Title: The Future of UK Carbon Pricing Impact Assessment **IA No:** BEIS019(F)-19-HET **RPC Reference No:** N/A **Lead department or agency:** BEIS **Other departments or agencies:** HMT, DfT, DAs	**Impact Assessment (IA)** **Date:** June 2020 **Stage:** Final **Source of intervention:** Domestic **Type of measure:** Secondary Legislation **Contact for enquiries:** emissions.trading@beis.gov.uk

Summary: Intervention and Options

RPC Opinion: N/A

Cost of Preferred (or more likely) Option (in 2019 prices)			
Total Net Present Social Value	**Business Net Present Value**	**Net cost to business per year**	**Business Impact Target Status**
£66 to 92m	£-29 to -63m	£5 to 11m	Not a qualifying provision

What is the problem under consideration? Why is government intervention necessary?

The impact of greenhouse gases on climate change is a negative externality that arises from the market's failure to account for the wider cost to society and the environment when producing goods and services associated with these emissions. In the Climate Change Act 2008 (2050 Target Amendment Order 2019), the UK set a legally binding target of net zero emissions by 2050, to mitigate the negative impacts of climate change. The EU Emissions Trading System (ETS) is a key policy for reducing emissions in the power sector, energy intensive industries, and the aviation sector (the 'traded sectors'). Government intervention is necessary to ensure that emissions from sectors currently covered by the EU ETS continue to be covered by a carbon pricing policy following UK withdrawal from the EU.

What are the policy objectives and the intended effects?

The objective of the policy is to incentivise cost-effective emissions reductions for sectors currently in scope of the EU ETS, while balancing this ambition with the competitiveness of UK industry. As set out in the Clean Growth Strategy, our future approach will be at least as ambitious as the current EU ETS and will provide a smooth transition for all relevant sectors.

What policy options have been considered, including any alternatives to regulation? Please justify preferred option (further details in Evidence Base).

Policy option: We assess the design of the UK ETS set out in the accompanying government response document, in its initial years of operation (from 2021 to 2024). This system is intended to fulfil the policy objectives outlined above as a standalone system, while also providing a platform to negotiate a linked system with the EU ETS, if it is in the best interests of both parties. Long-term ETS policy, including a linking agreement, is subject to ongoing negotiations with the EU and so quantitative analysis of this is not within scope of this IA.

Counterfactual: The policy option is compared against a counterfactual of continued UK participation in the EU ETS in Phase IV of the system. This represents the main policy that would have covered greenhouse gas emissions in the traded sectors if the UK were to have remained part of the EU.

Will the policy be reviewed? It will be reviewed. **If applicable, set review date:** Multiple dates from 2021.

Does implementation go beyond minimum EU requirements?	N/A			
Is this measure likely to impact on international trade and investment?	Yes			
Are any of these organisations in scope?	**Micro** Yes	**Small** Yes	**Medium** Yes	**Large** Yes
What is the CO_2 equivalent change in greenhouse gas emissions? (Million tonnes CO_2 equivalent)	**Traded** -2 to -3		**Non-traded** 0	

Summary: Analysis & Evidence

Description: The assessment considers the initial years of the UK ETS, based on the design set out in the government response: a cap on emissions set based on a 5% reduction on our notional share of the EU ETS, free allocation based on our notional share of the EU ETS, and a transitional auction reserve price starting at £15 per allowance.

FULL ECONOMIC ASSESSMENT

Price Base Year 2019	PV Base Year 2019	Time Period Years 6	Net Benefit (Present Value (PV)) (£m)		
			Low: 66	**High: 92**	**Best Estimate: 66 to 92**

COSTS (£m)	**Total Transition** (Constant Price)	Years	**Average Annual** (excl. Transition) (Constant Price)	**Total Cost** (Present Value)
Low	-		6	**36**
High	-		12	**70**
Best Estimate			6 to 12	**36 to 70**

Description and scale of key monetised costs by 'main affected groups'

Relative to the counterfactual the key monetised costs of the UK ETS are: i) the cost incurred by firms reducing their emissions to meet the cap i.e. 'resource' cost (£25 to 59m); ii) the administrative costs to firms in complying with the new policy (£4m); and iii) the administrative cost to government (including regulators) in establishing and administering the policy (£7m). Overall, the estimated range of monetised costs relative to the counterfactual is £36 to 70m (present value).

Other key non-monetised costs by 'main affected groups'

Relative to the counterfactual key non-monetised costs include: i) potential loss of UK business competitiveness relative to international competitors, if higher carbon costs lead to increased production costs and significantly impact profitability and market share; ii) potential carbon leakage as a result of higher carbon values; iii) potential increase in cost to consumers if higher carbon costs to businesses are passed on in the form of higher prices. However we do not expect these costs to materialise to a significant degree, as we do not expect a significant differential in carbon values in the UK ETS relative to counterfactual scenario.

BENEFITS (£m)	**Total Transition** (Constant Price)	Years	**Average Annual** (excl. Transition) (Constant Price)	**Total Benefit** (Present Value)
Low	-		17	**102**
High	-		27	**162**
Best Estimate			17 to 27	**102 to 162**

Description and scale of key monetised benefits by 'main affected groups'

Relative to the counterfactual the main monetised benefit of the policy scenario is the carbon benefit, which represents the benefit to society of reduced emissions in the sectors covered by the UK ETS. Based on the UK ETS design modelled, we expect greater emissions reductions under the policy compared to the counterfactual. The estimated range of the monetised benefit relative to the counterfactual is £102 to 162m (present value).

Other key non-monetised benefits by 'main affected groups'

Relative to the counterfactual the key non-monetised benefits are: i) potential improvements in air quality if the policy leads to reduction in activities that generate pollutants as well as greenhouse gas emissions; ii) potential long-term positive impacts on UK business competitiveness relative to international competitors, if higher carbon values increase investment and innovation in new low carbon technologies and processes; iii) more efficient and cost-effective decarbonisation if the policy leads to reductions in emissions through the least-costly methods; and iv) spill-over benefits through the growth of the green and circular economies.

Key assumptions/sensitivities/risks	**Discount rate (%)**	3.5%

The quantitative analysis relies on our modelling of carbon values and abatement, which in turn relies on our projections of 'business as usual' emissions and marginal abatement costs in the UK and EU. These are subject to significant uncertainty. A low-high range is used throughout the assessment to reflect this. Nevertheless, due to this uncertainty and uncertainty over future market participant behaviour in the UK and EU ETS, our modelled carbon value projections do not necessarily reflect the actual carbon prices that would prevail in either system. Therefore the analysis is illustrative of the relative impacts of the policy against the counterfactual and should not be interpreted as real-world outcomes.

BUSINESS ASSESSMENT

Direct impact on business (Equivalent Annual) £m:			Score for Business Impact Target £m:
Costs: 3 to 6	**Benefits: 0**	**Net: 3 to 6**	N/A

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Evidence Base

Introduction

Background

1. The UK Government and Devolved Administrations (DAs) consulted in May 2019 on the future of carbon pricing in the UK.[1] This consultation set out our intention to launch a UK Emissions Trading System (ETS).

2. This impact assessment (IA) accompanies the UK Government and DAs' ('government') response, which sets out our decisions on the design and operation of a UK ETS, considering the evidence gathered during the consultation. We may seek to link the UK ETS to the EU ETS, if it is in the best interest of both the UK and the EU (subject to negotiation).

Rationale for intervention and policy objectives

3. The primary rationale for government intervention is to address the failure of the market to account for the social and environmental costs associated with greenhouse gas (GHG) emissions from the power, industry, and aviation sectors.[2] Also, related to this, is the failure of the market to invest in innovation and deployment of clean technologies, as the associated positive externalities (e.g. reduced emissions, knowledge and productivity spill-overs) are not accounted for when making investment decisions.

4. In June 2019, the UK became the first major economy to pass legislation committing the government to achieving a legally binding target of net zero emissions by 2050. This represents a significant increase in climate ambition on the target originally set out in the Climate Change Act (in 2008) to achieve GHG emissions reductions of 80% on 1990 levels.

5. Additional legislative frameworks and targets exist in the DAs. Scotland has set a target to reach net-zero emissions by 2045, with increased interim targets for a 56% reduction by 2020, 75% reduction by 2030 and 90% reduction by 2040. The Welsh Government has agreed to cut emissions by 95% by 2050, and Northern Ireland also contributes towards the UK climate change targets and carbon budgets.

6. To meet these targets, the government has also set shorter term carbon budgets (currently set to 2032), which limit the amount of GHG emissions that can be legally emitted in five-year periods. A significant proportion of the emissions within scope of our carbon budgets are currently from sectors covered by the EU ETS (around a third of emissions since 2013).

7. UK withdrawal from the EU does not affect the statutory climate commitments set out above. In the Clean Growth Strategy (CGS) we set out that our future policy approach must be at least as ambitious as under the EU ETS and provide a smooth transition for all relevant sectors.[3] Having left the EU the UK will remain at the forefront of domestic and international action on climate change by committing to go further and faster in our efforts to deliver clean energy and a carbon-neutral future.

8. We are also committed to ensuring our climate commitments are achieved cost-effectively and avoid carbon leakage (where, as a result of more stringent policies businesses relocate production and investment abroad, potentially leading to increased global emissions). In the

[1] The Future of UK Carbon Pricing Consultation: https://www.gov.uk/government/consultations/the-future-of-uk-carbon-pricing
[2] For a summary of the social and environmental consequences of increased atmospheric concentration of greenhouse gas emissions see: https://www.theccc.org.uk/tackling-climate-change/the-science-of-climate-change/
[3] The Clean Growth Strategy (page 44): https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/700496/clean-growth-strategy-correction-april-2018.pdf

Industrial Strategy we set out our commitment to maximise the advantages to UK industry from the global shift to clean growth.[4]

9. Lastly, we intend to launch the UK ETS in January 2021 at the end of the EU Exit transition period. This seeks to ensure as far as possible a smooth transition from the EU ETS for businesses within scope and lay the foundation for an effective carbon pricing policy in the UK going forward.

Description of policy scenario

10. Carbon pricing is widely acknowledged in economic research and literature as an effective and technology neutral emissions reduction policy.[5] The government is committed to exploring long-term options for accelerating the decarbonisation of industry while maintaining UK competitiveness. In addition to carbon pricing, these options include a long-term decarbonisation funding stream sourced from a share of monetised UK ETS allowances, international agreements and product certification, demand-side measures, and other direct fiscal support.

11. As set out in the government response, our intention is to launch a standalone UK ETS which is independently viable but would have the ability to link with the EU ETS. The UK would be open to considering a link between any future UK ETS and the EU ETS (as Switzerland has done with its ETS) if it suited both sides' interests. Any such agreement would need to recognise both parties as sovereign equals with our own domestic laws.

12. The design of the UK ETS also includes bespoke features, which would help mitigate the risks associated with uncertainty over the outcome and timing of linking negotiations and ensure the effective operation of the system from day one in a standalone context. Numerous review points have been built into the first phase of the system, to ensure the effective operation of the policy over time and incorporate forthcoming advice from the CCC on the sixth Carbon Budget and UK ETS design specifically.[6] Therefore, while the first phase of the UK system will run from 2021 to 2030, this IA considers a shorter appraisal period spanning the initial years of the system, from 2021 to 2024.

13. The costs and benefits of the UK ETS design in these years are considered against a counterfactual scenario in which the UK remains a participant in Phase IV of the EU ETS from January 2021 onwards.

14. The following sections set out the key assumptions we make to assess the impacts of these scenarios in more detail.[7]

15. It is also worth noting that while the impacts of other carbon pricing policies that apply to the traded sectors (for instance, the Carbon Price Support, Climate Change Levy, and CORSIA respectively) are not considered explicitly within this IA, we are committed to ensuring they continue to provide an appropriate carbon price signal for these sectors alongside the UK ETS.[8]

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[4] The Industrial Strategy (page 42): https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/664563/industrial-strategy-white-paper-web-ready-version.pdf

[5] For a good overview of the case for pricing carbon see: http://www.worldbank.org/en/programs/pricing-carbon; and http://www.lse.ac.uk/GranthamInstitute/faqs/what-is-a-carbon-price-and-why-do-we-need-one

[6] See Chapter 1 of the government response for more detail.

[7] Other design features relating to the operation of the UK ETS (see Chapter 2 of the government response) are not explicitly modelled in this IA, though if relevant are considered when estimating the administrative costs to system participants and government in the cost benefit analysis.

[8] CORSIA is ICAO's Carbon Offsetting and Reduction Scheme for International Aviation. See Chapter 3 of the government response for more information.

UK ETS assumptions

Scope

16. In this IA we assume the scope of the UK ETS is consistent with the scope set out in the government response. The scope of the UK ETS in its first phase will be the same as the EU ETS in Phase IV for stationary sectors – covering carbon dioxide, nitrous oxide, and perfluorocarbon emissions from stationary installations in the power sector (combustion of fossil fuels) and energy intensive industries such as the production of steel and cement.[9]

17. Currently there are around 1,000 UK stationary installations within scope.[10] However, in this IA we assume around 655 stationary installations participate in the system, based on analysis of how many installations will opt out of the main policy under the small and ultra-small emitters opt-out schemes.[11]

18. We also assume that the aviation sector is within scope of the policy, and that the geographic scope of the system covers domestic flights, flights between the UK and Gibraltar, and departing flights from the UK to the European Economic Area (EEA) and Switzerland (if we reach an agreement with Switzerland).[12] In our analysis we assume this is the case over the entire appraisal period, however we acknowledge that decisions relating to the implementation of CORSIA alongside the UK ETS may affect this.

19. Given that the scope of the aviation component of the UK ETS is defined on a route basis rather than operator basis, there is uncertainty over the number of aircraft operators that would fall within scope of the policy. Currently there are around 140 UK regulated aircraft operators with verified emissions above zero in the EU ETS.[13] However, in the UK ETS we expect the number of aircraft operators within scope to be greater than this depending on the number of EEA and third country (i.e. countries outside of the EEA) operators that perform flights in scope of the UK ETS.

Cap

20. A key feature of the UK ETS design is the cap which sets the maximum level of emissions allowed in the system and therefore the supply of allowances.[14] Relative to 'business as usual' (BAU) emissions, this determines the level of abatement effort required under the policy.[15]

21. As set out in the introduction section of this IA and government response, we are fully committed to achieving the UK's net zero targets and recognise the contribution that can be made by UK ETS policy. As set out in the government response we acknowledge the CCC's recommendation to set the UK ETS cap in line with their cost-effective pathway to net zero, which they will provide further detail on as part of their Sixth Carbon Budget advice at the end of this year. We will subsequently consult again on what an appropriate trajectory for the UK ETS cap should be in light of this advice and aim to implement any amendments by January 2023 and no later than January 2024, while aiming to give participants at least one year's notice of changes.

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[9] With a total thermal input exceeding 20 MW. See Annex 1 of the EU ETS Directive for the full list of stationary activities and greenhouse gases within scope of the policy: https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:02003L0087-20180408&from=EN

[10] We include operators based in Northern Ireland within the scope of the UK ETS.

[11] The UK ETS will mirror the design of the small and ultra-small emitters opt-out schemes implemented for Phase IV of the EU ETS. See here for the full impact assessment of adopting these provisions in the UK: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/843605/continued-uk-membership-euets-phase-iv-response-impact-assessment.pdf

[12] Due to uncertainty over when this may come into force, and a lack of data, we do not include impacts associated with flights from the UK to Switzerland in this assessment.

[13] From the EU ETS Union Registry: https://ec.europa.eu/clima/policies/ets/registry_en#tab-0-1

[14] Each 'allowance' is worth one tonne of CO_2 equivalent (hereafter tCO_2e).

[15] Business as usual emissions represent expected emissions in the absence of the carbon pricing policy being assessed in this IA. For more information see Annex B.

22. In the meantime the UK ETS will be initially set at 5% below the UK's expected notional share of the EU wide cap in Phase IV of the EU ETS (hereafter referred to as the 'notional minus 5%' cap).[16]

23. In 2021 this notional minus 5% cap level equates to around 156 $MtCO_2e$ (based on the assumed scope of the policy set out earlier). This is higher than our BAU emissions projections in that year (ranging from around 126 to 131 $MtCO_2e$). However, there is significant uncertainty over these projections and market participant behaviour in this initial period could lead to significant demand for allowances above BAU emissions. This in turn means there is uncertainty over the level of demand for allowances in these years relative to supply, and therefore risk of extreme high or low prices.

24. Given these uncertainties we therefore believe it is appropriate to maintain sufficient headroom of allowances for a time-limited period at the start of the new system. However we believe that initially tightening the cap by 5% provides an appropriate balance between climate ambition in the context of the UK's net zero commitment and businesses competitiveness, which may be at risk due to early years' market behaviour (see 'behavioural assumptions' section below). This cap level alongside other temporary measures (see 'market stability mechanisms' section) seeks to provide appropriate mitigation of extreme high or low price risks, in the initial years of the UK ETS market.

25. As in the EU ETS, this cap level will be reduced annually to drive emissions reductions over time. In this IA we assume an annual linear reduction of around 4 $MtCO_2e$, based on the policy set out in the government response. Within the overall cap, all allowances are interchangeable between participating sectors, including stationary installations and aircraft operators.

26. Given uncertainty over the level and trajectory of a net-zero consistent cap, we cannot quantitatively assess the impacts of this policy change within the first phase of the UK ETS. We therefore model the notional minus 5% cap but assume a shorter appraisal period – to 2024 only – to reflect the initial period over which we have relatively more certainty.

Distribution of allowances

27. In an ETS once the cap on emissions is set, an important consideration is how allowances in the system will be distributed to participants within scope (the 'cap split'). The government response sets out our intention for allowances under the cap to be distributed across the following 'pots':

    A. **Free allocation:** The primary rationale for free allocation of allowances to system participants is to appropriately mitigate potential negative impacts of carbon pricing on business competitiveness and the risk of carbon leakage.[17] The maximum number of allowances available for free allocation to all stationary installations is defined by the 'industry' cap, and box 1 below summarises the methodology that will be used to determine free allocation to individual stationary installations in the UK system. Box 2 summarises the analogous methodology used to determine free allocation to aircraft operators.

    B. **New entrants reserve (NER):** The primary rationale for this pot is to ensure that new market entrants in the stationary sectors within scope of the policy are not competitively disadvantaged against incumbents – and to incentivise investment in new facilities and potentially cleaner production processes. The NER is also intended as a means of dynamically increasing or reducing free allocation to incumbent stationary installations in response to changing economic conditions. For aircraft operators there exists a special reserve (see box 2 for more information).

[16] While the cap in the EU ETS is set for the EU as a whole (rather than for individual Member States) the UK's 'notional share' represents the number of allowances 'held' by the UK under this EU-wide cap. We estimate the UK's notional share based on the number of allowances the UK auctions and receives via free allocation and funds.

[17] The displacement of – or potentially increase in – emissions as a result of production and investment moving from a jurisdiction with stringent regulations to others without comparable policies.

C. **Auctioned allowances:** Auctioning of allowances will be the primary method for distributing allowances to participants, as a means of increasing the economic efficiency of the system and reflecting the polluter pays principle.

28. As set out in the government response, to ensure a smooth transition for businesses, the distribution of allowances in the initial period of the UK ETS will be based on the same approach as in the EU ETS; i.e. while the UK ETS cap will be set based on a 5% reduction of our notional cap in the EU ETS, free allocation (stationary and aviation) and the NER will be set based on our notional share of the EU ETS. The 5% reduction in the cap will therefore be met by reducing the size of the auction pot.

29. Based on this approach, in this IA we assume the following split between these different pots under the notional minus 5% cap modelled over the appraisal period to 2024:

Table 1. Cap split assumptions[18]

Component	Share of cap	Assumption
Industry cap on stationary free allocation	37%	As set out in the government response, in this IA we assume the industry cap is set based on the UK's notional share of the EU ETS industry cap in Phase IV. In 2021 this equates to around 58 $MtCO_2e$; this cap then reduces annually by around 2 $MtCO_2e$. The final level of free allocation to stationary installations in each year will depend on the process set out in box 1 below.
Flexible share	≤3%	If preliminary free allocation to the stationary sector exceeds the industry cap, up to 3% of the UK ETS cap can be used for free allocation to avoid application of a cross sectoral correction factor (CSCF). Otherwise allowances in this pot are auctioned. In this IA we assume final free allocation is less than the industry cap and therefore these flexible share allowances are auctioned.
NER	2%	As set out in the government response, the NER for stationary installations in the UK ETS will be set based on the UK's notional share of the NER in Phase IV of the EU ETS. This will be fixed as around 30m allowances over the entire first phase.
Aviation free allocation	3%	As set out in the government response, free allocation to aircraft operators (including special reserve allocation) will be set based on the same methodology applied in the EU ETS but adjusted to reflect only activity on routes within the geographic scope of the UK ETS (see box 2 for more information). In this IA we estimate this equates to around 3% of the overall UK ETS cap.
Auction share	57%	As in the EU ETS, the auction share in the UK ETS will be determined as the sum of allowances remaining from the overall cap once the above pots are populated.

30. Ensuring UK stationary installations and aircraft operators (in respect of the relevant geographic scope) receive the same level of free allocation as they would in the EU ETS is intended to prevent any short-term distortions to competitiveness of these sectors and provide a smooth transition in the early years of the UK ETS.

31. However, as set out in the government response, in recognition of a wide range of stakeholder views during the consultation, we are committed to a review of the UK ETS free allocation policy within the first phase of the system. While any possible changes will need to be considered within the context of transition to a net-zero consistent cap and negotiating a potential linking agreement with the EU, the resulting free allocation and cap split in the UK system may differ to what we have assumed here over the appraisal period.

[18] Figures may not sum due to rounding.

Box 1. UK ETS stationary free allocation approach and assumptions

Mirroring Phase IV of the EU ETS, free allocation to stationary installations in the UK ETS will follow two stages:

Preliminary free allocation

The first stage calculates preliminary free allocation on the following basis:

Preliminary Free Allocation = Historical Activity Level x Benchmark x Carbon Leakage Exposure Factor

Historical activity level (HAL) is the historical production of a given installation per year over a defined baseline period.

The benchmark is a reference value for emissions relative to production activity ('performance'). There are 52 product benchmarks, each representing the average performance of the top 10% most efficient installations for each product. In cases where product benchmarks cannot be determined fallback benchmarks based on fuel consumption, heat consumption or process emissions are used. In our analysis we assume the UK ETS uses the EU ETS Phase IV benchmark values to calculate preliminary free allocation.[19]

The carbon leakage exposure factor (CLEF) adjusts the level of preliminary free allocation depending on whether or not an installation is deemed at risk of carbon leakage.[20] Installations in a sector deemed at risk of carbon leakage have a CLEF of 100%, meaning they receive 100% of their benchmarked preliminary free allocation. Those not deemed at risk of carbon leakage receive a provisional allocation of 30%, reducing to 0% from 2026 to 2030.[21]

Final free allocation

The second stage determines final free allocation to stationary installations by comparing total preliminary free allocation with the industry cap in each year. If total preliminary free allocation exceeds the industry cap any unallocated allowances from previous years and (if needed) allowances from the flexible share are used to 'top up' the industry cap. If this is insufficient to meet total preliminary free allocation a cross sectoral correction factor (CSCF) is used as last resort, which reduces preliminary free allocation proportionately across all stationary installations in line with the industry cap.

In this IA we use BEIS's Free Allocation Model to estimate the level of free allocation we expect UK installations to receive in the UK ETS according to the methodology set out above. We estimate UK preliminary free allocation to be around 56m allowances per year from 2021 to 2024. Relative to the industry cap in these years we do not expect a CSCF to be required. See Annex B for more detail on the modelling approach.

Box 2. UK ETS aviation free allocation approach and assumptions

Aircraft operators will receive the same amount of free allocation in respect to flights on routes included in a UK ETS as in Phase IV of the EU ETS, based on the following calculation:

Free Allocation = Historical Activity Level x Benchmark

As in Phase IV of the EU ETS, the historical activity level refers to tonne-kilometre (tkm) data from 2010, and up to 2014 for those eligible for the special reserve in Phase III of the EU ETS.[22] The geographic scope of the activity level in a UK ETS is limited to the following routes with surrendering obligations:

[19] As set out in the government response, from day one of the UK ETS free allocation will be determined by applying the EU ETS Phase IV benchmarks. The EU Commission will calculate these benchmarks based on Member States' National Implementation Measures (collected in 2019) and will only become available later in 2020. As these values are not yet available, we have relied on proxies in our analysis. See Annex B for more information.

[20] This is based on whether or not the installation is in a sector on the carbon leakage list (CLL), which is based on an assessment of their emissions and trade intensity and other qualitative indicators of carbon leakage risk.

[21] With the exception of district heating installations, which will continue to receive 30% of their benchmarked preliminary free allocation.

[22] For more information on the Special Reserve in Phase III of the EU ETS see: https://ec.europa.eu/clima/sites/clima/files/transport/aviation/docs/faq_special_reserve_en.pdf

- UK domestic flights;
- Flights between the UK and Gibraltar;
- Flights departing from the UK to aerodromes within EEA states;
- Flights departing from the UK to aerodromes in Switzerland (if we reach an agreement with Switzerland);

In line with Phase IV of the EU ETS, no free allocation will be made available for new applicants.

The UK ETS will apply the same aviation benchmark as currently in Phase IV of the EU ETS. It was calculated by dividing the total number of allowances set aside for free allocation (at the time 82% of the EU ETS aviation cap) by the total 2010 tkm of eligible aircraft operators.[23] The current benchmark equates to 0.6422 allowances per 1,000 tkm flown, and will reduce in line with the EU ETS Phase IV linear reduction factor.

In the absence of historical tkm data, in this IA we calculate the amount of free allocation available to aircraft operators by: i) dividing the UK's aviation auction share in the EU ETS by 15% to derive the UK's notional share of the EU ETS aviation cap; ii) multiplying this figure by 85%.[24] This assumes that the UK's notional share of the EU ETS aviation cap is split between free allocation and auctioned allowances in the same proportion as the total EU ETS aviation cap, where 85% of allowances are allocated for free (including allowances from the special reserve) and 15% are auctioned.[25] Based on this approach, we estimate the level of free allocation to be around 4m allowances per year from 2021 to 2024 on average.

Market stability measures

32. The cap in an ETS generally fixes the total volume of allowances in the system for a given period, for the duration of that period (typically a 'phase'). The demand for allowances in an ETS is determined by the amount of effort required to meet the emissions cap over the period. This in turn depends on numerous factors such as wider economic conditions, the impact of other countervailing or complementary policies, technological developments, and strategic market behaviour carried out by system participants (e.g. hedging and borrowing of allowances). [26]

33. Uncertainty over the demand for allowances when setting the cap means that in any year there may be an over- or under-supply of allowances relative to demand in the market, which can result in price falls or spikes (respectively). An undersupply of allowances relative to demand could result in high prices which may negatively impact the competitiveness of businesses within scope (see section on 'business competitiveness' for further consideration). An oversupply of allowances relative to UK participant demand for those allowances could result in low carbon prices and therefore reduced incentives for participants to invest in abatement technologies and permanently reduce their emissions.

34. In the initial years of the UK ETS – particularly within the context of a standalone system – there are several sources of uncertainty. Although participants will have experience of the EU market a standalone UK market will be smaller and its composition different compared to the wider EU market. Moreover, we expect some participants to build up a stock of allowances additional to their demand for compliance within year, to mitigate the risk of allowances prices increasing in future (known as hedging). This is expected to create additional demand for allowances whilst these stocks are built up, which may increase carbon prices in early years. Market expectations over the impact of future UK ETS design changes, and if a link with the EU ETS will become operational, may also influence their behaviour in the short term in ways we cannot predict. It is important that the UK ETS design facilitates price discovery in the initial years of the system,

[23] The calculation was based on aircraft operators' 'full scope' activity, covering all flights within the European Economic Area (EEA), flights departing from airports in the EEA to third countries and incoming flights to airports in the EEA from third countries. Whilst the total amount of free allocation was reduced to reflect the reduced scope of the EU ETS to emissions from intra-EEA flights, the benchmark was held constant.

[24] The UK's aviation auction share is determined by the UK's share of attributed aviation emissions from flights within scope of the EU ETS.

[25] The actual cap split might be different and depends on the relationship between the UK's share of the total EU ETS aviation emissions in 2010 (the basis for calculating a member state's auction share) and its historical activity levels.

[26] Hedging is the practice of purchasing allowances today for use in future years. See section on 'abatement and carbon values modelling' for more detail.

given some of the fundamental changes to the market, while mitigating against the risks of extreme high / low prices and volatility set out above.

35. The Future of UK Carbon Pricing consultation set out a proposal to introduce a rules-based Supply Adjustment Mechanism (SAM) broadly based on the EU's Market Stability Reserve (MSR). A SAM would adjust the number of allowances to be auctioned each year, based on a set of pre-defined thresholds and limits, to help maintain an appropriate supply-demand balance. However, as set out in the government response, a UK specific SAM cannot be operational until 2022 at the earliest due to the necessary data requirements to establish appropriate parameters for the mechanism. A separate consultation on the design and implementation of a SAM will be carried out in future, if required; therefore, we do not include a SAM in this IA.

36. To mitigate extreme high and low price risks, especially in the initial years of the UK ETS, the government response sets out our intention to introduce two transitionary market stability measures – a Cost-Containment Mechanism (CCM) and an auction reserve price (ARP) respectively.

37. As set out in the government response, the UK ETS will introduce a CCM based on Article 29a of the EU ETS (see box 3 below for explanation). However, this CCM will be more reactive in the initial years of the UK ETS in response to feedback from stakeholders in the consultation that the risk of significant short-term price increases may be greater when there is high uncertainty over how markets will behave when they are first created. In 2021 this more reactive CCM would be triggered by a lower price over a shorter time-period compared to the EU ETS CCM, but eventually revert to the same triggers after the first couple of years.

Box 3. CCM process

The CCM ensures that the government maintains the ability to intervene in the market to protect UK industry from the potential negative impact of significant short-term price increases but enables some short-term volatility which is important for market price discovery.

If for more than three consecutive months, prices exceed twice the average carbon price in force in the UK over the previous two years, and this is not due to a change in market fundamentals, the CCM will be triggered. If the CCM is triggered, officials from BEIS, DfT, HMT and the DAs will determine if intervention is necessary and, if so, can intervene by auctioning additional allowances from the following sources:

- Allowances brought forward from future auctions;
- Up to 25% of remaining allowances in the NER;
- Allowances from the UK reserve (populated with allowances unsold at previous auctions (see box 4).

In the EU ETS, the CCM can be triggered if the allowance price is three-times the preceding two-year average price for more than six consecutive months. As set out in the government response, in 2021 the UK CCM will be more responsive – instead triggered if the UK ETS price is two times the preceding two-year average carbon price in force in the UK for more than three consecutive months.

Note: when the system launches in 2021, it is assumed the carbon price in effect in the UK over the two preceding years will have been the EU ETS price. Therefore, the average EU ETS price in 2019 and 2020 will form the initial reference price for the UK's CCM threshold. From 2021 UK ETS prices will begin to feed into the calculation.

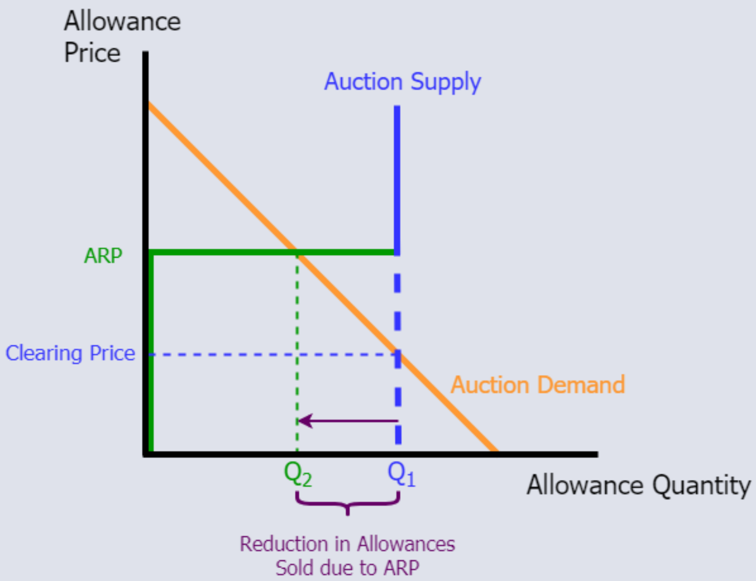
38. Due to limitations in the modelling capability, we are unable to include the potential impacts of the CCM in the quantitative analysis of this IA. However, we do not believe that UK carbon price increases of the scale necessary to trigger the CCM are likely to occur in the early 2020s (see 'abatement and carbon values modelling' section for further consideration).

39. The government response also sets out our intention to introduce an ARP of £15/tCO_2e, which will operate on the basis set out in box 4 below. We recognise the CCC's concern that if there is consistently low demand for allowances relative to the UK ETS cap, this policy could lead over time to the accumulation of a large reserve of unsold allowances. We will consult on how to appropriately deal with these potential allowances, should this occur, alongside our proposals to

amend the cap in light of our net zero commitment, following the CCC's advice on the Sixth Carbon Budget. The level of the ARP will also be reviewed in parallel to determine whether it should remain at the same level, be reduced, or removed over an appropriate transition period.

Box 4. UK ETS auction process and ARP

The ARP ensures a minimum price of allowances at auctions. If the 'clearing price' (determined by the price bid for the last available unit of allowances) is lower than the ARP, the following process as shown below is triggered.[27]



In the absence of an ARP, the market would clear at the 'clearing price', and the full quantity of allowances available at the auction would be sold (Q_1). However, if the ARP is triggered only the volume of allowances bid for at a price greater than or equal to the ARP are sold (Q_2).

Any allowances that remain go unsold (Q_1 - Q_2) are then distributed evenly over the subsequent 4 auctions. If the preceding mechanism results in any single auction having a volume in excess of 125% of its originally intended volume, any allowances above that volume will be added to a reserve.

40. In the quantitative analysis in this IA we assume an ARP consistent with the level set out in the government response of £15/tCO_2e, though noting uncertainty with respect to whether this level will be maintained over the entire appraisal period.

Counterfactual assumptions

41. The counterfactual against which we have appraised the UK ETS represents continued UK participation in the EU ETS. In this scenario, the UK remains a participant in the EU ETS following the end of Phase III, in Phase IV of the system – from 2021 to 2030 (inclusive). This includes continued participation in the aviation sector of the EU ETS, which we assume will operate in its current scope over Phase IV of the EU ETS.[28] This counterfactual represents what would have remained the main policy covering the traded sectors if the UK were to have remained in the EU.

42. The table below summarises the key assumptions we make in this IA with respect to this counterfactual scenario, based on the design of Phase IV of the EU ETS set out in EU legislation[29]:

[27] Note: as set out in the government response, the UK ETS will have an additional auction success criterion whereby the clearing price must not be significantly below the prevailing secondary market price. If the clearing price and ARP are significantly below the secondary market price the auction fails, and all allowances are distributed over the subsequent four auctions as described in box 4.
[28] Note however the same caveats set out in the UK ETS scope section apply here.
[29] See: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:02003L0087-20180408

Table 2. Summary of counterfactual assumptions

Component	Assumption
Scope	The scope of the system captures the same sectors and gases as currently included in the EU ETS. The geographic scope of aviation is assumed to continue to cover all intra-EEA flights over the appraisal period. We therefore assume the same number of UK installations / operators will be within scope of the EU ETS as in the UK ETS in this IA. However we note there is some uncertainty with respect to how the EU will implement CORSIA alongside the EU ETS.
Cap on emissions	We assume the EU ETS Phase IV cap set out in the EU ETS Directive, with a linear reduction factor of 2.2% of the cap in the defined base period applied to the overall cap (including both the stationary and aviation caps) from 2021 onwards.[30] Note: the cap is set across the EU ETS as a whole, rather than individually for each Member State. However, we estimate a 'notional' cap for the UK based on our share of allowances in the system for the purpose of the distributional impacts analysis in this IA (see earlier sections).
Distribution of allowances	We assume the UK's auction share in the EU ETS is around 10% of the total Phase IV auction pot (including aviation). We assume free allocation (including NER allowances) to UK installations and aircraft operators is the same as in the UK ETS scenario. Free allocation to stationary installations and aircraft operators is determined according to the methodology set out in boxes 1 and 2 earlier; and while in reality the NER in Phase IV is one reserve with no constraints on how many allowances individual Member States can receive, for simplicity we assume the UK's share of this based on historical usage of the NER.
Market stability mechanisms	The Market Stability Reserve (MSR) that came into effect in 2019 continues to operate in Phase IV, based on the rules set out in the EU ETS Directive. It is considered in the quantitative assessment. The EU ETS also has a CCM, as set out in box 3 above. However, as with the UK ETS CCM, we cannot model the counterfactual CCM. It is therefore excluded from the quantitative analysis in this IA.

Abatement and carbon values modelling

43. To estimate the main costs and benefits of the UK ETS against the counterfactual in this IA, we first need to estimate the level of abatement and carbon prices (referred to as 'carbon values' in our analysis) we expect to achieve under both scenarios.

44. The following section summarises our methodology for estimating these outcomes in both the UK ETS and counterfactual scenarios. Further detail with respect to our models and key input data and assumptions is provided in Annex B.

Fundamentals approach

45. We estimate carbon values and abatement in the UK ETS and counterfactual scenarios using in-house BEIS models – the UK and EU BEIS Carbon Price Models (BCPMs) respectively.

46. The approach in both models is to start estimating the carbon value in the system by assessing the market fundamentals of each system i.e. comparing the cap on emissions against 'business as usual' (BAU) emissions to determine the amount of abatement effort required to achieve this cap under each policy – also taking into account the operation of the relevant market stability measures we are able to model. For the counterfactual, we take the EU-wide Phase IV cap and compare this against the aggregate of all Member State BAU emissions, also factoring in the operation of the MSR. For the UK ETS scenario, we take the notional minus 5% cap and

[30] See https://ec.europa.eu/clima/policies/ets/cap_en for more information.

compare this against UK-only BAU emissions, also factoring in the operation of the ARP. As set out in earlier sections, we are not able to model the CCM in either scenario.

47. The models then refer to our evidence on the marginal cost of abatement in each system (our marginal abatement cost curves (MACCs)) to identify what abatement measures are undertaken to achieve the level of effort required and estimate the cost of this abatement effort. We assume that participants are rational – the cheapest abatement opportunities are taken up first, and participants abate up to the point at which their marginal abatement costs equal the prevailing market price.

48. The carbon value estimates that therefore result reflects the cost of the last additional unit of abatement required to meet the emissions cap in the system. All else constant, the tighter the cap relative to BAU emissions the more abatement effort undertaken and the higher the carbon value.

49. Note: in the EU BCPM modelling for the counterfactual scenario, abatement effort is determined across the EU ETS as a whole rather than for each individual Member State consistent with how the larger carbon market works in reality. Comparing EU-wide abatement effort against EU-wide MACCs gives us the EU ETS carbon values used in the counterfactual. However to then estimate how much abatement we expect the UK to achieve in this scenario, we read the EU ETS carbon values against our UK-specific MACCs.

50. Given uncertainty over future BAU emissions and MACCs we model a low and high range of abatement and carbon values in the UK ETS and counterfactual scenarios. The low end of the range reflects low BAU emissions projections and corresponding low MACCs, while the high end of the range reflects high BAU emissions projections and high MACCs.[31] Relative to a given cap level, and all else constant, this means that in the low scenario relatively less abatement effort is required to achieve the cap on emissions compared to the high scenario, and the costs of the technologies deployed to achieve this abatement are lower. Therefore, we expect to see less abatement and lower carbon values in the low scenario compared to the high scenario in this IA.

Key behavioural assumptions

51. In reality the behaviour of market participants significantly affects the demand for allowances in each system in addition to the market fundamentals. While it is not possible for us to reflect all features of participants' behaviour in our carbon price models, we do build on our modelling of the fundamentals (described above) by reflecting two key features of participant behaviour in our analysis:

A. **Foresight:** The time horizon that participants use to take a view of the market. In reality, participants' views of future abatement effort required and expected carbon prices will influence decisions today on investment in low-carbon technologies and when it is more cost-effective to abate. In our modelling our foresight assumption smooths demand across the foresight period, meaning carbon value changes are more gradual than they otherwise would be if supply and demand were only considered within a single year. In systems like the EU ETS and UK ETS, where a tightening cap means gradually increasing demand, the impact of this smoothing is also to bring demand forward. All else constant, longer foresight will bring forward more demand from future years resulting in higher values earlier, as well as smoother, more gradual value increases.

B. **Hedging:** The practice of buying allowances forward, i.e. when market participants purchase allowances above the volume needed to cover their surrender obligation at the end of the current year. Participants generally have an incentive to hedge if they expect future carbon prices to increase – purchasing them now can limit their exposure to higher prices later – or to mitigate against uncertainty over future prices. Hedging brings forward demand for allowances and can therefore increase scarcity of allowances in some years and therefore higher carbon values. Conversely, there are conditions where participants might want to wind

[31] Further detail on how we derive this range is set out in Annex B.

down their hedged positions by selling allowances and place downward pressure on the carbon price.[32]

52. The following table summarises what we assume for each of these behaviours in each of the scenarios modelled in this IA.

Table 3. Key behavioural assumptions in the scenarios assessed

	Counterfactual		UK ETS	
	Low	High	Low	High
Foresight period, years	6	10	3	3
Hedging accumulation period, years			3	3

53. Our foresight assumptions attempt to reflect the range of foresight behaviours from different market participants who are likely to act in different ways. In the UK ETS scenario we assume a foresight period of 3 years, compared to a 6 / 10-year foresight period in the counterfactual.[33]

54. A shorter foresight period is modelled in the UK ETS due to an assumption that participants will experience relatively more uncertainty in a new market compared to the more established EU ETS (at least in the initial period modelled in this IA) – as participants familiarise themselves with new market fundamentals and rules. UK participants may also perceive a UK system to be quicker and more susceptible to change than the EU ETS, where changes to the system must be agreed by Member States.

55. In the UK ETS we assume power generators will want to engage in hedging practices similar to their behaviour under the EU ETS. However, in the UK system market participants will start with no hedges and therefore have to accumulate hedging positions. We assume they do this over 3 years, in line with industry insight that hedging strategies may be planned over 3-year rolling periods.[34] In the EU ETS, the power sector already have established hedged positions and therefore the position is ongoing, with future hedging assumptions based on past behaviour.

Key caveat(s): Our modelling relies on:

- Projections of future BAU emissions and marginal abatement costs, which are by their nature subject to uncertainty (and assume perfect rationality among market participants);
- Foresight and hedging assumptions, which although help produce a more realistic model of the UK and EU systems, are subject to uncertainty, do not fully reflect the heterogeneity of market participants, and do not capture the full range of behaviours and dynamics that may influence market outcomes;
- Simplified approximations of the functioning of certain UK ETS design features, some of which we are unable to model at all (such as the impact of the CCM).

As a result, the outputs of our modelling are not necessarily accurate estimates or representations of the actual carbon prices that would prevail in either system, and so should not be interpreted as such. For this reason we refer hereafter to our modelled outputs as ‘carbon values’. For more information see Annex B.

[32] Hedging is a strategy available to all participants seeking to manage their compliance obligations in the most cost-effective way. While there are some known instances of hedging undertaken by energy intensive industrial installations and aircraft operators, in the UK under the EU ETS to date this practice has mainly been observed in the power sector – power generators typically sell electricity forward years in advance, and therefore hedge their emissions allowances (as well as other inputs e.g. fossil fuel requirements) to lock in their costs and guarantee profit margins. As observable hedging behaviour has mainly come from the power generators, the hedging assumptions in our carbon values modelling are confined to this sector.

[33] This counterfactual foresight assumption is based on peer review and internal evidence on the average period typically considered by firms when making investment decisions.

[34] From ICIS EU ETS Portal: https://analytics.icis.com/eu-ets/eu-ets-power-behaviour/

Note: in particular, our projected carbon values in the counterfactual scenario are illustrative for the purpose of comparison against the UK ETS. Outturn EU ETS carbon prices are not fed into our modelling of the counterfactual scenario to ensure methodological consistency – and hence fair comparison – with our modelling of the UK ETS scenario (for which real world carbon prices do not yet exist). For BEIS's official projections of EU ETS carbon values see our Updated Short-Term Traded Carbon Values publication.[35]

Modelling results

56. The following tables summarises the average modelled carbon values and total abatement in the initial years of the UK ETS (from January 2021 to December 2024) relative to the counterfactual over the same period. Note: this abatement represents abatement in addition to abatement delivered by other UK policies in the BAU scenarios.

57. As described above the low-high range for each scenario reflects low and high BAU emissions projections and low and high MACCs. Note: throughout, figures may not sum due to rounding.

Table 4. Estimated average annual carbon values in the UK ETS and counterfactual scenarios, £/tCO2e (2019 prices)

	Counterfactual		UK ETS	
	Low	High	Low	High
Average carbon value, £/tCO$_2$e	3	23	15	32
Difference from counterfactual			+12	+10

Table 5. Estimated total level of abatement in the UK ETS and counterfactual scenarios, MtCO2e (from 2021 to 2024 inclusive)

	Counterfactual		UK ETS	
	Low	High	Low	High
Total abatement, MtCO$_2$e	1	9	4	11
Difference from counterfactual			+3	+2

Counterfactual results

58. In this scenario UK installations / operators within scope are subject to the EU ETS carbon values. Based on the modelling approach and assumptions outlined above (including underlying policy assumptions about the level of the cap and MSR), we estimate average annual carbon values ranging from £3 to £23/tCO$_2$e.

59. At the low end of the range BAU emissions across EU ETS Member States are low and lower than the overall cap on emissions. This suggests there is an over-supply of allowances relative to demand for allowances (even with our 6-year foresight assumption), and in the absence of any market stability measures our model would suggest equilibrium carbon values of £0/tCO$_2$e (as no additional abatement effort would be required to achieve the cap). However, in this IA we take into account the EU's MSR, which reduces the supply of allowances in the system once the total of allowances modelled exceeds the threshold set in the EU ETS. Despite this, at the low end of the range, this has a limited effect and results in carbon values of around £3/tCO$_2$e on average.

[35] Updated Short-Term Traded Carbon Values used for Modelling Purposes: https://www.gov.uk/government/publications/updated-short-term-traded-carbon-values-used-for-modelling-purposes-2018

At around £3/tCO_2e per year, we estimate that it would be cost-effective for UK participants to deliver only 1 $MtCO_2e$ of abatement in total from 2021 to 2024.

60. At the high end of the range, BAU emissions across EU ETS Members States are higher relative to the cap, and participants also take a longer view of the market (see our foresight assumption in table 3) compared to the low end of the range. Annual abatement effort in the system at this end of the range is therefore higher in comparison, which results in higher carbon values (as shown in table 4) of around £23/tCO_2e on average. At around £23/tCO_2e per year, we estimate that it would be cost-effective for UK participants to deliver around 9 $MtCO_2e$ of abatement in total from 2021 to 2024.

UK ETS results

61. In this scenario we estimate an average annual carbon value ranging from £15 to £32/tCO_2e per year from 2021 to 2024, based on the UK ETS design assumptions set out earlier in this IA.

62. At the low end of the range BAU emissions in the UK are lower than the notional minus 5% cap over the entire period modelled. This suggests there is an over-supply of allowances relative to demand. In the absence of any market stability measures, our model would suggest equilibrium carbon values of £0/tCO_2e (as no additional abatement effort would be required to achieve the cap) – even when our hedging and foresight assumptions are taken into account. The main driver of the carbon values at this end of the range in this IA is therefore the introduction of the ARP, which in our model reduces the supply of allowances to the point at which the £15/tCO_2e reserve price is achieved.[36] At this value, we estimate that it would be cost-effective for UK participants to deliver around 4 $MtCO_2e$ in total from 2021 to 2024.

63. At the high end of the range our projected BAU emissions in the UK are higher than at the low end of the range, but still lower than the notional minus 5% cap over the initial period. However, these higher BAU emissions in combination with our hedging behaviour assumptions (described earlier) drive the demand for allowances higher relative to the cap. As a result, additional abatement effort is required to meet the cap level, resulting in higher average annual carbon values (of around £32/tCO_2e) compared to the low end of the range. At this value, we estimate that it would be cost-effective for UK participants to deliver around 11 $MtCO_2e$ in total from 2021 to 2024.

64. Our modelling therefore suggests that a UK ETS – based on the design set out in the government response, combined with it being in its initial years of operation and a relatively smaller carbon market – could lead to higher carbon values compared to if the UK remained in Phase IV of the EU ETS. This in turn suggests UK installations / operators within scope of the policy could be incentivised to deliver more abatement compared to the counterfactual.

Social cost benefit analysis

65. The following sections present consideration of the net costs and benefits to society of the policy scenario compared to the counterfactual. Costs and benefits are considered over an appraisal period of 6 years from 2019 to 2024 (inclusive). While the UK ETS (policy) start year is set as 2021, the appraisal period begins in 2019 to reflect the initial costs associated with establishing the policy (which in the counterfactual are largely already sunk). All values presented are in 2019 prices.

[36] As we cannot model individual auctions in our BCPMs, this approach approximates the way the ARP will work in reality (as set out in box 4). See annex B for more information.

Monetised impacts

Carbon benefit to society

66. The key aim and benefit of the policy is the reduction of GHG emissions. This is achieved by setting a cap on emissions, with a trajectory that decreases the amount of permissible emissions over time. Emissions reductions are achieved by individual installations / operators for whom it is cost-effective to carry out abatement or reduce their output at the prevailing carbon price.

67. To monetise the value to society of the emissions reductions (the 'carbon benefit') achieved in the UK under the UK ETS relative to the counterfactual, we take our estimates for level of abatement in each scenario and multiply this by BEIS's appraisal value of carbon in each year.[37] Note: we use low and high appraisal values respectively in the low and high policy scenarios to reflect uncertainty in the true value of the emissions reductions to society (see caveats below).

Key caveat(s): In our analysis of the carbon benefit in the UK ETS scenario, we expect the abatement delivered under the UK ETS to represent a net change in global emissions, relative to abatement delivered under the counterfactual. In contrast, in the counterfactual we see the 'waterbed effect', whereby for a given EU-wide cap level, additional abatement effort undertaken in the UK does not necessarily result in an overall reduction in emissions across the EU ETS, as other participating countries would be able to emit more.

As BEIS's traded carbon appraisal values are intended simply to reflect the value of redistributing emissions rather than the value of reducing emissions, we determined that the non-traded appraisal values would be a better approximation for the carbon benefit in this IA as they are a better proxy for the social cost of carbon in relation to total global emissions.

However, in the 2020s the current non-traded appraisal carbon values are estimated based on the cost of abatement in non-traded sectors e.g. transport and agriculture, rather than reflecting abatement costs in the traded sectors within scope of the policy appraised in this IA. Annex C presents the main IA results using the traded appraisal values to estimate the carbon benefit to illustrate the sensitivity of the results to this uncertainty.

68. The following table presents the estimated carbon benefit to society in the UK ETS scenario compared to the counterfactual over the appraisal period. As before the low-high range reflects our low and high projections for BAU emissions and MACCs.

Table 6. Estimated carbon benefit in the UK ETS relative to the counterfactual, £m discounted (2019 prices)

	Counterfactual		UK ETS	
	Low	High	Low	High
Carbon benefit, £m discounted	36	916	137	1,078
Difference from counterfactual			+102	+162

69. At both the low and high end of the range, our analysis suggests that the UK ETS delivers a higher carbon benefit to society relative to the counterfactual. This is due to the results presented in table 5, which suggest more abatement will be achieved under the UK ETS compared to in the counterfactual scenario over the appraisal period.

Resource cost to system participants

70. While the policy provides operators with flexibility over how and when they reduce their emissions, we expect that some level of permanent abatement will take place i.e. deployment of

[37] Updated Short-Term Traded Carbon Values used for UK Policy Appraisal: https://www.gov.uk/government/publications/updated-short-term-traded-carbon-values-used-for-uk-policy-appraisal-2018

low-carbon technologies rather than simply reducing emissions by reducing production. In theory this abatement occurs to the extent that the cost is less than or equal to the carbon price in the system. Where the cost of abatement is greater than the carbon price, it is more cost-effective for system participants to purchase allowances to cover their emissions rather than abate.

71. To monetise the resource cost associated with abatement carried out in the policy and counterfactual scenarios we take our estimates for the level of abatement in each scenario and multiply this by the average cost of abatement implied by our MACCs.

Key caveat(s): The carbon values modelled in our analysis reflect the cost of the last unit of abatement required to meet the emissions cap. To estimate resource costs however we need to know the cost of each individual unit of abatement delivered to meet the cap. Limitations in our modelling capability mean we are unable to model individual abatement decisions in our analysis.

Our approximation of the average cost of abatement is also subject to uncertainty as it relies on our MACC evidence and may not reflect the true abatement costs faced by operators. However, to the extent that our MACCs represent our best understanding of available abatement opportunities and associated costs, it is worth noting that their shape (convex) may mean that our approximation of resource costs is an overestimation.

72. The following table presents the estimated resource cost to installations / operators in the policy scenario and counterfactual over the appraisal period. As before the low-high range reflects low and high BAU emissions projections and MACCs, respectively.

Table 7. Estimated resource cost in the UK ETS relative to the counterfactual, £m discounted (2019 prices)

	Counterfactual		UK ETS	
	Low	**High**	**Low**	**High**
Resource cost, £m discounted	3	106	28	165
Difference from counterfactual			+25	+59

73. At both the low and high end of the range, our analysis suggests that the UK ETS leads to higher resource costs to system participants relative to the counterfactual. This is due to the results presented in tables 4 and 5, which suggest higher carbon values and more abatement under the UK ETS compared to in the counterfactual scenario over the appraisal period.

Administrative cost to system participants

74. Administrative costs to system participants are the costs incurred carrying out the administrative activities necessary to comply with the policy. This includes one-off costs such as those associated with setting up a registry account and an installation / operator's monitoring and reporting systems, familiarisation with the policy, and the free allocation process. Installations / operators also face ongoing administrative costs under the policy relating to the monitoring, reporting, and verification of emissions; in addition to the process of surrendering allowances at the end of the compliance year; and participating in allowance auctions and/or trading allowances. Table 8 below sets out the types of costs monetised in the UK ETS and counterfactual scenario in this IA:

Table 8. Summary of key types of administrative costs to system participants

One-off or ongoing cost	Type of cost	Description of cost
One-off	Familiarisation	Familiarisation with the system requirements and determining whether an installation / operator is in scope of the policy. We assume this largely applies to the UK ETS scenario in this IA only as in the counterfactual the EU ETS is already established.
	Initial registration	Application to the system, opening a registry account, and registering on the online system for emitters to manage, verify, and report their emissions. We assume this applies to the UK ETS scenario in this IA only as the counterfactual represents continued UK participation in the EU ETS from Phase III.
	Application for regular free allocation and/or NER allocation	Collection and verification of the necessary data and completion of the appropriate forms to receive free allocation, including participation in the NIMs data collection exercise.
	Other	Other one-off compliance activities.
Ongoing	Monitoring, reporting, and verification of emissions (MRV)	Costs associated with MRV activities including completion of necessary risk assessments and monitoring plans.
	Systems maintenance	Maintenance of monitoring and reporting systems.
	Improvement reporting	Costs associated with improvement reporting.
	Notifications	Costs associated with notifying the regulator of any changes to the installations / operator.
	Information management	Storing information and supporting regulator requests for access to information.
	Surrendering and trading of allowances	Costs associated with the surrendering and trading of allowances throughout the compliance year.
	Other	Other annual compliance activities.
	Voluntary activities	Activities not mandatory to fulfilling the requirement, e.g. meetings.

75. To monetise the total administrative cost faced by participants in the policy and counterfactual scenarios we multiply the number of stationary installations assumed (see paragraph 17) by the average administrative costs that apply in each scenario. These costs come from survey data collected on participants in Phase III of the EU ETS and are supplemented with data from the Environment Agency.[38] The administrative costs faced by aircraft operators are not monetised in the assessment due to limited available evidence of their costs and uncertainty over the number of operators that may be within scope of the policy.

76. Therefore, for the purposes of this analysis, we have assumed that if we sought to negotiate a linking agreement with the EU ETS, we would negotiate a simplified reporting arrangement with the EU where aircraft operators would be administered by one participating country for both their UK and EU ETS obligations, often referred to as a 'one-stop shop' agreement. Under this arrangement, there will be the same number of operators within scope of UK administration as in

[38] Assessment of Costs to UK Participants of Compliance with Phase III of the EU Emissions Trading System: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/799575/Cost_of_Compliance_Report.pdf

the counterfactual. If we cannot secure a 'one-stop shop' agreement, through linking or otherwise, aircraft operators could face higher administrative costs relative to the counterfactual.

Key caveat(s): The cost estimates presented in the Cost of Compliance report are averaged over a sample of survey respondents and may therefore not be an accurate representation of the true administrative costs faced by participants, nor reflect heterogeneity across different installations. The cost estimates are also based on costs incurred during Phase III of the EU ETS and may not reflect any changes in administrative costs over time. Lastly, the analysis does not capture any cost savings that may be realised due to the administrative simplifications we intend to implement in the UK ETS compared to the EU ETS.

77. The following table summarises estimates of the administrative cost to main system participants in the counterfactual and UK ETS scenario. As the administrative cost associated with the policy and counterfactual do not vary with our assumptions about BAU emissions and MACCs, they remain the same across the low and high range.

Table 9. Estimated administrative costs to participants in the UK ETS relative to the counterfactual, £m discounted (2019 prices)

	Counterfactual		UK ETS	
	Low	High	Low	High
Admin. cost to system participants, £m discounted	55	55	58	58
Difference from counterfactual			+4	+4

78. Relative to the counterfactual, our analysis suggests that administrative costs to participants are slightly higher in the UK ETS scenario. This is mostly driven by higher one-off start of phase costs in the UK ETS (largely incurred before the launch of the system in 2021) which are associated with familiarisation and registration with new systems. In the counterfactual, where participants are already in scope of the EU ETS ahead of Phase IV, we assume these costs are already sunk.

Administrative cost to government

79. Administrative costs are also incurred by the government and regulators in designing, setting up, and operating the policy. This includes costs associated with staff pay, activities carried out by the regulators to prepare for delivery of the policy and regulate participants, and the development of the necessary IT systems (including the allowance registry) to support the functioning of the policy. These costs have been estimated using BEIS budget data.

80. The following table summarises estimates of the administrative cost to government in the counterfactual and UK ETS scenarios, which remains the same across the low and high range.

Table 10. Estimated administrative cost to government in the UK ETS relative to the counterfactual, £m discounted (2019 prices)

	Counterfactual		UK ETS	
	Low	High	Low	High
Admin cost to government, £m discounted	9	9	16	16
Difference from counterfactual			+7	+7

81. Table 10 shows that total UK ETS set-up and operation costs to government are estimated to be higher compared to the counterfactual. This difference reflects the additional cost to government in designing a new ETS, both in terms of staff required and the systems that will be needed (such as a UK allowance registry).

Overall Monetised NPV

82. To estimate the net benefit to society of the UK ETS scenarios relative to the counterfactual, we compare the monetised net benefits against monetised net costs from 2019 to 2024 (inclusive), and discount these values to the present day.[39] This gives us the net present value (NPV) of the UK ETS relative to the counterfactual. Table 11 below presents this NPV for low-high range of the UK ETS compared to the counterfactual.

Table 11. Estimated NPV of UK ETS relative to counterfactual, £m discounted (2019 prices)

Impact	UK ETS NPV (relative to counterfactual)	
	Low	High
Total present value of benefits (PVB)	**102**	**162**
Carbon benefit to society	102	162
Total present value of costs (PVC)	**36**	**70**
Resource cost to system participants	25	59
Administrative cost to system participants	4	4
Administrative cost to government	7	7
Total net present value (NPV)	**66**	**92**

83. Our analysis suggests that in its initial years of operation the UK ETS design set out in the government response could deliver a modest net benefit to society compared to continued UK participation in Phase IV of the EU ETS over the same period.

84. We estimate total costs to the government and stationary and aircraft operators within scope of the policy to be higher in the UK ETS compared to the counterfactual due to i) the requirements associated with setting up a new system; and ii) more abatement effort required from businesses within scope under the UK ETS cap. However, for this same reason, we estimate the carbon benefit to society under the UK ETS to be greater than under the counterfactual – and find that the value to society of this additional abatement offsets the additional costs to participants incurred as a result of this additional effort, leading to a positive NPV relative to the counterfactual.

Non-monetised impacts

85. The following section considers other net social impacts of the policy relative to the counterfactual that we cannot monetise robustly in this IA due to modelling limitations.

Air quality

86. Many of the activities within scope of the policy release air pollutants into the atmosphere in addition to greenhouse gases, e.g. combustion of coal releases significant quantities of nitrogen

[39] We discount costs and benefits occurring over different periods of time using the Green Book recommended annual rate of 3.5%: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/685903/The_Green_Book.pdf

oxides (NOx), sulphur dioxide (SO_2), and particulate matter (PM). These air pollutants can have a significant negative impact on human health, well-being, productivity, and the environment.[40]

87. Improvements in air quality could have considerable positive effects on health; according to the World Health Organisation (WHO), there are about 6.5m deaths each year due to air pollution.[41] Particulate matter in the air has been found to be the sixth largest risk factor for global premature mortality, for example due to asthma, diabetes and cardiovascular disease.[42] These impacts on public health directly impose a cost on the NHS and reduce productivity.[43] By implementing emissions reductions policies, such as emissions trading, the UK would be able to realise the health benefits of improving air quality.

88. To the extent that these co-benefits arise in the switch to cleaner technologies and/or more efficient operations in the sectors covered by an ETS, we expect improved air quality in the UK ETS relative to the counterfactual (as we estimate greater emissions reductions over the appraisal period).

Electricity generation mix and security of supply

89. An ETS places a cost on electricity generators who emit carbon through the burning of fossil fuels (such as gas and coal), which, all else held constant, increases the marginal cost of fossil fuel generation relative to low-carbon generation sources such as nuclear and renewables. This can increase the competitiveness of cleaner sources of generation and lead to the displacement of fossil-fuel based generation in the electricity system.

90. However, higher carbon costs on electricity generators could potentially increase the price of electricity relative to other forms of energy, such as gas.[44] This may have a marginal impact on reducing the incentive to switch from gas to low-carbon electricity in sectors such as heating and transport.

91. Furthermore, there are some risks surrounding the impact of higher carbon costs on carbon leakage. All else constant, if fossil fuel generators pass on higher carbon costs to suppliers (who will ultimately pass the costs onto their electricity customers), electricity supply in the UK could become more expensive relative to other countries. If carbon prices are consistently higher in the UK than in other connected markets, this could lead to an increase in electricity imports via interconnectors. If electricity generated in these markets is relatively more carbon intensive than domestic generation, this could result in carbon leakage.

92. As the difference in carbon values between the UK ETS and counterfactual scenarios are relatively small, it is not expected to lead to significant impacts on the electricity market and security of supply. As set out earlier in the IA, it is also worth noting that fossil-fuel electricity generators in the UK currently face the CPS in addition to the ETS price to give a Total Carbon Price (TCP). The CPS component of this TCP could be adjusted over time if desirable to minimise the difference between the carbon price UK electricity generators face compared to competitors in other markets.

Business competitiveness

93. Business competitiveness is the capacity of a firm or sector to gain and maintain a sustainable, profitable market share relative to its competitors in international markets. An ETS can have both downside risks and upside opportunities for the competitiveness of businesses through increased carbon costs. These additional costs can affect the initial conditions that businesses face, and their conduct in response to them (which ultimately determines their market share and profitability). The extent to which carbon costs impact competitiveness also depends on the

[40] The Clean Air Strategy: https://www.gov.uk/government/publications/clean-air-strategy-2019

[41] Energy and Air Pollution, World Energy Outlook Special Report: http://pure.iiasa.ac.at/id/eprint/13467/1/WorldEnergyOutlookSpecialReport2016EnergyandAirPollution.pdf

[42] Reducing Greenhouse Gas Emissions and Improving Air Quality: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5719981/

[43] Co-benefits of Climate Change Mitigation in the UK: https://www.imperial.ac.uk/media/imperial-college/grantham-institute/public/publications/briefing-papers/Co-benefits-of-climate-change-mitigation-in-the-UK.pdf

[44] Energy Use Policies and Carbon Pricing in the UK (page 7): https://www.ifs.org.uk/comms/r84.pdf

market structure they compete in, and whether businesses are able to pass on additional costs to consumers through higher prices or have lower-cost abatement opportunities available. However, it is important to note that carbon costs are only one of many factors which influence business competitiveness as a whole.

94. For emissions-intensive businesses who typically compete on price and in highly globalised markets, their ability to pass on costs may be limited. Holding all else constant, if competitors in other regions do not face similar carbon costs, this could lead to a reduction in their competitiveness and a higher risk of carbon leakage.

95. However, carbon pricing can also motivate firms to change their conduct to exploit upside opportunities for their competitiveness, particularly in the long term. The Porter Hypothesis suggests that carbon pricing policy can incentivise firms to innovate (either in their production methods to reduce their carbon costs or in their product offering to gain additional demand) and lead to productivity benefits. Further, there is potential for positive spill-over arising from an increase in low-carbon investment, driving further R&D and innovation, and potentially increasing the range of decarbonisation options available to hard-to-abate industrial sectors. This is shown empirically, by an up to 10% increase in low-carbon patenting of firms covered by the EU ETS, a measure which is often used as a proxy for innovation.[45]

96. In the aviation sector, including UK flights in a UK ETS has the potential to negatively impact competition in the aviation market, especially if there are substantial differences in the compliance costs incurred by aircraft operators under a UK ETS and the operators under the EU ETS. In particular, UK aircraft operators and airports may face an increase in their costs which could impact their competitiveness, as well as impacting consumers through higher prices if the costs are passed on. However, the impacts are subject to uncertainty, for instance due to the potential changes in the scope of aviation under the EU ETS in the future.

97. In our analysis we estimate carbon values in the UK ETS to be slightly higher compared to the counterfactual over the appraisal period. Combined with free allocation to sectors at risk of carbon leakage in the UK ETS (see 'distributional impacts' section below for further consideration), this suggests we do not expect there to be a significant impact on business competitiveness as a result of the policy in these years.

Larger carbon market impact

98. In the UK ETS and counterfactual scenarios assessed, system participants can purchase allowances either at government auctions or through secondary market trading. System participants whose marginal abatement costs are lower than the prevailing market carbon price can benefit and earn revenue by abating and selling their allowances to other installations / operators whose marginal abatement costs are higher than the market price. Participants whose marginal abatement costs are higher than the market price also benefit as a result of this transfer by purchasing allowances for compliance at a lower cost than reducing their emissions (see 'distributional impacts' section for further consideration).

99. In the counterfactual scenario, it may be that some UK installations / operators benefit from trading allowances with installations / operators in other Member States. This represents a net benefit to the UK – although the size of this benefit depends on the heterogeneity of abatement options in the UK compared to other Member States, and availability of abatement options at the prevailing carbon price in the system.

100. Similarly, in the counterfactual, there could be a net benefit to the UK from selling any unsold allowances at auctions to non-UK market participants for compliance. In the UK ETS scenario assessed however, this benefit (to the extent that there may be any unsold auction allowances in the system) is foregone.

[45] Environmental Policy and Directed Technological Change: http://personal.lse.ac.uk/calel/Calel%20and%20Dechezlepretre%20(2012).pdf

101. Note: with linking we would expect similar benefits of trade to the UK as in the counterfactual. Although the extent of these benefits depends on the potential linked ETS design agreed with the EU, and the relative abatement potential and distribution of allowances in each system.

Wider economic impacts

102. Wider economic impacts can be felt through the fast-growing low-carbon economy; the Clean Growth Strategy suggests that it has the potential to grow at 11% per year from 2015 to 2030.[46] This has had a number of positive spill-overs, including over 10,000 jobs created in the offshore wind sector and significant innovation leading to the UK manufacturing one in five electric vehicles driven in Europe.[47]

103. There is also the potential for a move towards a more circular economy, to improve the efficiency of resource use and improve productivity. If the UK follows the current trajectory of growth in the circular economy, there is the potential for an additional 204,000 jobs in the sector and a reduction of 54,000 in overall unemployment.[48]

Distributional impacts analysis

104. There are some impacts of the policy scenario and counterfactual that are distributional ('economic transfers') rather than having a net economy-wide impact and are therefore not captured in the NPV estimates above. However, they are relevant to consider in ensuring that the policy scenario implemented satisfies our objectives of achieving emissions reductions, while maintaining and boosting the competitiveness of the businesses within scope.

Monetised impacts

Revenue to government / cost of allowances purchased by system participants

105. In both the UK ETS and counterfactual scenarios, value is transferred from businesses to government through the purchase of allowances at auction. Operators whose emissions exceed their free allocation must purchase allowances to cover their surrender obligation. These allowances can either be purchased at auctions or via secondary markets (see paragraphs 114 to 116 below for consideration of the latter). The allowances bought by stationary operators and aircraft operators at auction therefore represent a cost to businesses complying with the policy. However, this cost is 'offset' by the revenues received by the government through selling these allowances at auction.

106. In the UK ETS and counterfactual scenarios, we estimate auction revenue to government by taking the volume of allowances auctioned in each year and multiplying this by our carbon value estimates under each system. As before, the low and high scenarios reflect low and high assumptions with respect to our BAU emissions projections and MACCs (and in turn carbon value estimates).

Key caveat(s): Our estimates of how many allowances are auctioned to (/purchased by) stationary operators and aircraft operators are based on assumptions about the level of free allocation to these operators. However these estimates are subject to uncertainty given the Phase IV benchmarks are not yet known. Moreover, we have relied on an approximation for the level of free allocation to aircraft operators given we do not currently have data on the tkm relevant to the intended geographic scope of the UK ETS.

It is also worth noting that we cannot currently separate out how many allowances are purchased at auction by UK vs EU participants when modelling the counterfactual (given we model the market as a whole).

[46] The Clean Growth Strategy: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/700496/clean-growth-strategy-correction-april-2018.pdf

[47] Co-benefits of Climate Change Mitigation in the UK: https://www.imperial.ac.uk/media/imperial-college/grantham-institute/public/publications/briefing-papers/Co-benefits-of-climate-change-mitigation-in-the-UK.pdf

[48] Employment and the Circular Economy: http://www.wrap.org.uk/sites/files/wrap/Employment%20and%20the%20circular%20economy%20summary.pdf

Implicitly we therefore assume that all allowances auctioned by the UK government under the EU ETS are purchased by UK participants, which may not be the case in reality. As a result, we may be overestimating the cost to UK participants of purchasing allowances for compliance in the counterfactual in this IA.

107. Table 12 below summarises the number of allowances we estimate the UK to auction / expect installations to purchase at auctions in each scenario:

Table 12. Estimated volume of allowances auctioned / purchased in the UK ETS and counterfactual scenarios, millions

	Counterfactual		UK ETS	
	Low	High	Low	High
Total number of allowances purchased / sold, millions	385	385	344	344
Difference from counterfactual			-41	-41

108. Compared to the counterfactual it is also worth noting that we estimate fewer allowances to be auctioned in the UK ETS scenarios for the following reasons:

A. In the UK ETS scenarios, the cap determines the number of allowances in the system and compared to the counterfactual we must account for additional features under the cap – for instance, the NER. (See policy scenario assumptions for more detail on the UK ETS cap.)

B. Relative to our notional cap in the counterfactual, the UK ETS cap modelled is tighter. However, the cap split assumptions set out in table 1 imply that the 5% reduction in the notional cap is achieved by reducing the size of the auction share (while keeping the free allocation pots the same as under the notional cap).

109. Based on the number of allowances we assume to be auctioned, and estimated carbon value in each year, we estimate total revenue to government (/cost to businesses of purchasing allowances at auctions) over the appraisal period in each scenario below:

Table 13. Estimated auction revenue to government / cost to businesses from purchasing allowances at auction, £m discounted (2019 prices)

	Counterfactual		UK ETS	
	Low	High	Low	High
Total revenue / cost, £m discounted	1,047	7,648	4,586	10,201
Difference from counterfactual			+3,538	+2,553

110. At the low end of the range, we estimate auction revenue (/the cost to business) to be higher in the UK ETS scenario in the initial period compared to the counterfactual. This is due to relatively higher carbon values estimated in the UK ETS compared to the counterfactual (as a result of the ARP), which offsets the impact of auctioning fewer allowances overall over the period (shown in table 12).

111. At the high end of the range, we see a similar pattern in the results. While the volume of allowances auctioned in the UK ETS relative to the counterfactual does not change across low and high range (as shown in table 12), the average carbon values do (as shown in table 4). At the high end of the range, we estimate carbon values to be higher on average compared to the counterfactual (and higher than in the low UK ETS scenario) in the early years of the system.

Therefore, while relatively fewer allowances are auctioned in the UK ETS in these years auction revenue (/cost to business) is estimated to be higher than in the counterfactual.

112. While the results above present the overall estimated cost to business from purchasing allowances at auction, different sectors will be impacted to varying degrees:

A. **Power sector:** Power sector installations will not receive any free allocation in the UK ETS (and do not receive free allocation in the counterfactual). As described in earlier sections we expect power generators to manage / attempt to minimise the impact of higher prices through hedging of allowances and potentially adapt their price mitigation strategies compared to in the counterfactual. Further, it is likely that power sector installations may simply pass on higher costs under the UK ETS to end consumers of energy (see 'consumer impacts' section below for more detail).

B. **Industry:** Energy intensive industrial installations will receive the same amount of free allocation in the UK ETS as they would in the counterfactual in the period considered in this IA.[49] Therefore, the main difference between the counterfactual and policy scenarios is the extent to which the effective carbon price faced by installations is higher. We expect this to potentially vary quite significantly across different industrial sectors depending on their emissions, and particularly whether or not they are on the carbon leakage list (and receive 100% of their benchmarked free allocation vs 30% over the period appraised). However, as set out earlier, there is limited evidence to suggest the effective carbon values modelled in the UK ETS compared to the counterfactual will lead to significant costs to industry overall.

C. **Aviation:** Aircraft operators will receive the same amount of free allocation in respect to flights on routes included in the UK ETS as in the counterfactual. As aviation abatement opportunities are limited, higher carbon values will likely result in additional compliance costs to operators to the extent that they have emissions above their free allocation. This is especially true for any new entrants that are not eligible for free allocation. The resulting financial burden of the policy will depend on the ability of the sector to pass on costs to customers (see consumer impacts section below).

Non-monetised impacts

113. The following section considers other distributional impacts of the policy relative to the counterfactual that we cannot monetise robustly in this IA due to modelling limitations.

Secondary market trading between system participants

114. The monetised distributional analysis only captures the economic transfer from businesses to the government through the auctioning of allowances. However, a key feature of the ETS is the ability for a secondary market to form, where participants can trade allowances with each other after the primary allocation. In the secondary market, there will be an economic transfer from operators with high marginal abatement costs to operators with low marginal abatement costs, through the additional purchasing of allowances between participants.

115. In theory, trading will occur until the marginal cost of abatement for each firm is equal to the resulting price of allowances; operators with low marginal abatement costs will pursue emissions reductions until the marginal price of abating is equal to the cost of allowances, whereas operators with high abatement costs will purchase allowances until the price is equal to their marginal abatement cost (while also pursuing some abatement themselves). The resulting price and allocation will ensure that emissions are reduced in the least-cost way.

116. As explained in paragraphs 98 to 101, participants may benefit from a larger carbon market as it allows a more efficient distribution of allowances based on the cost-effective way to decarbonise. Similarly, the secondary market enhances this process, by allowing for participants to buy and

[49] Though, as set out earlier, the planned free allocation review could mean deviation from the Phase IV approach before 2024.

sell allowances among themselves. As the size of the carbon market increases, so does the secondary market and therefore the amount of trading between participants.

Consumer impacts

117. The extent to which consumers are impacted is dependent on whether electricity generators and/or businesses are able to pass on their carbon costs in the form of higher prices.

118. In the current wholesale electricity market, the marginal / price-setting generator is typically a fossil fuel plant (e.g. gas CCGT). As such, any increase in fossil fuel generators' carbon costs are expected to be passed through to energy suppliers (and ultimately electricity customers) via higher wholesale (and ultimately retail) electricity prices.

119. In the case of residential consumers, those who are relatively more electro-intensive (e.g. households with electric heating or an electric vehicle) are likely to be impacted more than average. Higher electricity prices could also increase the depth of fuel poverty. However as we estimate carbon values in the UK ETS scenario to be only slightly higher on average compared to the counterfactual, we do not expect a significant impact on household electricity bills.

120. Non-domestic consumers would also face higher prices if higher carbon costs on electricity generators are passed on. However we expect that in the UK ETS scenario, as in the counterfactual, eligible electro-intensive businesses will continue to receive compensation for the indirect carbon costs associated with the policy (up to 60% of the cost of carbon on wholesale prices).[50] Therefore, we expect the impact of higher carbon values in the UK ETS scenario compared to the counterfactual in this IA on non-domestic consumers to be limited.

121. With respect to the aviation sector, research commissioned by DfT found that there is uncertainty regarding aircraft operators' ability to pass through carbon costs; and that this could vary between non-congested and congested airports, and between passenger and freight flights.[51]

Conclusion

122. Overall, the analysis in this IA suggests that a standalone UK ETS design, as set out in the government response, could deliver a net benefit to society in its initial years, compared with the counterfactual of staying in the EU ETS. The analysis suggests a positive net present value (NPV) to society.

123. The main benefits of the UK ETS scenario, compared with the counterfactual, are the higher carbon benefit of additional abatement and the higher revenue that the government will receive due to higher expected carbon values (partly offset by lower estimated number of allowances purchased). There are also non-monetised benefits, such as an improvement in air quality and switching to a less carbon-intensive energy supply.

124. The main costs of the UK ETS scenario, compared with the counterfactual, are the additional admin costs for the government in setting up the UK ETS and one-off cost to businesses of complying with the new scheme, and additional costs to system participants due to them facing higher expected carbon values under the UK ETS scenario.

125. Our analysis shows that, despite an overall benefit to society of reduced emissions, the costs to businesses of delivering these emissions reductions are higher in the UK ETS scenario than the counterfactual. The degree to which these costs are significant to businesses will depend on a wide range of factors and will vary depending on the characteristics of the business affected and the amount of free allocation that they receive. Further, higher carbon costs in the short term

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[50] UK Industrial Electricity Prices: https://www.ucl.ac.uk/bartlett/sustainable/sites/bartlett/files/uk_industrial_electricity_prices_-_competitiveness_in_a_low_carbon_world.pdf

[51] The Carbon Leakage and Competitiveness Impacts of Carbon Abatement Policy in Aviation: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/763260/carbon-leakage-report.pdf

could benefit businesses through an increased incentive for more innovation and investment in low-carbon technologies, which will improve their long-run competitiveness.

126. However, the results of this analysis are largely driven by our assumptions for how UK participants will behave in the early years, over which there is significant uncertainty. In the initial years of the UK ETS scenario, we have assumed that participants will build up hedged positions, i.e. buy allowances now to reduce exposure to increases in the carbon price later. This increases demand for allowances, and therefore carbon values, in our modelling of the UK ETS scenario compared with the counterfactual. In reality, the extent to which hedging accumulation and abatement will occur is uncertain. In the longer term, after participants have built up their hedges, the fundamentals of the system (i.e. the relationship between BAU emissions and market design) become more important in our modelling.

127. In the longer-term, comparing the notional minus 5% cap against our BAU emissions suggests that without a further tightening of the cap, the carbon benefit in the UK ETS could be lower than the counterfactual. However, it is likely that the advice from the CCC on the cap necessary to reach Net Zero will lead to a tightening.

128. As set out in the government response, our intention is to launch a standalone UK ETS which is independently viable but would have the ability to link with the EU ETS. The UK would be open to considering a link between any future UK ETS and the EU ETS (as Switzerland has done with its ETS) if it suited both sides' interests. Any such agreement would need to recognise both parties as sovereign equals with our own domestic laws.

129. Further, we are committed to a number of reviews of the UK ETS following the launch of the system. The aim of the reviews is to ensure the UK ETS continues to be fit for purpose and meet its policy objectives. The initial reviews include a review of the cap and trajectory, the free allocation methodology, and market stability mechanisms. These will be reviewed in the context of our Net Zero ambition and the status of linking negotiations. The first substantive review will be conducted from 2023 and will assess the performance of the system as a whole during the first half of the phase. Any necessary changes will be implemented for the second half of the phase. To ensure a high-quality evidence base for these reviews, and to support future policy decisions, we will implement a monitoring and evaluation framework for the launch of the UK ETS.

Annex A – Wider impacts

Small and micro business assessment

130. As set out earlier in the IA, the main costs to businesses in the policy scenario will be those associated with undertaking abatement and/or purchasing allowances to cover their emissions. Businesses will also incur administrative costs associated with compliance with the policy. These impacts are described further in paragraphs 70 onwards and 105 onwards.

131. Relative to the counterfactual we estimate the costs to businesses to be higher in the UK ETS scenario due to higher carbon values (as shown in table 4). For many businesses exposure to these carbon values will be limited as they receive free allocation of allowances. However, the level of free allocation received varies significantly depending on the type of operator.

132. We do not however expect there to be any disproportionate impacts on small and micro businesses, as the UK ETS will offer exemptions to small emitters, ultra-small emitters, and hospitals (the 'opt-out schemes'). These policies provide cost savings to these emitters as they are not required to purchase and surrender allowances or carry out other administrative activities associated with the main UK ETS policy.[1] Equivalent exemptions and simplified reporting provisions will also be in place for small aircraft operators. As the UK ETS will mirror and maintain the same criteria for eligibility for these opt-outs as in Phase IV of the EU ETS, we do not expect small emitters to be significantly affected compared to the counterfactual.

Trade and investment assessment

133. As set out earlier in the IA an increased carbon price differential with the EU and other jurisdictions globally may impact business investment and UK trade flows. As set out in paragraphs 93 to 97 there are both upside opportunities and downside risks to UK trade and investment.

134. Relative to the counterfactual, we do not expect any significant difference in the impacts on trade and investment in the policy scenario. However, we do acknowledge that increasing the environmental ambition of the system in the policy scenario is expected to lead to increases in the price of allowances relative to the counterfactual. As a result, some businesses may face higher direct and indirect carbon costs relative to countries with less stringent carbon policies.

Equality impact assessment

135. Relative to the counterfactual, we do not believe the policy will have a direct disproportionate impact on groups with protected characteristics as defined in the Equalities Act of 2010. This is because the policy is not expected to incur a direct cost on these groups, even if it becomes more environmentally ambitious.

[1] For a more detailed assessment of the impact of the small and ultra-small emitter opt-out schemes see: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/843605/continued-uk-membership-euets-phase-iv-response-impact-assessment.pdf

Annex B – Note on BEIS's models used in this IA

Background to BEIS's carbon price models

136. In 2013 BEIS constructed the EU BEIS Carbon Price Model (BCPM) to project carbon values in the EU ETS. These are primarily used for the purpose of appraising policies that applied to UK sectors within scope of the EU system.

137. The model uses a primarily fundamentals-based approach to estimate EU ETS carbon values, based on the design of the EU ETS in Phase III and IV (see 'modelling methodology' section below for more information). The model is updated annually, with a major update in 2017 to incorporate a module to represent the effects of the EU ETS Market Stability Reserve (MSR). The assumptions used in the model were reached following peer review in 2014. A subsequent peer review in 2017 confirmed that the model assumptions were still appropriate, and the model has been through BEIS's formal quality assurance and sign-off process. This IA uses the 2018 version of the model.

138. A UK-only version of the model (the UK BCPM) was developed in 2018 for the purpose of supporting policy development on the design of a UK ETS from its projected launch in 2021.

139. This model was based on the 2017 version of the well-established EU model, and largely follows the same methodology. The UK BCPM underwent substantial development in 2019, consistent with BEIS's standard for quality assurance and modelling best practice. The 2019 update added new functionality, allowing the modelling of an auction reserve price (ARP), and updated hedging assumptions in line with the new 2019 'business as usual' (BAU) emissions trajectories.

140. The following sections provide more detail on the methodology used by both models to produce carbon values in the EU and UK ETSs, the key inputs assumptions that influence the model outputs, and some of the key risks and limitations of the models.

Modelling methodology

Fundamentals

141. The approach in both models is to start estimating carbon values by assessing the market fundamentals of each system i.e. comparing the cap on emissions against BAU emissions to determine the amount of abatement effort required to achieve this cap under each policy. For the counterfactual we take the EU-wide Phase IV cap and compare this against the aggregate of all Member State BAU emissions. For the UK ETS scenario we take the notional minus 5% cap and compare this against UK-only BAU emissions.

142. The models then refer to our evidence on the marginal cost of abatement in each system (our marginal abatement cost curves (MACCs)) to identify what abatement measures are undertaken to achieve the level of effort required, and then estimate the cost of this abatement effort. We assume that participants are rational i.e. the cheapest abatement opportunities are taken up first, and participants abate up to the point at which their marginal abatement costs equal the prevailing market price.

143. The carbon value estimate that therefore results reflects the cost of the last additional unit of abatement required to meet the emissions cap in the system. All else constant, the tighter the cap relative to BAU emissions the more abatement effort undertaken and the higher the carbon value.

144. Note: in the EU BCPM modelling for the counterfactual scenario, abatement effort is determined across the EU ETS as a whole rather than for each individual Member State consistent with how the larger carbon market works in reality. Comparing EU-wide abatement effort against EU-wide MACCs gives us the EU ETS carbon values used in the counterfactual. However to then estimate

how much abatement we expect the UK to achieve in this scenario, we read the EU ETS carbon values against our UK-specific MACCs.

Market behaviour

145. To go beyond a purely fundamentals-based approach, assumptions around market behaviour have also been included in the models to simulate market interactions when estimating the demand for allowances. In modelling the counterfactual and policy scenario in the IA, such assumptions include market foresight, hedging behaviour, cost of carry and banking and borrowing of traded allowances. These assumptions (summarised in table 1 below) are based on our best understanding of existing market behaviour in the EU ETS and how this may change under a UK ETS scenario.

Annex B Table 1. Summary of key EU and UK BCPM input assumptions and sources

Input	EU BCPM	UK BCPM
BAU emissions	Enerdata POLES model outputs (2018) for EU28 as a whole.	Enerdata POLES model outputs (2019) for UK only.
MACCs	Same as above to produce EU ETS carbon value projections; however 2019 UK specific MACCs used to determine UK abatement effort in the EU ETS in the counterfactual.	Same as above.
Foresight period	6 to 10 years; this is based on a 2014 methodology peer review by Dr William Blyth and internal evidence on the average period typically considered by firms when making investment decisions.[1]	3 years; this assumption was developed for the UK BCPM for the purpose of this analysis to reflect participant uncertainty in a new market and perception of the possibility for changes to be made to the system more easily / rapidly compared to the EU ETS.
Hedging ratio	Around 45% of the EU ETS cap (excluding aviation); this is based on assumption of 833m allowances hedged in 2019 in line with the EU ETS MSR design.	Around 140% of annual power sector BAU emissions. Hedging practices are considered commercially sensitive and not generally made public. ICIS publishes assumptions on historic hedging activity by the UK power sector in the EU ETS.[2] According to these assumptions the UK power sector collectively hedges around three years in advance, according to the following pattern: ~80% hedged for year x+1, ~40% hedged for year x+2, ~20% hedged for year x+3. Together (years x+1 to x+3) this amounts to a total hedge of ~140%.
Hedging position accumulation	N/A; in the EU BCPM from 2021 onwards we assume hedged positions are already accumulated.	3 years; this assumes that the power sector would attempt to build new hedges in a UK ETS over several years, as there are not enough allowances issued annually to allow them to do it in one year. According to ICIS analysis the UK power sector plans their hedging strategy over 3 years prior to delivery.
Cost of carry	3.8 to 8%; in the low scenario this is based on the average convenience yield implied by the traded futures in 2013-2015. The high scenario is based on recommendation from the 2014 methodology peer review by Dr William Blyth.	3.8% in both high and low scenarios. As the UK ETS will be a new market and there is no observable indication of what the cost of carry will be, a cautious approach was adopted to assume the same cost of carry as in the low scenario of the EU BCPM.

[1] See https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/359708/Peer_review_William_Blyth.pdf
[2] ICIS, EU ETS Portal: https://analytics.icis.com/eu-ets/eu-ets-power-behaviour/

Banking and borrowing	Assumed that banking and borrowing are allowed and there is no 'time-stamping' of allowances. While EU ETS policy does not allow borrowing across phases our simplified modelling does not introduce this constraint.

Market stability mechanisms

146. In both the EU and UK ETS certain design features exist to provide stability to the market. These mechanisms when triggered directly influence the volume of allowances in the market and consequently the carbon values that prevail. As set out earlier both the EU and UK BCPM attempt to incorporate these design features when projecting carbon values in each system. The following section provides more detail on how these features are modelled.

147. In the EU BCPM we simulate the functioning of the Market Stability Reserve (MSR), introduced in the EU ETS from 2019 onwards. This mechanism is essentially designed to withdraw / return a certain volume of allowances from / to the market when the total number of allowances in circulation crosses a maximum / minimum threshold.[3]

148. In the model the MSR is designed according to the parameters set out in the EU ETS Directive and runs as a loop process. The pre-MSR carbon value is used with the MACCs to establish the level of abatement in each year. Given the level of abatement, the model revises future emissions estimates. From these new figures, the model produces a surplus trajectory to the end of the period. The supply of EUAs on the market is revised to account for the operation of the MSR; EUAs are withdrawn from the market when the surplus reaches a certain threshold and returned to the market when the surplus falls below a certain threshold. By removing / returning allowances the MSR adjusts the EU ETS cap. The new EU ETS cap is then used in the EU BCPM to produce a new carbon value trajectory that corresponds to the MSR-based cap. The new post-MSR cap is then fed back into the model (as the cap input) and values are 'looped' and re-estimated on this basis.

149. In the UK BCPM we simulate the functioning of the ARP, to be introduced as a transitional measure from day one of the system. As described earlier in the IA, the ARP sets a minimum price at which allowances can be sold at auctions, and any unsold allowances as a result are either rolled forward into the next 4 auctions or placed in a reserve.

150. In the model, we cannot simulate individual auctions and so represent the impact of the ARP on carbon values using the following methodology. The UK BCPM calculates the number of allowances which are assumed to be unsold, by comparing the target ARP to the corresponding carbon value in our MACCs. Using this, it determines the annual effort needed to achieve that value (in $MtCO_2e$ of abatement). This annual effort value is then used to calculate the annual supply need to achieve the ARP. Finally, the number of allowances is calculated and is annually adjusted to be equivalent to the annual supply needed to achieve the ARP. These allowances are assumed to go unsold and placed into the UK reserve.

Business as usual (BAU) emissions

151. BAU emissions aim to capture expected emissions in the absence of the carbon pricing policy that aims to limit them i.e. the EU ETS or UK ETS. The BAU emissions used in our BCPMs are developed by external energy intelligence consultants Enerdata, using their Prospective Outlook on Long-term Energy Systems (POLES) model. The modelling assumptions used to determine these emissions projections are developed in collaboration with a cross-government steering group.

152. Emissions in the BAU scenarios are considered as a baseline and change over time with technological or behavioural change, and other current and committed future UK and EU policies which also affect decarbonisation. BAU emissions are influential in modelling both the EU ETS in the counterfactual and UK ETS scenarios: as BAU emissions set the baseline against which we

[3] The EU ETS Directive sets these thresholds as 833m allowances for withdrawal, and 400m allowances for return. Any backloaded or unallocated allowances are also placed in the Market Stability Reserve (MSR).

consider abatement required to meet the cap level, the higher the BAU emissions the more effort is required to reduce emissions in line with the cap.

153. In the 2018 version of the EU BCPM (used in this IA for modelling carbon values in the counterfactual) we use low and high 2018 BAU emissions projections aggregated across all EU ETS Member States. This low-high range reflects uncertainty around our projections of future economic growth and fossil fuel prices. The assumptions underpinning this low-high range are given in table 2 below, however note that any considerable change, such as a recession (or economic boom) leading to much lower (or higher) than expected emissions could fall outside of this range.

Annex B Table 2. Drivers of the 2018 low and high BAU projections used in the EU BCPM

BAU scenario	Fossil fuel price assumptions	Economic growth assumptions
Low	High coal, low oil prices and low gas prices	Low economic growth (-0.5% from central)
High	Low coal, high oil prices and high gas prices	High economic growth (+0.5% from central)

154. Common assumptions across all BAU scenarios include the following:

A. Non-traded sector emissions reduction target: 30% reduction by 2030 compared to 2005 in line with EU targets.[4]

B. 2020 renewables and energy efficiency are consistent with the National Renewable Energy Action Plans (NREAPs) for each of the EU member states.[5]

C. The 2030 EU renewables and energy efficiency targets[6] – 27%. After 2030 we assumed that support to renewables / energy efficiency continues along a historical trend.

D. Carbon Capture and Storage (CCS) capacity levels are compatible with International Energy Agency's Energy Technology Perspectives report. [7]

E. It is assumed there is no carbon price (equivalent to a carbon price of zero) in BAUs from 2018 onwards.

F. Nuclear capacities for the UK were approximated using Enerdata's capacity plans database Power Plant Tracker which tracks commissioning dates for planned projects. This includes examples such as Hinkley Point C coming online.

G. Although BAUs do not explicitly capture UK specific climate policy such as Contracts for Difference, there will be some overlap with this and EU wide targets as described above.

155. In the UK BCPM however we use UK-specific BAU emissions projections updated in 2019 and calibrated to BEIS's latest (2018) Energy and Emissions Projections (EEP) for 2020, 2025 and 2030 for the power and industrial sectors within scope of the UK ETS.[8] Future BAU emissions levels (for other years and up to 2050) are the result of the calibration to the EEP scenario for those 3 years.

156. The EEP emissions projections that were used in the calibration of BAU emissions for the model reflect our best available evidence on future traded sector emissions. They are based on policy analysis from July 2018 and modelling from September 2018 and assume a zero traded carbon value from 2020 to 2030. The projections reflect how the UK energy and emissions system could evolve under implemented, adopted and agreed UK Government policies if no

[4] See https://ec.europa.eu/clima/policies/strategies/2030_en

[5] See https://ec.europa.eu/energy/en/topics/renewable-energy/national-renewable-energy-action-plans-2020

[6] See https://ec.europa.eu/clima/policies/strategies/2030_en. Targets revised upwards to 32% and 32.5% respectively after model development.

[7] See https://www.iea.org/etp/

[8] https://www.gov.uk/government/publications/updated-energy-and-emissions-projections-2018

new policies or changes to existing policies were introduced.[9] This means that their construction differs from the 2018 EU ETS data used for previous EU ETS BAU emissions because the EEP data are UK-specific, reflect UK policies and use UK sources, whilst the 2018 BAU emissions were not based on EEP but uses sources from which data are available across the EU ETS. However one key similarity is that the 2018 EEP is based on the EU ETS for the traded sector as this is current government policy.

157. Unlike the 2018 BAU emissions projections used in the counterfactual, the low-high range for these BAU emissions is driven solely by our future fossil fuel price assumptions (updated for 2019).

Marginal abatement cost curves (MACCs)

158. Marginal Abatement Cost Curves (MACCs) aim to capture the quantity of abatement available at a given carbon value across sectors within scope of the EU or UK ETSs. The low and high MACCs used in our BCPMs are also provided by Enerdata and developed using the POLES model, and correspond to the low and high BAU emissions projections described above.

159. MACCs influence the results of carbon value modelling in both the counterfactual and UK ETS scenarios as they provide the cost of delivering the required amount of abatement effort under each policy. For a given level of abatement effort, the low and high MACCs result in different abatement opportunities available at the same price point and therefore lower or higher (respectively) carbon values.

160. In the POLES model, the MACCs are produced by exposing all sectors in the economy to a single carbon value in a given time horizon and comparing the emissions level that results to a scenario with no carbon value (i.e. the BAU scenario). Abatement potential is the result of the POLES model dynamic, which is sector-specific and centred on technology data (costs, equipment lifetime), prices (fuel prices, and price-based energy and climate policies outside of the carbon price) and modelling parameters (e.g. price elasticities in econometric-type equations in certain sectors).

161. For each BAU scenario, following the creation of the aggregated sectoral MACCs, mitigation options underlying the emission reductions are provided. These options are activity-related (e.g. decrease of electricity demand induced by higher prices) or technology-related (e.g. different competition environment for certain heating fuels, increased competitiveness for non-emitting technologies, increased stimuli for efficiency measures).

162. Technology costs come from the International Energy Agency’s World Energy Outlook and the Université de Grenoble’s TECHPOL database. New capacities are calculated depending on the competition between electricity generation technologies, in particular on their relative costs. MACC generation considers average power plants per technology type and incorporates a decommissioning process throughout time, at a regular rate over the lifetime of these average plants. Learning rates and research and development per technology are based on International Energy Agency and TECHPOL estimates.

163. Note: as set out in the modelling methodology section, to estimate the level of abatement achieved in the counterfactual we use the 2019 UK-specific MACCs. These MACCs are not consistent with the EU wide BAU emissions projections and MACCs used to estimate the carbon values in the counterfactual – primarily due to the difference in fossil fuel price and economic growth assumptions in the 2019 update compared to 2018. For the IA analysis, we did not consider it proportionate to update the 2018 EU wide BAU emissions projections and MACCs for consistency with the UK-specific 2019 projections; and based on previous updates provided by Enerdata we do not expect this difference in assumptions to significantly drive the counterfactual carbon value results. However, we have used the 2019 UK-specific MACCs (and BAU emissions projections) in the IA as these represent the best available evidence of traded sector abatement potential in the UK.

[9] Agreed policies are at the point where policy-specific analysis has been published with sufficient detail for inclusion in the EEP.

Background to BEIS's stationary free allocation model

164. BEIS's free allocation model was created in 2015 to support the development of the EU ETS Phase IV Free Allocation Rules for the stationary sector. The version of the model used in this IA was updated in 2018 and adapted (consistent with BEIS's standard for quality assurance and modelling best practice) to support UK ETS policy development.

165. The model estimates free allocation to UK and EU stationary sectors (at NACE 4 level) in a UK ETS / Phase IV of the EU ETS based on the policy design set out in box 1 earlier in this IA.[10] As set out in more detail below, due to data limitations at the time it was developed, the model relies on proxies for benchmarks and HAL, which are key variables in calculating free allocation.[11] More detail on how we derive estimates for these variables and the overall modelling approach is set out below.

Modelling methodology

Historical activity level (HAL)

166. There is no publicly available data for production volumes by NACE 4 code and therefore the free allocation model uses verified emissions data from the EU Transaction Log as a proxy. To estimate HAL for the 2014 to 2018 (and 2019 to 2022) baseline period for Phase IV free allocation in the first (and second) allocation period(s), we take 2013 verified emissions for each sector and multiply these by sector-level production growth rates in each year. These production growth rates are provided by the ICIS for the EU on average and the UK specifically; however do not disaggregate to NACE 4 level. We therefore make a simplifying assumption that assumes each sub-sector grows at the same rate, which in reality may not necessarily be the case.

167. Note: production growth rates are used rather than emissions growth rates to remove any impact of efficiency gains. As free allocation is based on a benchmark (tCO_2e per tonne of product) applied to production (tonnes) any change in emissions due to efficiency will not lead to a corresponding change in free allocation. i.e. if for an industry, production is expected to grow by 5% but efficiency is expected to grow by 3% and therefore emissions grow by only 2%, using emissions growth rates will underestimate the volume of free allocation required.

168. Once HAL is estimated in each year based on the approach set out above, the average over the relevant baseline period is calculated. This is then multiplied by the relevant proxy Phase IV benchmark (see below) to estimate preliminary free allocation to each sector.

Benchmarks

169. As the EU ETS Phase IV benchmarks are not yet available, nor available at NACE 4 level, the free allocation model relies on a proxy methodology and values. The starting point for this methodology is estimating proxy Phase III benchmarks from the formula used to derive Phase III free allocation. Using actual free allocation from the EU Transaction Log, stripping out the cross sectoral correction factor (CSCF) that was applied in Phase III, and the carbon leakage exposure factor (CLEF) applied (as set out in the EU ETS Directive), and dividing by proxy HAL over the relevant baseline period, we derive the proxy benchmark. I.e. for each NACE 4 sector performing the following calculation:

Proxy benchmark = Final Phase III free allocation / CSCF / CLEF / proxy HAL

170. Once the proxy Phase III benchmark is derived, the model uses the minimum and maximum benchmark ratchets set out in the EU ETS Directive to estimate the proxy Phase IV benchmark.[12]

[10] For more information about NACE codes see: https://siccode.com/page/what-is-a-nace-code

[11] It is worth noting that checks of the 2015 version of the model carried out with the European Commission, and comparison of outputs of the 2018 version of the model against the UK's initial Phase IV NIMs return, suggest the model may tend to overestimate total free allocation.

[12] Note: before the Phase IV benchmark ratchets are applied, we adjust the proxy Phase III benchmarks to correct for instances of missing data and/or significant outliers so as not to bias the results.

For benchmarks that will apply in the first allocation period of the EU / UK ETS, these ratchets range from a 0.2% to 1.6% annual reduction on the Phase III benchmark to the mid-point of the first allocation period – implying a possible 3% to 24% reduction on the Phase III benchmarks. In reality the ratchets for the Phase IV benchmarks will likely lie somewhere in between this range. However as the free allocation model estimates free allocation based on NACE sector classifications (rather than on a product or input basis as in reality), and we do not yet know how the ratchets will vary by sector, we assume an average ratchet of 0.9% and apply this to each proxy Phase III benchmark.

171. Once these proxy Phase IV benchmarks are calculated, for each sector the free allocation model multiplies these by proxy HAL to begin calculating preliminary free allocation.

Carbon leakage

172. The carbon leakage exposure factor (CLEF) that applies to a sector depends on whether or not that sector is on the EU's carbon leakage list. For Phase IV this carbon leakage list has already been determined and published.[13] The model references this list directly and applies the appropriate CLEF to the sector's benchmarked free allocation: in the first allocation period of the EU ETS / UK ETS, if the sector is on the carbon leakage list it is considered at risk of carbon leakage and receives a CLEF of 100% in the model; otherwise a CLEF of 30% is applied.

173. In the model this is the last step applied to estimate preliminary free allocation.

Final free allocation

174. To determine final free allocation to UK and EU installations in the policy and counterfactual scenarios the model follows the same process set out in box 1 earlier in this IA. Total preliminary free allocation is compared to the industry cap in each year (on a UK-only or EU wide basis depending on the relevant scenario). If total preliminary free allocation exceeds the industry cap any unallocated allowances from previous years are first used to 'top up' the industry cap. Once these allowances are exhausted, the model uses allowances from the flexible share (taken as 3% of the UK ETS or Phase IV cap as appropriate) to top up the industry cap. If this is still insufficient to meet total preliminary free allocation, the model applies a cross sectoral correction factor (CSCF) to reduce preliminary free allocation proportionately across all stationary installations in line with the industry cap. If preliminary free allocation at any point before this stage does not breach the industry cap, the model sets final free allocation equal to preliminary free allocation.

[13] https://ec.europa.eu/info/law/better-regulation/initiative/1146/publication/535145/attachment/090166e5c192d10e_en

Annex C – Note on BEIS's appraisal carbon values

175. This annex sets out in more detail the rationale for the appraisal values of carbon used in the main cost benefit analysis of this IA, in addition to the results of sensitivity analysis carried out around these values.

Background

176. The purpose of assigning a value to the greenhouse gas emissions that arise under potential government policies is to allow for a more objective, consistent, and evidence-based approach to determining whether policies should be implemented. Carbon values are used in the framework of broader cost benefit analyses to assess whether, considering all relevant costs and benefits (including impacts on climate change), a particular policy may be expected to improve or reduce the overall welfare of society.

177. BEIS's appraisal values of carbon are derived using a target-consistent approach, based on estimates of the abatement costs that will need to be incurred to meet specific emissions reduction targets – the main long-term target (on which the values are based) being our duty under the Climate Change Act to reduce greenhouse gas emissions by 2050 by 80% on 1990 levels.[1] Under this approach for deriving appraisal values, the valuation methodology differs according to the specific policy question being addressed[2]:

A. **Traded appraisal values:** For appraising policies that reduce / increase emissions in sectors covered by the EU Emissions Trading System (ETS), and other future trading systems, a 'traded price of carbon' will be used. This will be based on estimates of the future price of EUAs and, in the longer term (2030 and beyond), estimates of future global carbon market prices. This reflects the fact that in an emissions trading system, for a given level of emissions reductions, abatement effort in one part of the system results in a need for less effort elsewhere and therefore no net change in global emissions as a result of the policy under appraisal.

B. **Non-traded appraisal values:** For appraising policies that reduce / increase emissions in sectors not covered by the EU ETS (the 'non-traded' sector) a 'non-traded price of carbon' will be used, based on estimates of the marginal abatement cost required to meet a specific emission reduction target. These values therefore reflect the value of a net change in emissions, rather than the value of redistributing emissions.

Rationale for the values used in the main cost benefit analysis

178. In the main economic appraisal in this IA, the non-traded appraisal values of carbon have been applied in estimating the carbon benefit to the UK of emissions reductions under the policy scenario relative to the counterfactual.

179. The reasoning for this relates to how global emissions would be impacted from the UK moving from one ETS to another. Within the EU ETS, once the EU ETS cap is set, there is no direct net change in global emissions as a result of UK action in the traded sector – the only change is how many allowances the UK buys and sells, i.e. how the emissions reduction effort is distributed across the EU.

180. However, if the UK moved from the EU ETS to a standalone system, it is likely that there will be a net change in global emissions, as UK action will no longer be offset by other EU Member States.

[1] We acknowledge that the UK has since revised its target domestic and international climate ambition and legislated for a new 2050 target of net-zero emissions across the UK economy. We are currently planning a review of BEIS's appraisal values given this new context.

[2] Note from 2030 onwards, the two sets of values converge into a single traded price of carbon, on the assumption of development of a more comprehensive global carbon market.

Therefore, this change should be valued using the non-traded appraisal values as it is a closer proxy for the social cost of carbon and will better estimate the impact on global emissions and our long-term decarbonisation targets.

Sensitivity analysis

181. While the non-traded appraisal values are judged on balance to be the most appropriate for the appraisal in this IA, there are two key uncertainties:

A. **Global emissions as a result of the UK leaving the EU ETS:** Within the context of the UK leaving the EU ETS and implementing a UK system, there is uncertainty over how the EU might adjust the level of ambition in the EU ETS in response. It may be possible for the level of ambition set across both independent systems to result in no net change in global emissions compared to the counterfactual of continued UK participation in the EU ETS. If this were the case, the traded carbon appraisal values would be considered most appropriate for valuing the societal benefit of the emissions reductions modelled. However, we do not consider this response to be credible in the context of the EU's decarbonisation ambition.

B. **How the non-traded appraisal values are calculated:** Before 2030, the non-traded appraisal values of carbon are based on the cost of abatement in the non-traded sectors, e.g. transport and agriculture. These values do not reflect abatement costs in the traded sector to which the policy we are appraising applies.[3]

182. As a result, we carry out sensitivity analysis on the carbon benefit results to test the impact of using the traded rather than non-traded appraisal values. The table below summarises the difference in estimated carbon benefit we see as a result:

Annex C Table 1. Sensitivity of the carbon benefit to the appraisal values of carbon, £m discounted (2019 prices)

	Counterfactual		UK ETS	
	Low	High	Low	High
Carbon benefit (traded values), £m discounted	14	471	43	501
Carbon benefit (non-traded values), £m discounted	36	916	137	1,078
Difference in carbon benefit between traded and non-traded values	-22	-445	-94	-575

183. The traded appraisal values of carbon are generally lower than the non-traded appraisal values. As shown in table 1, using the traded appraisal values results in a lower carbon benefit in both the policy and counterfactual scenarios compared to using the non-traded appraisal values.

184. The following table summarises what impact this has on the overall NPV results:

[3] Note however that these values are consistent with the 2050 target on which the rest of the appraisal value series is based (2030 and beyond), unlike the 2020 traded appraisal values that simply reflect the EU ETS market price. As mentioned earlier, this 2050 target is consistent with the UK's original commitment under the Climate Change Act to reduce UK emissions by 80% on 1990 levels rather than the UK's net zero target. We are currently planning a review of the appraisal values now that the UK has increased its domestic and international climate ambition.

Annex C Table 2. Estimated NPV of UK ETS relative to counterfactual using the traded carbon appraisal values, £m discounted (2019 prices)

Impact	UK ETS NPV (relative to counterfactual)	
	Low	High
Total present value of benefits (PVB)	**29**	**30**
Carbon benefit to society	29	30
Total present value of costs (PVC)	**36**	**70**
Resource cost to system participants	25	59
Administrative cost to system participants	4	4
Administrative cost to government	7	7
Total net present value (NPV)	**-7**	**-40**

185. The carbon benefit is still estimated to be higher in the policy scenario compared to the counterfactual, however the overall size of this difference is smaller as a result of using the traded instead of non-traded appraisal values in the analysis. Consequently this benefit compared to the counterfactual is no longer great enough to offset the higher costs associated with the policy relative to the counterfactual. This suggests the UK ETS could lead to a small net cost to society compared to continued participation in the EU ETS, if the emissions reductions achieved under the policy are not valued as highly.