Grantham Research Institute on Climate Change and the Environment

Centre for Climate Change Economics and Policy

August 2022

The London School of Economics and Political Science

University of Leeds

Who pays for greenhouse gas removal in the UK?

Designing equitable policy to fund BECCS and DACCS

Summary

- Greenhouse gas removal (GGR) technologies, such as bioenergy with carbon capture and storage (BECCS) and direct air carbon capture and storage (DACCS), are expected to be an important contributor to the UK's net zero goals.
- Currently there is a lack of clarity over key governance questions for BECCS and DACCS, including how these technologies would be funded and who would pay.
- Exploring how GGR can be funded in an equitable way requires an assessment of the distributional impact created by different policy options – i.e. how the costs would fall to UK households across different income levels.
- Funding BECCS and DACCS through income tax is a progressive policy option. The three other options studied – polluter pays, carbon contracts for difference and multi-sector government contracts – result in regressive outcomes, meaning that low-income households pay disproportionately more than higher-income households.
- Introducing carbon contracts for difference (which closely resemble current UK government policy to support low-carbon energy generation) is found to be the most regressive policy option. It would fund BECCS and DACCS through household energy bills and as a result further entrench inequality as low-income households spend a disproportionately large share of income on electricity.
- Aviation is an important point for intervention to reduce unfair distributional impacts. High-income households have larger aviation carbon footprints, so passing costs on to households via air travel could help to fund GGR technologies while having minimal impacts on social welfare.

Policy briefs provide analysis on topical issues, presenting specific recommendations to inform ongoing policy debates. Drawing on the Grantham Research Institute's expertise, they summarise either our research findings or the state of knowledge about a particular issue.

This policy brief has been written by **Anne Owen, Josh Burke and Esin Serin.**

It is based on an article published in *Climate Policy*: **Owen A, Burke J and Serin E (2022) Who pays for BECCS and DACCS in the UK: designing equitable climate policy. *Climate Policy*. doi: 10.1080/14693062.2022.2104793**

Greenhouse gas removal’s place in UK climate policy

The UK’s net zero commitment assumes the use of greenhouse gas removal (GGR) technologies, which include bioenergy with carbon capture and storage (BECCS) and direct air carbon capture and storage (DACCS) (see Box 1 for definitions). All five net zero pathways for the UK produced by the Climate Change Committee (CCC, 2020) include the deployment of these technologies to varying degrees. This is consistent with almost all modelled emissions scenarios aligning with the Paris Agreement’s target of limiting global temperature increase to well below 2°C.

Despite the prevalence of GGR technology in Paris-consistent scenarios, and its inclusion in the UK’s own net zero pathway, there is neither sufficient regulatory support for emerging technologies in the UK nor a clear understanding of important governance questions such as how they would be funded and who would bear the cost. As the UK looks ahead to meeting its net zero target – with BECCS and DACCS playing a role – it is important to understand how the costs of funding these technologies are distributed across society.

Depending on the sectors or consumption categories on which costs of GGRs are placed, there is a risk of socially regressive impacts, whereby the cost as a proportion of income is greater for low-income groups than for higher-income groups.

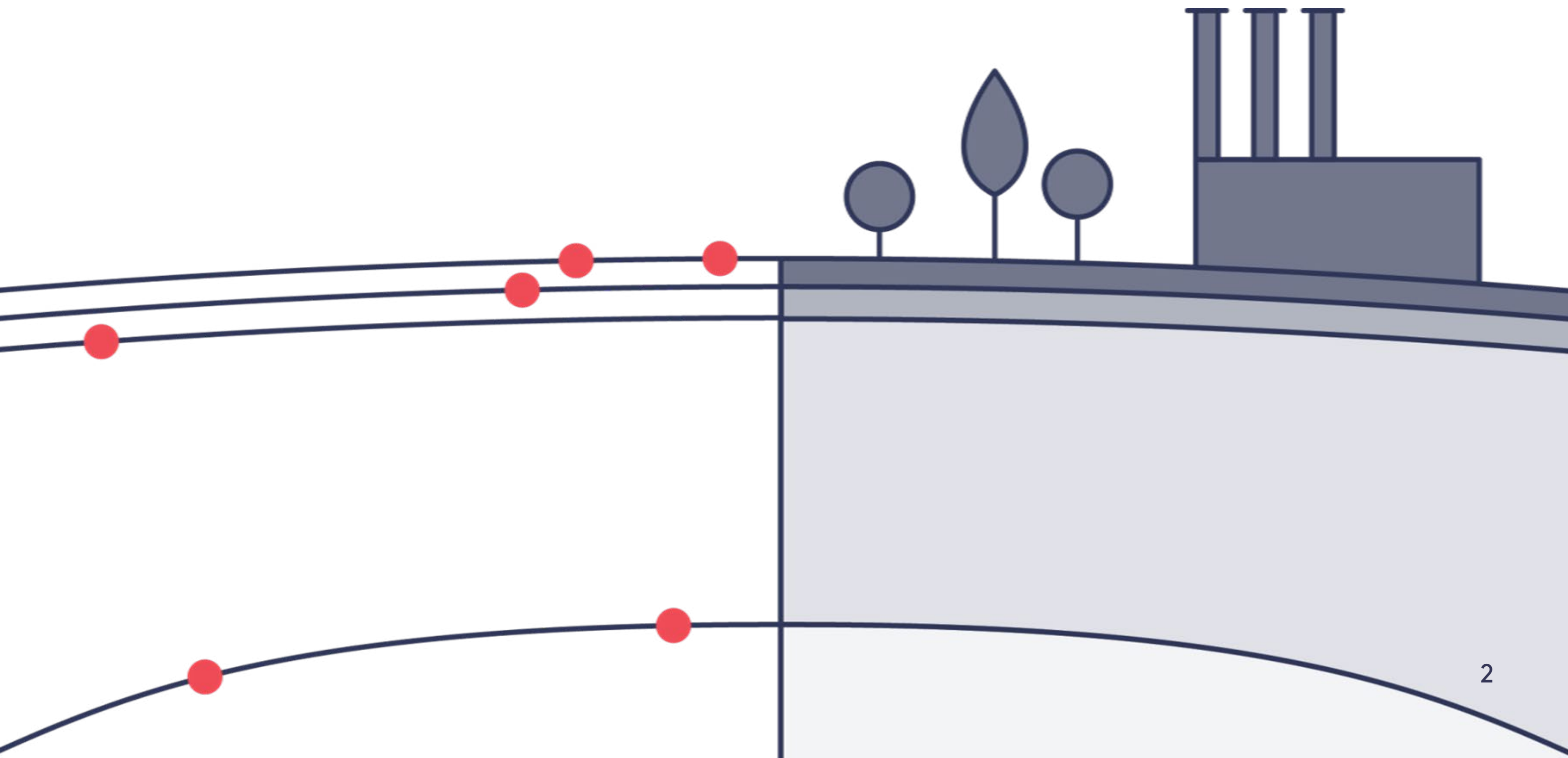
This policy brief examines four policy options for funding greenhouse gas removal technologies and assesses their distributional impact – how the costs fall to UK households across income levels.

We focus on BECCS and DACCS as these GGR techniques are currently seen by the public as controversial and incompatible with prevailing visions of decarbonisation (Cox et al., 2020). Land-based GGR processes, such as afforestation, are more popular (Lezaun et al., 2021). However, for the UK to meet net zero, the quantity of removals and total investment required for BECCS and DACCS is estimated to exceed that of land-based biological removal processes.

Box 1: Definitions

Bioenergy with Carbon Capture and Storage (BECCS) works by burning biomass (organic materials such as wood or crops) for power, collecting the CO_2 released, and storing it underground. The process results in the net removal of CO_2 from the atmosphere because of the CO_2 that the biomass absorbs while it grows.

Direct Air Carbon Capture and Storage (DACCS) uses electricity to remove CO_2 directly from the atmosphere with fans and filters, passing the air through a liquid solution that removes CO_2 before storing it underground.



Policy funding options for GGR technologies

We have constructed four policy funding options to examine the potential impacts on UK household spending if costs for deploying GGR technologies – specifically BECCS and DACCS – are placed on different sectors of the economy (see table below).

Policy funding option		Description	Mechanism	Operational approach	Government intervention
1	'Polluter pays' principle	The cost of GGR technologies is allocated to sectors based on their proportion of residual emissions. The cost is shared by UK households and the Government.	A GGR obligation whereby producers must purchase GGR credits and demonstrate that a percentage of their emissions are offset by GGR. Carbon markets provide a mechanism where polluters purchase GGR credit directly from producers.	Market-based	Low
2	Carbon contracts for difference (CfD)	The cost of GGR technologies is levied entirely on household energy bills. The cost falls to UK households.	All GGR is contracted via a carbon CfD or GGR service contract. Both mechanisms are funded via a levy on household energy bills.	Contracted	
3	Multi-sector government contract	The cost of GGR technologies is allocated to sectors based on end-use application. The cost is shared by UK households and the Government.	GGR technologies are funded based on end-use application. For example, BECCS power is contracted via power sector contracts, BECCS energy from waste (EfW) through waste sector contracts, and BECCS in industry via the industrial sector. This could be operationalised using bilateral sector contracts that reward additional low-carbon products.	Contracted	
4	Income tax	GGR technologies are funded via income tax. The cost falls to UK households.	Household contributions to funding GGR technologies are weighted by the household's contribution to total UK income tax payments.	Government interventions	High

Note: In options 1 and 3, both UK households and the UK Government are consumers of products produced by these sectors.

Distributional impacts to households

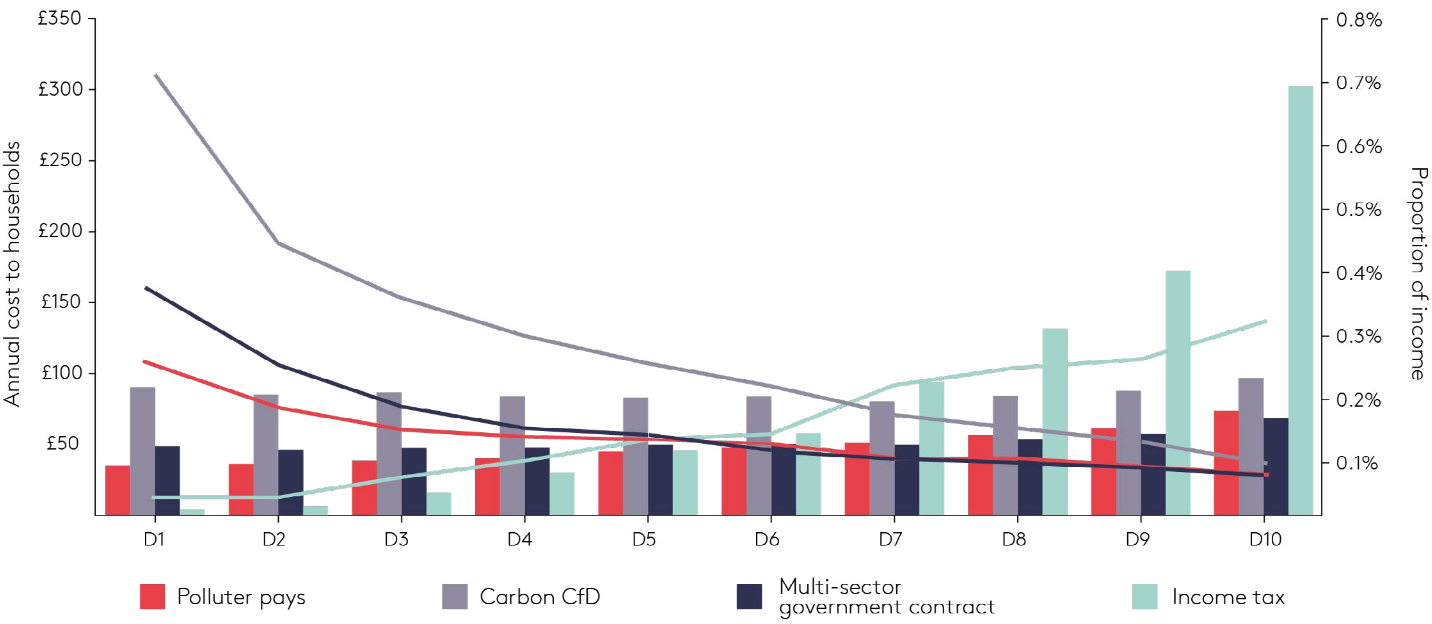
While the total cost of GGRs under the CCC's Balanced Net Zero scenario (BNZ) (which underpins this analysis) is constant, the costs passed on to households vary with each policy funding option. Firstly, the cost of GGRs is shared by both UK households and the Government in options 1 and 3 (polluter pays and multi-sector government contract), but in options 2 and 4 (carbon contracts for difference [CfD] and income tax), households pay the full costs. Secondly, in options 1 and 3, the cost to households is dependent on the share of consumption of goods by both the public and the Government, with some (e.g. energy) incurring a greater proportional cost to low-income groups than others. Thirdly, option 1 (polluter pays) has the smallest and flattest spread of costs as the main sectors that bear the costs in this policy (e.g. aviation) represent a smaller proportion of spend for low-income households than for higher-income households. This becomes especially apparent in 2050, where the majority of costs under this option are apportioned to the aviation sector, alongside agriculture.

Figure 1 shows that for the polluter pays and income tax policy funding options, the wealthier the household, the more it contributes to funding GGR technologies in absolute terms (represented by the bars). Carbon CfD and multi-sector government contract are relatively flat, with most households contributing similar amounts in absolute terms. Household costs vary most across income groups for the income tax option.

By considering these costs as a proportion of annual income (see Figure 1 line chart), we can determine whether a policy funding option is regressive (negative gradient) or progressive (positive gradient). The polluter pays, carbon CfD, and multi-sector government contract options are all shown to be regressive, with carbon CfD the most severely regressive. The income tax option is the only policy studied that produces a progressive outcome.

> "As the UK looks ahead to meeting its net zero target, it is important to understand how the costs of funding BECCS and DACCS are distributed across society."

Figure 1. Distributional impacts of GGR policy funding options on UK households, income deciles 1-10



Notes: Decile 1 (D1) is the lowest income group and decile 10 (D10) is the highest. Based on a 2-person household under the CCC's Balanced Net Zero Pathway in 2035. Bars show annual costs (in 2018 prices) and lines show proportion of annual income.

Explaining the regressive funding options

It is important to illustrate not only the overall size and distribution of the GGR costs to UK households, but also where the costs are incurred. Figure 2 shows the total cost of BECCS and DACCS for deciles 1 and 10 by industry and consumer spending sectors for the three regressive policy funding options,[1] revealing areas of spending where the proposed policies have the most unequal impact on household spending across income level.

Figure 2 shows that with the polluter pays policy, the costs of GGR technologies are passed to households mainly through the residential buildings, agriculture, aviation and surface transport sectors, the largest being in residential buildings (including costs such as natural gas for heating and hot water). However, the latter represents a smaller proportion of overall spending for high-income households (23% in decile 10 vs 42% in decile 1).

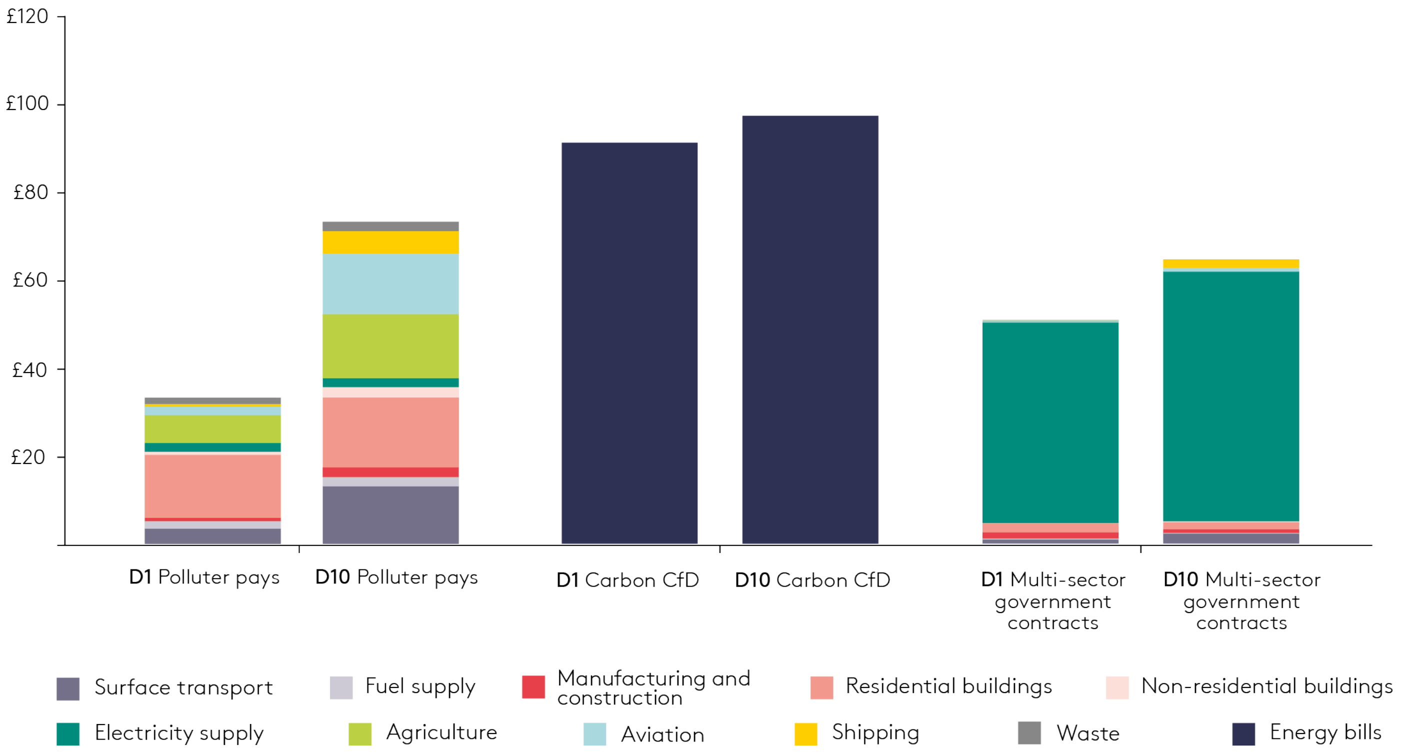
In the carbon CfD option, the costs of BECCS and DACCS are levied only on energy bills. The associated cost borne by each income decile is therefore proportionate to their energy consumption. This option creates the most regressive outcome of all options.

Multi-sector government contracts use the scale of BECCS and DACCS deployment in end-use sectors, such as for power, energy or waste, as the basis for allocating costs. Since BECCS power accounts for most of the total removal of carbon from BECCS and DACCS in the Balanced Net Zero (BNZ) Pathway (Climate Change Committee, 2020), the majority of the costs are allocated to the electricity supply sector.

"It is important to illustrate not only the overall size and distribution of the GGR costs to UK households, but also where the costs are incurred."

[1] Policy funding option 4 cannot be broken down into sectors given it is paid for through income tax – a sector-agnostic form of payment. In other words, the policy cost of funding option 4 is borne by households as taxpayers rather than as consumers of products and services.

Figure 2. Breakdown of GGR costs by sector for UK household income deciles 1 and 10



Notes: Based on the CCC's Balanced Net Zero Pathway in 2035. The 'energy bill' category represents a scenario in which costs of GGR technologies are levied directly and entirely on the purchase of energy (electricity and gas) as a product. The 'electricity supply' category reflects GGR costs placed on electricity supply as a source sector of emissions, passed to consumers via the purchase of all products involving electricity in their provision.

The importance of equitable policy design

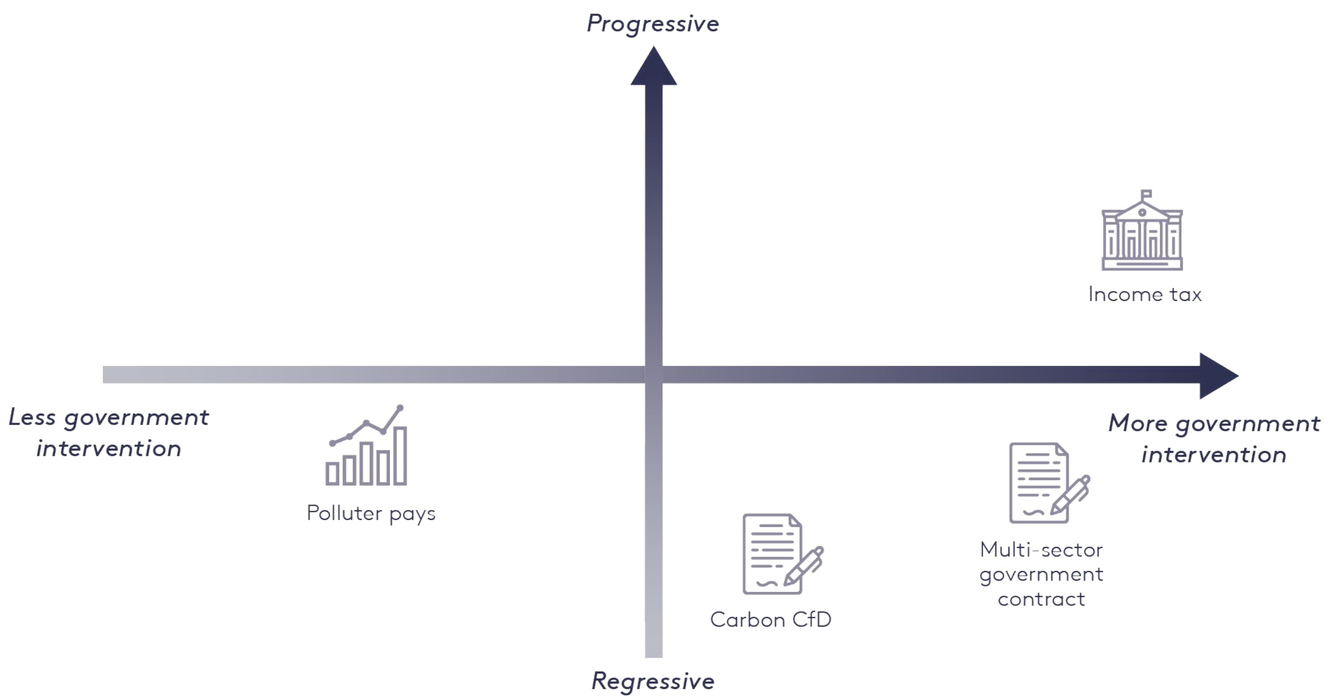
Designing effective climate policy for a net zero world requires careful consideration of how costs and benefits are distributed across society in ways that ensure both the immediate political feasibility of a policy and its durability over time. Understanding the distributional impacts of funding BECCS and DACCS is particularly important as, to date, there is little empirical evidence on how different policies influence public perceptions of GGR technologies. However, one study found that the public opposed guarantees of higher prices for producers selling energy derived from BECCS due to the resulting high costs imposed on taxpayers by such a mechanism (Bellamy and Healey, 2018).

With the exception of income tax, we find that the funding options studied disproportionately affect low-income households. Figure 3 illustrates that the two funding options with the least regressive impacts (income tax and polluter pays) have vastly different levels of government intervention. Although this suggests that how regressive a policy is does not entirely depend on the level of government intervention, it is also clear that the only funding option with a truly progressive outcome is the one requiring a greater role for the state. This also demonstrates that even though the polluter pays principle – which rests on a key principle of environmental law – is framed as an equitable policy choice, it is not inherently fair.

The policy option with the most regressive distributional impacts, carbon CfD, bears the closest similarity to current government policy for funding low-carbon energy generation: via a levy on consumer energy bills. This mechanism has already been shown to be regressive (Owen and Barrett, 2020). Funding GGR technology through energy bills would further entrench inequality and therefore is not a recommended policy option.

> "Given evidence that suggests the public see BECCS and DACCS as controversial technologies, choosing a fair funding model is vital to ensure public legitimacy."

Figure 3. GGR funding options according to level of government intervention and progressive vs. regressive outcome



Although funding GGR technologies through income tax avoids excessive costs for low-income households, socialising costs in this way may have the unintended consequence of blunting the price signal polluters face. Passing costs to carbon emitters themselves may be desirable as an increase in the cost of production helps create an incentive to switch to cleaner inputs, adopt low-carbon technologies, or mobilise large-scale investments to achieve net zero in hard-to-abate sectors.

> "Funding GGR technologies through income tax may have the unintended consequence of blunting the price signal polluters face."

Conclusion

Given that evidence suggests the public see BECCS and DACCS as controversial technologies, choosing a fair funding model is vital to ensure public legitimacy.

It is largely expected that funding options for GGR technologies may create an unequal distributional impact across UK households; this policy brief offers novel detail on the potential magnitude of this distributional impact, and enables comparisons between different policy options. Policymakers can use this information to determine the most equitable and politically acceptable policy pathways for funding greenhouse gas removal technologies.

Looking at the sector implications of the different funding models, aviation emerges as an important point for intervention. High-income households have larger aviation carbon footprints than low-income households, so passing on costs through aviation alone could help fund GGR technologies while having minimal impacts on social welfare.

Image: 'Orca' Direct Air Carbon Capture plant, Iceland | © Climeworks

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The authors would like to thank Lucie Middlemiss (University of Leeds) and Steve Smith (Oxford Net Zero) for their helpful review comments.

The authors acknowledge support from the Grantham Foundation for the Protection of the Environment, and the UK Economic and Social Research Council (ESRC) through the Centre for Climate Change Economics and Policy (CCCEP).

This work builds on an earlier report prepared for the National Infrastructure Commission: **https://www.lse.ac.uk/granthaminstitute/publication/distributional-impacts-analysis-of-engineered-greenhouse-gas-removal-technologies-in-the-uk/**

Natalie Pearson edited and produced this policy brief. Additional editing by Georgina Kyriacou.