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About this submission

This written evidence was submitted in June 2022 to the joint consultation on 'Developing the UK Emissions Trading System (ETS)' carried out by the ETS Authority, made up of the UK Government, the Scottish Government, the Welsh Government and the Department of Agriculture, Environment and Rural Affairs in Northern Ireland. More information on the consultation is available at: **www.gov.uk/government/consultations/developing-the-uk-emissions-trading-scheme-uk-ets**

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Introduction

This consultation was divided into nine chapters. Below we present our responses on five of those chapters, in the areas that match our research and expertise.

Chapter 1 sets out proposals for changes to align the UK ETS cap and trajectory with the UK's net zero target.

Chapter 2 considers the role of Free Allocation policy as a carbon leakage mitigation tool in the context of the net zero aligned cap. It also puts forward potential improvements to the current Free Allocation regime based on stakeholder views expressed in response to the 2019 consultation on carbon pricing and the call for evidence on free allocation in 2021.

Chapter 3 sets out proposals for bringing in unallocated allowances and/or the flexible share to the market.

Chapter 4 calls for evidence on potential drivers of evolving market conditions in the UK ETS and objectives for market stability policy as the scheme evolves.

Chapter 8 calls for early views on the incorporation of greenhouse gas removal (GGR) into the UK ETS and the monitoring, reporting and verification requirements necessary to address greenhouse gas emissions in the land use and agriculture sectors. We do not propose expanding the UK ETS to agriculture.

Chapter 1: Net zero consistent cap

Q1: Do you agree with the Authority's proposed range for the net zero consistent cap?

The proposed initial range of emissions allowances of 887-936 million, as set out by BEIS, is suitable but requires minor adjustments. This cap is 5% below that which the UK has been allocated during the EU Emissions Trading Scheme (ETS). This reduction is likely due to the lower production intensity of UK industry, thus requiring a lower emissions allocation, and can be seen as an appropriately ambitious target for the country to meet. The range is planned to be tightened annually to reach a 35% reduction in emissions between 2021-2030, which is substantially more ambitious annually than the EU ETS, which accommodates a 43% reduction over a significantly longer period of 2005-2030 (Jalard et al., 2015). This net zero target may be assisted by the flexibility provided by the suggested range, which has the potential to act as a lever, forcing regulated entities to act accordingly.

A suitable buffer between the current emissions of the UK and the initial allocation is required to allow for increased liquidity within the market and a more fluid adaptation to the new scheme (Hasegawa and Salent, 2015). In 2021, the UK produced 424.5 million tonnes of CO_2 (BEIS, 2021). The proposed range of 887-936 million allowances provides a suitable initial adjustment level beginning with a lower bound almost double that of the current UK yearly emissions. This should in turn allow for a steep reduction in emissions allowances from the offset (Hasegawa and Salent, 2015).

Forty-nine million allowances, the difference between 887 and 936, isn't a trivial number. The range provided represents approximately 5% of the entire upper-most allocation. To put this into context, the halt in production due to the COVID-19 pandemic corresponded to a total reduction in emissions equivalent to 8.9% of annual emissions (Conway, 2021). The range accounts for the uncertainty in expected sector emissions, however it could have the potential to cause further uncertainty for investments in included companies. The large range also allows for flexibility within the government decision-makers, which is important to limit the pollution level to that desired by the government at the time of implementation (Hasegawa and Salant, 2015). This limits the potential for political backtracking which can often cause uncertainty for investments (Baker et al., 2016). It is advisable that this allocation range is gradually narrowed in the lead-up to the UK ETS's implementation in order to provide greater regulatory certainty and less investment procrastination. This should give firms confidence to invest as they wish and greater levels of market confidence, despite the relative irreversibility of most investments (Dixit and Pindyck, 1994; Taschini, 2022). Furthermore, the gradual reduction of the range should allow for a more efficient market with greater due diligence, assuming the range is narrowed with sufficient warning prior to implementation (Hasegawa and Salant, 2015).

An area of difficulty that may be experienced during the implementation of the UK ETS is the requirement for a considerable drop in emissions by 2024 to stay on track for the 35% reduction between 2021-2030. Subsequently, the lower end of the range could be preferable in order to provide an incentive for a steeper reduction in emissions, whilst still retaining the required market liquidity and adaptability due to the large buffer between current BEIS emissions figures, and the proposed range.

Chapter 2: Free allocation review

Q4: Do you agree with the Authority's minded to position to reset the industry cap, as presented above?

No.

Free allocation is a measure put in place to prevent carbon leakage. Decisions as to whether and how the industry cap is set should intrinsically be a function of the overall leakage protection strategy. If free allocation continues to be the sole anti-leakage measure, then an industry cap implies that free allocation cannot be guaranteed, thus weakening leakage protection. If alternative or complementary leakage protection measures will be implemented, this will affect the need and industry demand for free allocation. For example, if a Carbon Border Adjustment Mechanism (CBAM) is implemented on imports but there is no rebate on exports, then some degree of free allocation is likely needed to prevent leakage in exports. If an excise carbon duty is implemented on the consumption of carbon intensive materials, then free allocation to these material producers is needed to avoid double-charging.

Q5: Do you agree with the rationale put forward to support decisions the Authority will make in the future if resetting the industry cap?

No.

We agree that free allocation comes at various costs (it's not exactly free!), including delayed decarbonisation among those sectors receiving free allocations. But reducing free allocation alone does not resolve the issue either. It may in fact harm industry's ability to decarbonise. Instead, to address the limitations of free allocation, a comprehensive package of policies should be developed to ensure robust leakage protection as well as robust carbon price signals throughout the value chain to deliver a transition towards climate-neutral industrial production.

Free allocation works by taking most of the carbon price out of the product: the carbon cost of producing more is offset by the value of the additional free allowances obtained. This means that the cost pass through from upstream (supply) to downstream (product) is avoided. A major downside of free allocation is that it limits the carbon cost pass through to intermediate and final consumers. However, this carbon cost pass-through is necessary for upstream producers to recover costs and also create incentives on the demand side for consumers to use lower-carbon products and services, as well as for companies to create products to meet this demand.

Reducing free allocation does not solve this issue. Complementary measures to reinstall the carbon price signal at the consumption end (such as with a carbon excise charge) and/or standards or labels are necessary.

A key problem with free allocation is that it fails to provide full incentives for efficient domestic production. While free allocation is based on output, and benchmarks give producers an incentive to make incremental carbon efficiency improvements to meet the benchmarks, it doesn't incentivise the radical technology upgrades necessary to transform carbon-intensive material sectors. Reducing free allocation alone cannot encourage investments in radical technology innovation and upgrades. This requires additional policies like Carbon Contracts for Difference, direct technology support, etc., which could be funded by auction revenue or excise duty revenue.

In conclusion, free allocation is likely to take on a reduced role in leakage prevention, but it is not yet clear exactly what its role will be, and what other measures will come into play. The answer to the question of whether and how to reset the industry cap should emerge from discussions around formulating a comprehensive policy framework that simultaneously supports industrial decarbonisation and prevents carbon leakage.

Q7: Do you agree with the principles set out above[1], by which we will propose future changes to free allocation policy?

The framing of the free allocation policy and questions around the quantity of free allocation to be distributed are somewhat problematic. The objective should be to ensure sufficient support for industrial decarbonisation. Part of this is about leakage protection, which may or may not involve free allocation going forward. There is no credible way to determine the optimal quantity of free allocation provided without a wider plan for industrial decarbonisation support and strategies for robust leakage prevention.

A key principle should be: to ensure that the UK ETS adequately supports industrial transition to carbon neutrality. Currently, free allocation adequately addresses leakage, but the downside is that it dampens mitigation incentives. This is because carbon cost pass-through is limited, meaning that carbon prices are not reflected in the value chain and therefore incentives for efficient material consumption do not arise. Incentives for radical technology change do not materialise either, because with low-cost pass-through, low-carbon producers cannot recover the investment costs. Therefore, free allocation reform should centre around ensuring efficient mitigation incentives throughout the value chain. This cannot be done by simply adjusting the free allocation quantity. Additional measures must be considered.

Q9: Are there specific elements of free allocation design with regards to eligibility, calculations, or other rules where you would like to see changes made, if you have not already flagged these via your call for evidence response?

It is likely that sector-specific bespoke policy frameworks are needed to deliver carbon-neutral production whilst addressing leakage. For the key energy-intensive industrial sectors (materials like steel, cement, non-ferrous metals etc.), demand-side response is an important lever for reducing sectoral emissions, thus free allocation alone is inadequate. Alternative or

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[1] Principle One – To ensure that the UK ETS appropriately mitigates carbon leakage risk caused by the carbon price it sets, ensuring a true reduction to global emissions. Principle Two –To take into consideration the availability and affordability of decarbonisation technologies for UK ETS sectors. Principle Three – Future changes to Free Allocation policy will align with our wider climate targets.

supplementary policies include CBAM, excise duty and consumption charge. Eligibility for free allocation would depend on these other significant elements of the full policy package.

Q10: Are there alternative areas you think we should consider making changes to, or alternative methodologies for the provision of free allocations which you would like us to consider?

There is scope for renewed discussions around benchmark-setting and scope.

Q12: Are there other carbon leakage mitigation policies which are not already being considered by the UK Government, Scottish Government, Welsh Government, and DAERA, as listed above, which you would like to flag to us?

There are two major alternatives to CBAM: a consumption charge and carbon excise duty. On non-pricing approaches, in addition to embodied emission standards, there is a wide range of policies that can encourage more efficient production and consumption without discriminating on where goods are produced (i.e. address leakage) such as green public procurement, subsidies, standards banning on certain carbon intensive products, etc.

Chapter 3: Unallocated free allowances and flexible share

Q29: Do you agree that, should the industry cap be reset to a level that would fall below the free allocation in 2024 and 2025, a portion of unallocated allowances and/or flexible share should be used, as currently legislated, to mitigate against the application of a cross-sectoral correction factor (CSCF)?

Cross-sectoral correction factors (CSCFs) are regularly deployed in Emissions Trading Schemes (ETSs) if emissions allowances are under-allocated within a certain sector. In order to provide additional allocation for the required sectors, all non-electrical generational sectors allowances are reduced by an even proportion across the board (European Commission, 2017). This has been employed in the EU ETS with varying levels of success. The EU ETS is now transitioning towards an output-based allocation, with a best-in-class baseline to avoid CSCF implementation. The overall impact of CSCFs can be detrimental to market efficiency because of its lack of ability to reflect emissions performance within sectors, therefore not utilising all available information. Consequently, the decision to limit its application is favourable.

The suggested unallocated allocation and/or flexible share would begin in 2026, allowing for a 5-year period between 2021 and 2025 in which excess allocation would be collected by the government. This would enable a market to form prior to government intervention (Hasegawa and Salant, 2015), and further justifies the steep reduction in the industry cap to 887-936 in the initial phase of the UK ETS. This allows for unallocated allocation to be used, and it should be used to adjust imbalances in supply and demand within affected industries.

Flexible share within the free allocation is incredibly important as it presents the option for both free allocation and auctioning of these remaining allowances (BEIS, 2020). Flexible share should mitigate the possible negative impacts that excess allocation may produce. An example of this is the potential lack of incentive for a company to reduce their emissions due to free allocations covering excess emissions. Wang et al. (2013) point out that a reduction in company emissions is regularly linked with sub-optimal short term company financial performance, particularly within production heavy industries, as they may be required to reduce output. A company must be given a financial incentive to change their actions in order for a large flexible share to be successful.

Additional outlining of company eligibility for excess permits is required. A potential framework could be based around historic performance. Companies exceeding their allowance continually, with little attempt to improve could be labelled as ineligible for free allowance and must go through auctioning to purchase greater allowances. Subsequently eliminating the negative impact of low company ambition.

Alternatively, the additional allocation provides stability to companies which may experience unprecedented high emissions and allows for more certainty within their investments due to the safety net provided through the flexible share (Dixit and Pindyck, 1994). Through the course of the UK ETS, allocation of free allowances should become more difficult to obtain, thus gradually reducing the flexible share and encouraging the transition to net zero by 2050.

Finally, CSCFs are known to encourage carbon leakage through the process of companies moving operations to regions unaffected by ETSs (Goldberg and Bille, 2022). This can be incredibly dangerous as companies attempt to shield their emissions from policy, thus not properly contributing to the pledged net zero by 2050 target in the UK (ibid.). The implementation of excess allocation collection by the government and its distribution via flexible share likely limits this potential for carbon leakage, and furthermore encourages the net zero transition. The setting of the industry cap below the free allocation in 2024 and 2025 can therefore be seen as appropriate, however, this requires stringent monitoring and frequent revisions.

Q30: Do you agree that a portion of unallocated allowances and/or flexible share should be auctioned to smooth the transition to the net zero cap?

Yes.

Adjusting the emissions cap is a necessary step to make it consistent with UK's carbon budgets and Nationally Determined Contributions (NDCs). This will make fewer allowances available for regulated installations in the future. Although UK operators are less carbon-intensive than those in the EU, an uneven transition to the net zero cap could be severely detrimental to market liquidity and, therefore, mitigation measures may be required.

Allocating a portion of allowances to flexible share allows for the opportunity for both additional free allocation and additional auction-ready allowances to be utilised. Auctioning a proportion of them has the potential to mitigate the impact that a lack of incentive to change, related to free allocation, may cause. Companies requiring additional allowances would be concerned that they may need to commit considerable funds to acquiring the permits, which could incentivise them to invest in abatement technologies instead. Furthermore, as the market cap will be continually lowered in order to meet the 2050 net zero commitments, auction-ready flexible share allowances would likely increase in price, due to continually more limited supply.

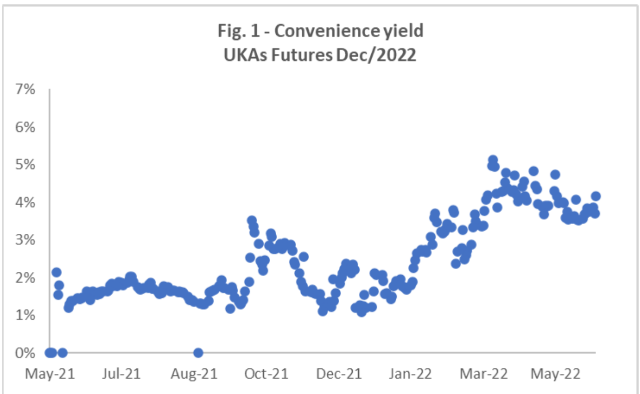
Despite this, close monitoring is required to mitigate the potential for undesired detrimental impacts that the excess allowance may produce. A good example can be drawn from the EU ETS (Assous, 2022). In addition, as highlighted by Kollenberg and Taschini (2019) with reference to the events of 2013 in the EU ETS, oversupply of allowances may endanger policy targets and reduce short-term incentives for low-carbon investment. In turn, this could risk long-term emissions reductions and net zero targets not being met.

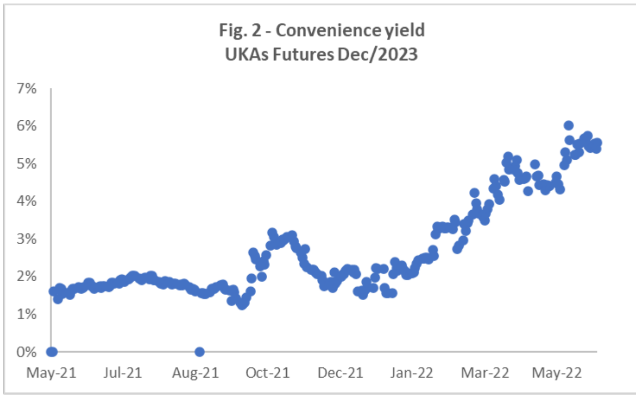
Q31: Do you agree we should consider auctioning a portion of unallocated allowances and/or flexible share before 2024 to support market liquidity?

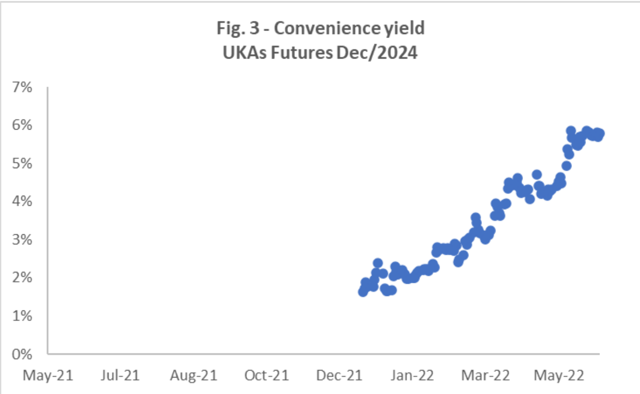
Yes.

As mentioned in the response to the prior question, transitioning to a reduced cap may impose pressure on certain installations. The need to comply under the new industry cap could develop into even higher carbon prices. Actual prices may reflect inflation and rising interest rates. As shown in Figures 1, 2 and 3, convenience yield (Bredin and Parsons, 2016) in UK Allowances (UKAs) Futures prices have been steadily increasing since December 2021 and now range between

4% and 6%. Although there is the potential for inflationary pressures to ease in the coming years, there is no certainty around the future path of prices. In this way, offering unallocated allowances prior to 2024 may help to smooth the transition to the net zero cap.

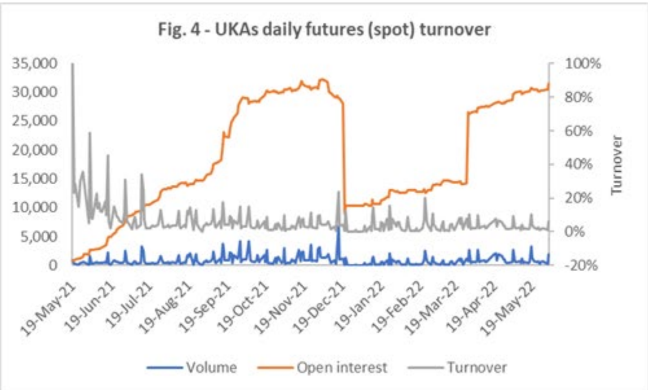


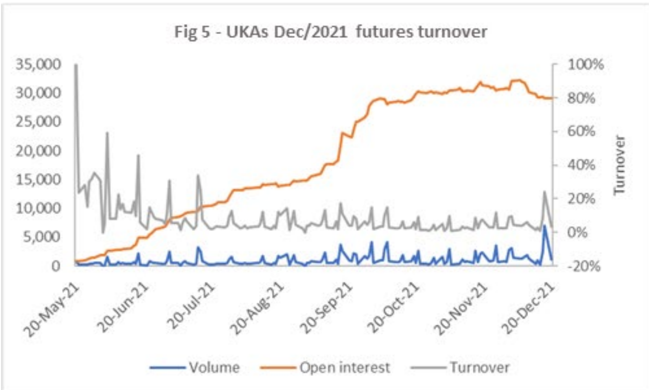


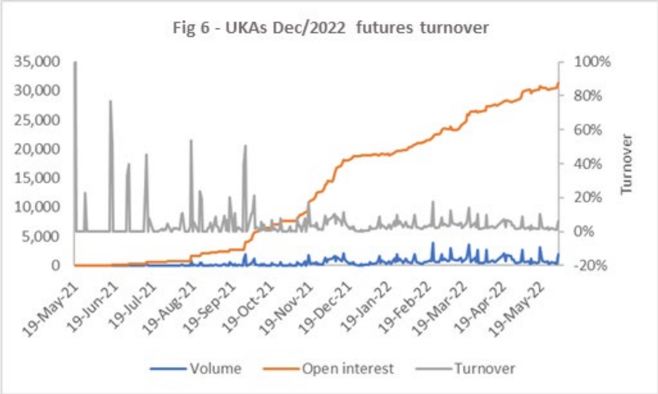


Source: *Bloomberg terminal, with information from IC(**https://www.theice.com/products/80216150/UKA-Futures**)*

Before the departure of the UK from the EU, nearly 9% of the 11,000 installations covered by the EU ETS were British. With fewer participants in the UK ETS, there is the possibility of a thin market being developed. As shown in Figures 4, 5 and 6, the actual liquidity of the market is relatively low, as measured by the turnover of daily transactions (volume of contracts traded over open interest), which averages at around 9%. In addition to a potential auctioning of unallocated allowances to increase liquidity, and given the foreseen yearly reduction of the cap, there could be a renewed case for linking the UK ETS to the EU ETS.







*Source: Bloomberg terminal, with information from IC (**https://www.theice.com/products/80216150/UKA-Futures**)*

Q32: Do you agree that a portion of unallocated allowances and/or flexible share should be retained for market stability purposes?

Yes. Please refer to question 44.

Q33: Are there features of ETS markets that put them at greater risk of market abuse than other financial markets?

Carbon markets share several common features with traditional commodities markets and are similarly susceptible to abusive activities. Two widespread concerns are manipulation and excessive speculation. Abusive activities in the market could lead to sudden and unreasonable deviations of market prices away from their fundamentals-based competitive values. This can hurt market liquidity and low-carbon investment decisions which rely on appropriate price signals (Taschini and Comendant, 2014).

Recently in the EU ETS, stakeholders lamented the growing role of speculative trading and their distortionary effect on EU ETS. This occurs when market participants disrupt the orderly functioning of the market, ultimately leading to undesired market outcomes including excessively volatile prices, price crashes and price spikes, and illiquidity (Pahle and Quemin, 2021). Some stakeholders have requested amendments to the EU ETS legislation in order to curb the role of speculative trading in the EU ETS carbon market. They are seeking to limit market access to the power generators, industries and airlines covered by the EU ETS programme and financial intermediaries purchasing carbon allowances on behalf of compliance entities. Their rationale is to reduce access to the EU ETS for entities that do not have EU ETS installations. It is important to recognise that any such limitation could reduce liquidity in the market, leading to reduced price transparency and making trading more difficult for compliance entities.

We believe that the implementation of participation restrictions can be complex, so we recommend that BEIS considers improving monitoring and market oversight, scrutinising atypical trading behaviours and anomalous price changes (Taschini and Comendant, 2014).

We also recommend considering a wider set of complementary measures that might alleviate the risk of abusive activities, including minimum holding periods and limits on financial positions (ibid.). In addition, structural measures could be considered to curtail short-term price volatility (e.g. volatility limits or price-based activation of the Supply Adjustment Mechanism [SAM]) thereby disincentivising short-term abusive activities. These measures should, however, be carefully designed and calibrated to protect compliance entities from excessive compliance costs while allowing prices to smoothly respond to changes in market fundamentals.

Q34: Are there other drivers of evolving market conditions that future UK ETS markets policy should take into account?

Carbon allowances have become a liquid and investable asset class that now trades approximately US$1 billion per day across physical carbon, futures and options (World Bank Group, 2022).

It is now possible to trade Exchange Traded Funds (ETFs) which offer exposure to future prices of carbon credits. There are also ETFs that invest directly in allowances, basically offering a guarantee of 'physical' exposure by holding allowances. While holdings associated to ETFs like SparkChange are still relatively insignificant (totalling approximately 375,000 spot European allowances as of May 2022), the number of said ETFs is increasing and the demand for permits coming from specialist carbon investments like these should not be underestimated for the UK ETS too.

Q35: What impacts do you envisage that these drivers could have in the UK ETS in the coming years, particularly in relation to market stability and integrity? What evidence do you have to support your view?

Buying a physically backed carbon allowance effectively corresponds to reducing the cap by one unit. As such, by investing directly in allowances, ETFs restrict the supply of allowances. Combined with the number of allowances already held by financial entities like hedge funds – used to hedge their exposure to investments in fossil investments – this extra demand for allowances could pose problems. Combined with the unavoidable shrinking of the 'available' quantity of allowances due to the decreasing cap, trading frictions in the UK ETS could increase. This effect is consistent with the basic intuition that is more costly to operate in a thin than in a thick market, and the common idea that the ease with which trade can be conducted depends on the market liquidity.

We recommend that BEIS investigates the potential impact of specialised carbon financial products that could permanently shift the demand of allowances, affecting the stability and integrity of the market. The original design of both the Supply Adjustment Mechanism (SAM) and the Cost Containment Mechanism (CCM) provide sufficient response to *transitory* shocks in allowance demands, but are not designed for *permanent* shocks that shift the entire demand of allowances (Taschini and Duffy, 2014; Kollenberg and Taschini, 2016; Kollenberg and Taschini, 2019).

Chapter 4: A call for evidence on future markets policy

Q44: Should the Authority consider stocking the market stability mechanism account with allowances?

A key lesson from the 2008-2012 economic downturn in Europe is the importance of building flexibility into cap-and-trade systems (Taschini and Duffy, 2014; Kollenberg and Taschini, 2016; Hepburn et al., 2016). The EU ETS has created a Market Stability Reserve (MSR) to insulate the system from allowance supply imbalances linked to business-cycle shocks (Kollenberg and Taschini, 2019; Perino et al. 2021).

The MSR began operation on 1 January 2019 and is initially seeded with the 900 million allowances backloaded in 2014-2016 (Kollenberg and Taschini, 2016; Quemin and Trotignon, 2021; Perino et al. 2022 [forthcoming]).

We recommend that BEIS stock the Supply Adjustment Mechanism (SAM) with a sufficient number of allowances to guarantee the correct functioning of the mechanism and the appropriate response to economic, policy and technology shocks that could cause supply-demand imbalance in the UK ETS. The reserve could be seeded with future, non-allocated allowances in an amount proportional to the yearly total allocation.

Q45: Does the current banking and borrowing policy remain fit for purpose? (Y/N) If not, how should it be amended?

In every cap-and-trade system, regulated firms have to decide how much they want to offset their emissions (either by abating or by purchasing allowances), considering not only the current but also the expected future cost of doing so. Under the usual assumption of abatement costs rising alongside increasing scales of abatement, firms start to accumulate allowances and then draw them down (Rubin, 1996; Schennach, 2000; Kollenberg and Taschini, 2016; Kollenberg and Taschini, 2019). The rationale for banking is quite intuitive: if tomorrow's expected discounted costs are higher than today's, it is worth banking allowances, whether they are obtained by abating more emissions today or by purchasing them and using them either to cover some of tomorrow's emissions or selling them for profit later on. How much banking will occur and for how long depends on the values embedded in the firms' expectations. For example, an unexpected negative shock to aggregate emission demand would result in a reduction of the required abatement and a surplus of allowances, or alternatively, a longer banking period. In this instance, the continuation of banking permits indefinitely (vs. banking limitations) will mitigate the effect of market imbalance.

We recommend that BEIS maintains the current banking and borrowing policy.

If setting limits on banking is an option, the government should consider whether the reduction in the lifetime of permits is followed by acceleration in abatement. We suggest testing the robustness of the choice of permits' lifetime by computing, for example, the number of extra years before full deployment of the bank in response to a potential surplus, i.e. the variation of emissions in the UK ETS sectors caused by one of the following scenarios: (1) more stringent UK Renewable Energy Share targets; (2) technological innovation; or (3) UK ETS link to a system that announces a post-link coal phase-out.

Chapter 8: Calls for evidence on greenhouse gas removals and agriculture and land use emissions

Q147: Do you believe the UK ETS could be an appropriate long-term market for GGRs?

Using the UK ETS as the principal short- to medium-term policy framework for Greenhouse Gas Removal technologies (GGRs) brings a number of risks. First, treating emissions removals and emissions reductions as entirely fungible allows for undesirable substitution. Second, carbon markets may provide insufficient demand pull to deploy the currently more-costly GGR techniques at commercial scales. Third, opening a carbon market for potentially lower-cost GGR (such as nature-based solutions) too early could exert downward pressure on the overall market-based price of carbon, in the absence of adjustments to emissions caps or other safeguards. These risks could hamper overall efforts to deploy GGR. Instead, a multi-pronged and inter-temporal policy and governance framework for GGR is needed. This includes considering separate accounting targets for GGR and conventional emissions abatement, removing perfect fungibility between GGR permits and carbon market permits and promoting a wide range of innovation and technology-specific mechanisms to make currently expensive, yet highly scalable, technological GGR more affordable. Such a framework would ensure that policymakers can utilise carbon markets and other incentives appropriately to drive the development of GGR techniques without compromising near-term climate change mitigation.

Q148: How could the design of the UK ETS be adapted to include GGRs while still maintaining the incentive to decarbonise for ETS participants?

If GGR is to be integrated, there are a number of questions that first need to be addressed. For example, should policymakers limit access to GGR permits to only hard-to-abate sectors, or should they be integrated into and freely traded between carbon market participants? One possibility would be to impose sectoral limits on the use or allocation of quantitatively restricted GGR for trade-exposed sectors or for activities associated with high residual emissions (Rickels et al., 2021). In answering this question, it is important to remember that most residual emissions in 2035 and 2050 are expected to be in sectors that are not currently covered by the UK ETS, such as international aviation and land use.

Unless the scope of the UK ETS is expanded to cover these sectors, or the cap is set to net negative, it may not be useful to include GGR permits in an ETS. One alternative approach under the current sectoral coverage would be to make the cap within a UK ETS net negative. For example, the EU Commission is looking to make the EU ETS net negative by 2050. This is one way to design an ETS that is compatible with net zero and the integration of GGR techniques. Moreover, the availability could be managed by having a clear set of parameters to be achieved – such as a balance between supply and demand or permit quality – before technological removals can be integrated.

Q149: To what extent could the UK ETS price signal incentivise development of the full range of GGRs, including engineered and nature-based GGRs, given the expected differences in the project costs?

Many large-scale GGRs (particularly technological solutions such as BECCS and DACCS) remain relatively expensive compared to other near-term mitigation options. There are several reasons to be sceptical about the ability of an Emissions Trading System to singly drive the requisite innovation and cost reductions in such techniques in the coming decades.

The most striking and arguably most relevant precedent is carbon capture and storage (CCS), which continues to languish in terms of its contribution to climate change mitigation, with just two power generation plants operating with CCS, at a combined power output of less than half a gigawatt (Global CCS Institute, 2021). This technology was singled out over a decade ago as one of the most important solutions to climate change by the International Energy Agency (IEA), which envisaged 38 CCS power plants with a combined 22 gigawatt capacity by 2020 (IEA, 2009). While there are tens of operational CCS projects outside of the power generation sector (primarily for natural gas processing and chemicals production), in total all operational CCS projects contributed just under 40 metric tonnes of CO_2 a year ($MtCO_2$/yr) of carbon capture (GCSS, 2021), equivalent to about 0.1% of global emissions.

Even though a strong future carbon price could provide a much-needed boost to the economic prospects of CCS, such a price has failed to materialise in most world regions to date. GGRs are likely to be so expensive that they will require a significant carbon price and, in the current carbon markets, could be effective in incentivising low cost GGRs, most notably afforestation and reforestation, which come with multiple environmental and other co-benefits (Smith et al., 2015). However, fully integrating all viable GGRs into carbon markets would create an incentive to prioritise the use of these low-cost solutions at the expense of conventional emission reductions at the same time as potentially impeding GGRs with higher investment costs and higher abatement potentials.

This is particularly important as the potential for such lower-cost, nature-based solutions to contribute on the possible scale of removals required to meet stringent climate change mitigation goals is unlikely to be sufficient (ibid). In addition, nature-based solutions could have potential risks relating to their long-term sequestration of carbon, as well as ensuring genuine additionality of removals.

As such, the large-scale technological solutions such as BECCS and DACCS loom large. In both cases, mitigation costs could remain high for decades to come, requiring carbon prices of over £100/tonne of CO_2 (tCO_2) in addition to specific provisions for these GGR measures. Daggash and Macdowell (2019) suggest that even a social cost of carbon that peaks at £349/tCO_2 in 2075 from £6/tCO_2 in 2015 is insufficient to kickstart the deployment of BECCs and DACCS throughout this time period (2015-2075). This further illustrates that even very high carbon pricing levels may be unable to deliver carbon dioxide removal at scale.

Nemet et al.'s (2018) systematic review of innovation and upscaling for negative emissions technologies asserts that several processes will be necessary to drive this innovation and learning, including deployment incentives and niche markets and public acceptance, in addition to the demand created by carbon markets. Evidence from technological innovation systems (TIS) analysis around offshore wind, for example, points to a multifaceted innovation system consisting of government working closely with entrepreneurs to set the direction of research, support for pilots and demonstrations, as well as associated demand-pull policies such as Feed-in Tariffs and Contracts for Difference to provide a stable, high revenue for initial projects (Reichardt et al., 2016). Nor do carbon trading schemes feature heavily in the story of solar photovoltaics' remarkable innovation and cost-reduction journey (Gambhir et al., 2014), which is far more a result of staged periods of research and development, demonstration and direct deployment support, the latter coming in many cases from targeted Feed-in Tariffs which created a huge demand-pull for the technology at a time when carbon pricing was either absent or significantly too low to level the playing field for it.

Q152: Are there any impacts, constraints or unintended consequences that need to be managed if incorporating GGRs within an ETS?

There is a growing literature on the potential for negative emissions technologies to create a moral hazard or to weaken strong near-term mitigation. The term "mitigation deterrence", which refers to this latter effect, is now gaining widespread usage in the literature.

While certified, permanent negative emissions technologies do not themselves create a moral hazard, reliance on them to achieve future negative emissions does. Incorporating GGR within carbon markets has the potential to exacerbate this risk.

It is therefore right to question whether GGR credits should be treated as entirely interchangeable with conventional carbon permits. Moral concerns are raised around fungibility in carbon markets because under neo-liberalism, markets have become the primary arbiters of whether and to what extent technologies are substitutable (Markusson et al., 2018). Technologies are often preferred solutions because they require less behaviour change and can be constructed as fungible substitute for it. Such fungibility is easier to operationalise if technological functions are viewed are having standardised effects (Lohmann, 2005). In the context of GGR, standardization between nature-based and engineered GGR techniques could mask differences in environmental durability and additionality. Consequently, poor substitutability between GGR and conventional mitigation could be obscured under a policy framework that promotes carbon markets, and thus increase the likelihood of mitigation deterrence.

This could be further exacerbated if policymakers wish to incorporate inter-temporal flexibility mechanisms (such as banking or borrowing) into a carbon market to reduce compliance costs. But too much borrowing – in combination with the inclusion of GGR-based carbon permits in a trading scheme – may lead some firms to over-emit in the current trading period, deterring mitigation and potentially locking themselves into carbon-intensive activities, with the hope that future abatement through GGRs would atone for this. If GGRs fail to scale up and this future abatement fails to materialise, this could be a ruinously costly move. It may also incentivise these firms to lobby for a relaxation in policy stringency – a risk that was identified early in the development of ETSs (OECD/IEA, 2004). This would suggest that GGR borrowing should have a limited role in an ETS. This also prevents an over-substitution of "easier" Clean Development

Mechanism (CDM) emissions reductions, whose additionality was questionable compared to longer-term investments towards a low-carbon transition.

Q155: For GGRs that have a risk of carbon being re-released into the atmosphere, are there any potential solutions we should consider enabling market participation?

Risks associated with the genuine permanence and environmental integrity of the offset credit present a further set of risks. At the heart of this is whether the codification of CO_2, or other greenhouse gases, as a tangible commodity provides GGRs with absolute fungibility with established emissions reductions measures. Implicit in this assumption is that a tonne of CO_2 sequestered by natural sinks is equivalent to either a tonne of CO_2 captured by engineered solutions such as BECCS or DACCS, or a tonne of CO_2 not emitted (abated).

Such an assumption must recognise the distinctive contexts in which these very different solutions operate, and the risks embedded within them, especially as it can be difficult to scientifically define the equivalence between one negative emissions unit generated through a given GGR and one positive emissions unit abated. If these two units are to be considered entirely fungible, long-term durability and overall net additionality of emissions reductions needs to be ensured in both the capture and storage of greenhouse gases to ensure genuine and permanent emissions reductions. Nature-based solutions are far more prone to reversal than engineered solutions, particularly in jurisdictions with a chequered history of land use governance (Bailey and King, 2020), due to the imperative to protect stocks of vegetation over substantial periods of time (Gough and Upham, 2011). Inclusion of GGR in carbon markets therefore raises important considerations for regulation and temporal governance in relation to monitoring, reporting and evaluation (Cox et al., 2018).

We have already seen the pitfalls of substituting genuine mitigation techniques for overly-easy options with questionable integrity; in the early phases of the EU ETS, the inclusion of hydrofluorocarbon (HFC) incineration activities outside of the European Union arguably incentivised chemical companies (particularly in China) to expand production of HFC-23 (a refrigerant gas) in order to benefit from relatively lucrative CDM credit sales to EU companies in the ETS (Zhang and Wang, 2014).

This HFC example could be replicated in the future use of nature-based GGR, which have low levels of permanence or additionality.

Environmental integrity issues such as permanence can be addressed by removing perfect fungibility between GGR permits and carbon market permits. For example, a ratio that is higher than a one-to-one relationship between GGRs and generated credits can be implemented. Under such a scenario, system-level risk could be hedged if, for example, for every GGR permit, two conventional permits are surrendered.

Q156: What are challenges of integrating non-permanent removals alongside permanent removals in the UK ETS and how can these be overcome?

Linking a GGR market for non-permanent removals with traditional carbon markets may impose downward pressure on the positive emissions carbon price. Although the nascent nature of GGR techniques prevents any ex-post evaluation of linking these markets, the historical use of offsets in carbon markets provides useful context to highlight the risks of allowing cheap GGR permits in future carbon markets. This includes reversal, governance or price risk (Bumpus and Liverman, 2008). The latter is best demonstrated by the New Zealand (NZ) carbon market, where the allowance of unlimited offsets can be considered analogous to the future inclusion of unlimited cheap GGR permits in carbon markets. The NZ ETS was initially introduced with unrestricted linking to the international CDM market (Flachsland, 2011) where Certified Emissions Reductions (CER) units could be used for compliance. When the financial crisis occurred, New

Zealand experienced excess supply from both a decline in emitting activity and from an oversupply of international offset credits (CERs) in the trading market (Narassimham et al., 2018). This led to a collapse in the New Zealand allowance price (NZU) from $20 in May 2011 to $2 in May 2013 (Richter and Chambers, 2014).

A low price makes mitigation unattractive and stifles low-carbon investment (Salant, 2016). A number of studies conclude that unrestricted linking, with participants opting for low cost CER units, had a significant impact on the ability to deliver genuine additional abatement (Ruthner et al., 2011) with the resulting low prices discouraging low carbon investment and higher-cost domestic mitigation.

The parallels with future use of GGR credits is clear. In such a scenario, facilities undertaking GGR activities could generate GGR credits or allowances to be sold to market participants who need to meet their compliance obligations. But because early abatement in offset sectors can often be achieved at relatively low costs, as is the case with cheap nature-based GGR credits (Chitkara and McGlynn, 2018), allowing unlimited use of such credits for compliance could result in a linked future GGR market overly influencing market outcomes in an ETS. When deciding whether it is appropriate to include GGRs in carbon markets, the distinction needs to be made between GGR techniques that will be likely to be additional (often more expensive engineered GGRs that won't depress the market price) and GGRs that may never be additional (often cheap with the potential depress the market price).

By having a separate market for negative emissions, it is possible to ensure that cheap GGRs don't put downward pressure on carbon market prices. In addition, if mature GGRs are to be incorporated into emissions trading schemes in the future, unrestricted linking should be avoided in order to avoid substitution and downward price pressure, regardless of the potential efficiency gains.

Q159: Should GGRs be incorporated into the UK ETS or would it be preferable to establish a separate, but linked, market for GGRs?

A more complex set of mechanisms than simply an Emissions Trading System-determined carbon price are needed to deliver innovation cost reductions, as demonstrated in the literature and by real-world experience. Therefore, we suggest that well before any integration of GGRs into carbon markets, there should be a range of innovation and technology-specific mechanisms to drive currently expensive, yet highly scalable technological GGR down the cost curve. This involves a multi-pronged inter-temporal policy framework. In the short-term this means a near-term focus on ensuring the cost-effective, scalable and reliable development of these novel techniques through piloting and demonstration support. In the medium-term policymakers can draw on the successful experience of promoting renewable energy sources in the electricity sector, particularly the role of Contracts for Difference (CfDs) in deploying significant quantities of offshore wind in the UK. A similar approach could be used to encourage nascent GGR techniques. For example, the Government may choose to ringfence negative emissions techniques into different pots based on technological maturity with deployment support offered via a stable price for each tonne of carbon removed. It may be attractive to use a competitively awarded public procurement contract such as Carbon Contracts for Difference, with the contract benchmarked against a reference price (e.g. the prevailing carbon price) and the top-up paid by Government. This may be preferable to a general subsidy for negative emissions (such as Feed-in Tariffs in the electricity sector where the Government rewards all producers with a fixed level of support) as an auction is more responsive to technological progress, which can reduce the overall cost of the policy and control the levels of deployment (which tend not to be fixed under a Feed-in Tariff policy). Although not a simple process, if robust monitoring, reporting and verification (MRV) standards are established in the longer-term and are enforced through an independent MRV regulator, as proposed by the UK Government (BEIS, 2021), a separate negative emissions carbon market could be established, to eventually link to existing markets.

Q161: How and when could eligible GGRs be phased into a market such as the UK ETS?

GGRs may be included in carbon markets if they are able to: provide proven, high-integrity removal and sequestration of CO_2 and/or other greenhouse gases; benefit from the carbon price in ETSs in a way that allows them to be deployed and come down in cost; and be incorporated without risking downward price pressure on the market. If this is not the case, there are a range of measures that should be undertaken to maintain the integrity and strength of carbon markets while incentivising the development and cost-reduction of GGRs. In all cases, a technology-specific approach must be taken as different GGR solutions will entail different risks, depending on their stage of development, the durability of emissions removals and sequestration that they provide, and their cost.

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