence to what seems to be an attempt to situate the future role of GGRs within the UK's full energy system. It seems short-sighted to rely on the market alone to deliver a technology which seems to be emerging as possibly one of the most crucial technologies we will need as a society. Relying on the market increases the risk that the removals will either not be delivered at scale due to high prices - or they will go to the highest bidder, and may not be allocated in the way across the economy to most effectively reach Net Zero.

As we have pointed out above, it seems very difficult to know what is the most efficient use of scarce renewable energy resources - whether to prioritise renewables for green hydrogen production, home-heating, EV charging or steel and cement, and equally whether it is the best use of resources to produce feedstock (CO<sub>2</sub> from DAC) for fuels, which are then put in planes and burned again, instead of simply removing the CO<sub>2</sub> from the atmosphere and burying it in underground storage. We would welcome the idea that this review should approach engineered removals in this economy-wide way, with a view to developing something like a "best end-use (of feedstocks) hierarchy".

In terms of the relative prioritisation of biomass use, the CCC pathways developed as part of CB7 see BECCS being deployed ahead of DAC. This is because BECCS can deliver savings across the rest of the economy (biofuels, power, industry), whereas DAC is viewed as only being used to “mop up” residual emissions which cannot be abated in other ways. There are currently no BECCS plants in operation in the UK, but it seems more feasible that a plant such as Drax can be converted more easily than a DAC plant with a connection to the CO<sub>2</sub> transport pipelines and storage facilities under the North Sea can be built from scratch. Ensuring that these questions are thought through carefully before the technologies reach scale means that we can be more confident that the best possible climate outcomes are reached.