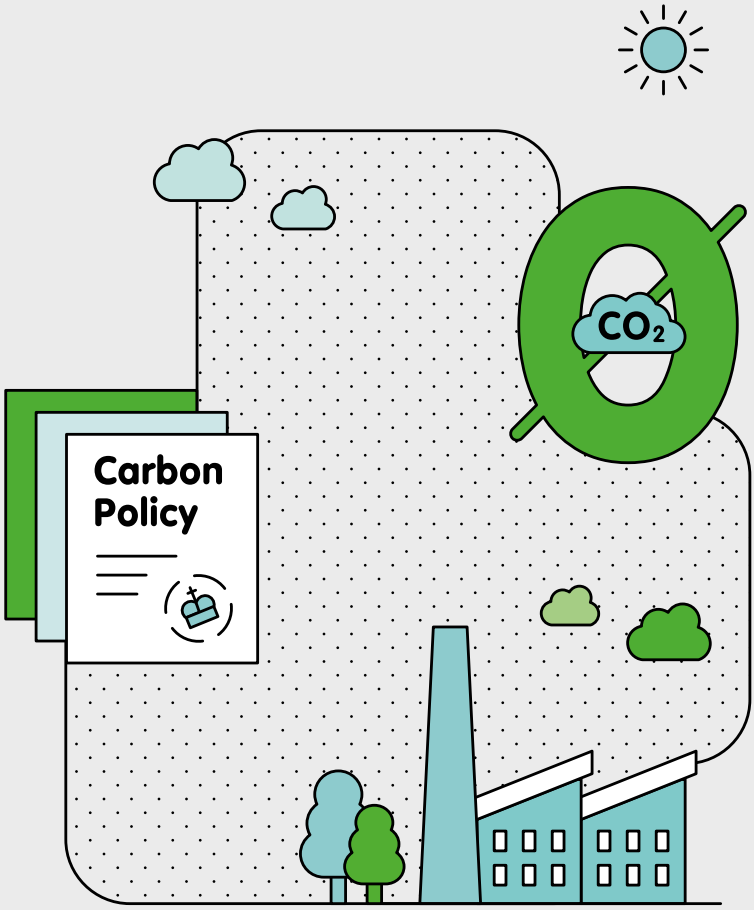
Net Zero Carbon Policy

CATAPULT Energy Systems



Industrial Decarbonisation:
Net Zero Carbon Policies to Mitigate Carbon Leakage and Competitiveness Impacts

A report for the Climate Change Committee.

Contents

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About Energy Systems Catapult

Energy Systems Catapult was set up to accelerate the transformation of the UK's energy system and ensure UK businesses and consumers capture the opportunities of clean growth. We are an independent, not-for-profit centre of excellence that bridges the gap between industry, government, academia and research.

We take a whole systems view of the energy sector, helping us to identify and address innovation priorities and market barriers, in order to decarbonise the energy system at the lowest cost.

We have more than 200 staff based in Birmingham and Derby with a variety of technical, commercial and policy backgrounds. We work with innovators from companies of all sizes to develop, test and scale their ideas. We also collaborate with industry, academia and government to overcome the systemic barriers of the current energy market to help unleash the potential of new products, services and value chains required to achieve the UK's clean growth ambitions as set out in the Industrial Strategy.

Net Zero Carbon Policy

Net Zero Carbon Policy is our new thought leadership project, focusing on how the UK can build an innovation-friendly, economy-wide framework for Net Zero.

We aim to build on the insights from our Rethinking Decarbonisation Incentives[1] project, to develop credible policy options for an efficient and socially beneficial transition.

We will be publishing a number of reports and policy briefs during 2020-21 ahead of the Climate Change Committee's recommendations on the Sixth Carbon Budget, HM Treasury's Net Zero Review, and COP26.

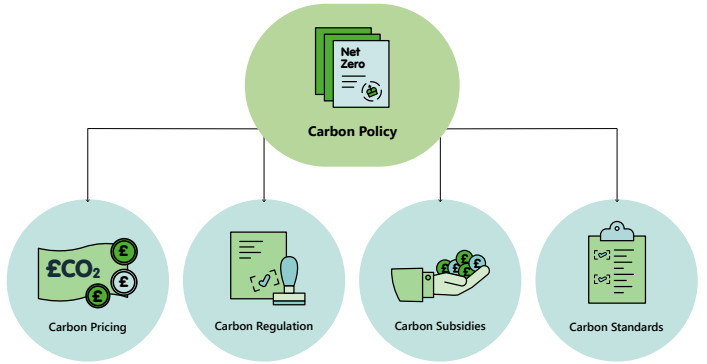
Acknowledgements

We would like to thank:

- The Climate Change Committee for co-funding this report.
- Members of both the Climate Change Committee Working Group and Steering Group on Industrial Decarbonisation Policy for their input and feedback throughout the development of this report.

Glossary of Terms

Carbon Policy - Carbon policy is a shorthand term for all policies that require or incentivise action to reduce or remove greenhouse gas emissions, including pricing, regulation, subsidies, and standards. These can be combined with complementary policies, such as innovation support and access to finance, to form policy packages.



International Competitiveness Impacts - Competitiveness is the capacity and ability of a firm or sector to gain and maintain a profitable, sustainable market share relative to rivals. Carbon policy can impact competitiveness, but not all competitiveness impacts (e.g. labour costs) count as carbon leakage.

Specifically, competitiveness impacts that arise from carbon policies may put firms at a disadvantage with their international peers (e.g. where a firm is not able to abate and/or pass through costs).

Carbon Leakage - Carbon leakage can occur if the competitiveness impacts that arise from carbon policies leads to emissions reduction from domestic firms combined with increases in emissions in other jurisdictions where carbon policy is either less ambitious or does not exist. This can lead to a net increase in global emissions.

Effective Carbon Prices - The incentive or reward (in £/tCO_2e) for a firm or individual to reduce or remove emissions resulting from direct (e.g. explicit carbon pricing instruments, energy and fuel taxation, etc.) and indirect (e.g. reduced VAT on energy, subsidies for low and zero carbon options, etc.) carbon policies.

Executive Summary

Concerns about the impact of carbon policies (including pricing, regulation, subsidies, and standards) on competitiveness and carbon leakage particularly affect energy-intensive, trade-exposed (EITE) industries. EITE industries are constrained in their ability to pass through carbon policy costs due to actual or potential international competition. In light of Net Zero ambitions, this poses a unique challenge for carbon policy design. Measures aimed at mitigating these concerns are often a trade-off between preserving competitiveness and incentivising emissions reduction.

In this report we focus on the UK context of international competitiveness impacts that arise directly from carbon policies and evaluate their ability to enable deep decarbonisation of industry in line with Net Zero pathways while simultaneously mitigating carbon leakage and competitiveness impacts, including the potential timings and phasing of implementation.

Carbon Policies to Mitigate Carbon Leakage and Competitiveness Impacts

The fundamental role of carbon policy is to require or incentivise action to reduce or remove greenhouse gas emissions. In addition, for EITE industries carbon policies can be designed to also mitigate carbon leakage and competitiveness impacts. The choice of which mechanism is used depends on the nature of the base carbon policy being applied (e.g. free allocation of allowances is only suitable where there is an emissions trading system). In addition, a single carbon policy is unlikely to completely mitigate competitiveness impacts without significantly diluting the incentive to reduce emissions. Therefore, policies are often combined, including with complementary policies, to form policy packages.[1]

Figure 1 provides an overview of the evaluated carbon policy mechanisms that can be used to mitigate carbon leakage and competitiveness impacts.

- In the case of carbon pricing, mechanisms tend to be implemented to directly alleviate a specific carbon price arising from a tax or emissions trading system.
- Carbon standards come in two forms:
  - » Flexible compliance standards on producers, which can be used within a carbon pricing system (e.g. for setting benchmarks for free allocation of allowances); and
  - » Mandatory standards on producers and purchasers, which set minimum requirements, for example, related to carbon.
- Finally, subsidies can be used to provide additional support during the transition.

All carbon policies require some form of transparent and robust monitoring, reporting, and verification (MRV) of emissions, either direct or embodied. In the case of the industries currently covered by the EU ETS, the data collected for determining the number of allowances that require surrendering could be used as a starting point for introducing flexible compliance or mandatory standards.

In its design and implementation, carbon policy should ideally not only address its short-term impacts on competitiveness, but also be enduring and provide certainty to prevent long-term leakage and encourage investment. This suggests a policy pathway, with clear timelines of phasing, aligned with carbon budgets.

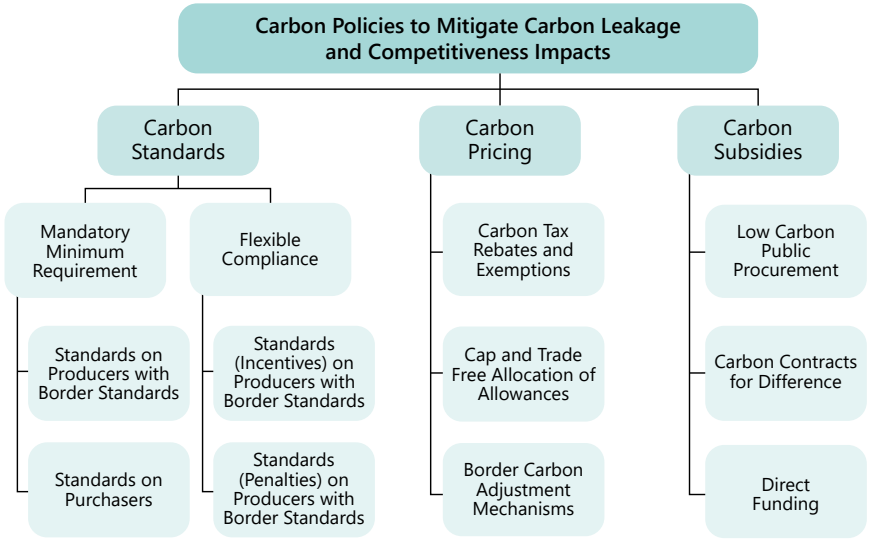


Figure 1 Overview of carbon policies used to mitigate carbon leakage and competitiveness impacts.

Timings and Phasing of Carbon Policies

The timing and phasing of carbon policies to enable deep decarbonisation of industry are crucial for the success of mitigating carbon leakage and competitiveness impacts and must account for:

- The existing framework of policies, especially where additional measures may increase administrative complexity for firms. It may be desirable to streamline existing carbon policies or phase measures to minimise overlapping and additional administrative burdens.
- The variations in policy implementation times, taking account of technical feasibility and measurability, of the different approaches. The evaluation undertaken in this report points to an overall transition from subsidies in the near-term allowing time to overcome the technical, political, and legal challenges of implementing a border carbon adjustment mechanism and mandatory standards applied to both domestically produced products and imported products (i.e. at the border).
- Each industrial sector will decarbonise at different rates and cannot all move at the same pace, especially where implementation of low carbon technologies is limited in the near-term. There will also be variation between smaller sites and industrial clusters. This suggests Net Zero policy pathways that potentially vary for industrial sectors and regions.
- Ensuring incentives remain for low carbon products that are exported, especially in the near-term when global action remains relatively nascent, will continue to be a key consideration of policy choice and design.
- The dynamic variation in trade exposure of different sectors over time.

Our evaluation broadly suggests a transition from subsidy-based support in the near-term to the longer-term use of standards, including at the border, to both mitigate carbon leakage and enable deep decarbonisation of industry in line with Net Zero. These should also be considered as part of wider policy packages, including a market for negative emissions. Figure 2 illustrates an example of overall timings and of phasing of carbon policies between now and 2050:

- Immediate steps can be taken to realise benefits in the near-term, including continuing to provide direct funding and by improving the methodology for allocation of free allowances under a UK ETS. These can build on existing policies, which is important for business continuity in the context of Brexit and impacts of COVID-19.
- Alongside these, design and implementation of additional support measures such as low carbon public procurement practices and carbon contracts for difference (i.e. setting a strike price for carbon for a project) can play an important role for beginning to develop low carbon markets.
- In the interim, a border carbon adjustment mechanism could be developed as part of a longer-term pathway, which could be integrated with a UK ETS and form the basis for wider coverage of standards on producers.
- Over time, these could be phased down as longer-term policies are fully implemented, including standards on carbon for both purchasers and producers, with border standards eventually used for the latter.
- The phasing of these will enable industry to adjust, with a UK ETS and the wider set of standards tightening over time in line with carbon budgets.

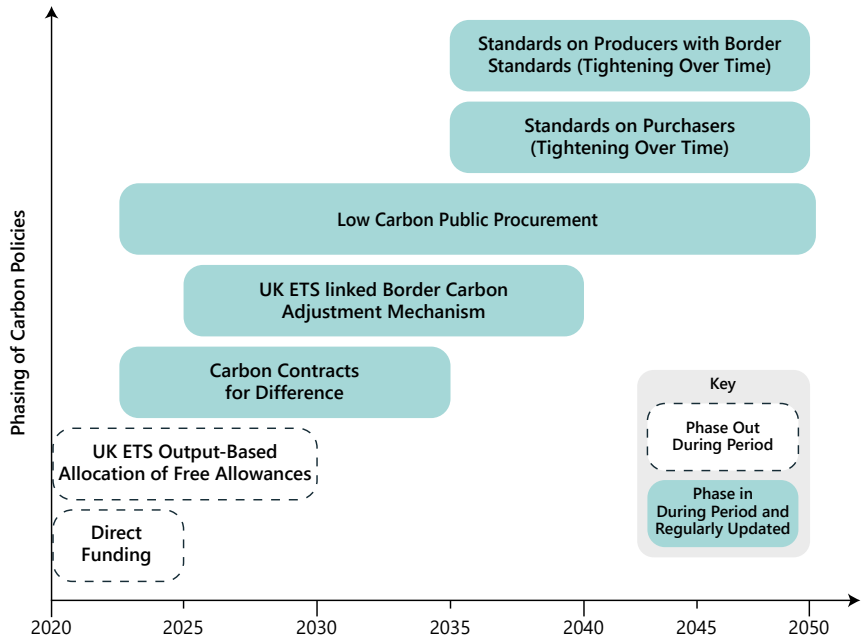


Figure 2 Potential timings and phasing of carbon policies to enable deep decarbonisation of industry in line with Net Zero and for mitigating carbon leakage and competitiveness impacts.

Recommendations for Policymakers

The decision over carbon policy coverage and stringency often involves balancing the trade-off between political economy considerations (i.e. generating sufficient acceptance for carbon policies) and the desire to avoid economic distortions (i.e. undermining the rationale for introducing the carbon policy in the first place). This trade-off is further emphasised when potential competitiveness impacts arise that could lead to carbon leakage and further offshoring of UK emissions.

Ultimately, the decisions surrounding the implementation of carbon policies will be made by policymakers that need to weigh feasibility and deliverability alongside cost and the political and diplomatic effort required to introduce more ambitious policies such as border standards. Above all, the policies that are eventually used must enable industrial decarbonisation in line with Net Zero while also, as far as possible, minimising negative and maximising positive competitiveness impacts for affected UK industrial firms.

The following recommendations are intended to provide the direction for an overall approach to industrial decarbonisation that would most effectively mitigate carbon leakage and competitiveness impacts in line with the Climate Change Committee's Sixth Carbon Budget Pathways:

1 Study the policy pathways required for industrial sectors, in particular, where competitiveness impacts affect investment decisions, including differences between cluster and non-cluster based firms.

2 In the near-term, continue to provide support to industry through direct funding and explore alternative policy measures, for example, carbon contracts for difference for low-regret projects.

3 During Phase I of a UK ETS, implement improvements in the methodology for allocation of free allowances, for example, by using output-based allocation. These should be phased down during the 2020s and potentially replaced with a targeted border carbon adjustment mechanism calibrated to align with the UK ETS price and phased in from 2025.

4 Explore the use of standards on both producers and purchasers as part of the long-term policy framework to enable industrial decarbonisation. To begin, standards on producers could employ a form of flexible compliance, for example, tradable performance standards. Standards on purchasers could be initiated through a low carbon public procurement programme providing initial demand for low carbon products, before expanding to cover other sectors.

5 In the long-term, to ensure that the implementation of standards is aligned with Net Zero levels of ambition while mitigating competitiveness impact, explore options to impose standards on producers at the border on imported products.

Introduction

Concerns about the impact of carbon policies (including pricing, regulation, subsidies, and standards) on competitiveness and carbon leakage particularly affect energy-intensive, trade-exposed (EITE) industries. EITE industries are constrained in their ability to pass through carbon policy costs due to actual or potential international competition. In light of Net Zero ambitions, this poses a unique challenge for carbon policy design. Measures aimed at mitigating these concerns are often a trade-off between preserving competitiveness and incentivising emissions reduction.

In this report, we focus on the UK context of international competitiveness impacts that arise directly from carbon policies and evaluate their ability to enable deep decarbonisation of industry in line with Net Zero pathways while simultaneously mitigating carbon leakage and competitiveness impacts, including the potential timings and phasing of implementation:

- Section 1 introduces the concept of carbon leakage and discusses the link between competitiveness and innovation.
- Section 2 describes the current policies used in the UK to mitigate carbon leakage.
- Section 3 describes the various carbon policy options available for incentivising emissions reduction while still maintaining competitiveness.
- Section 4 follows with three international case studies.
- Section 5 evaluates the carbon policy options described in Section 3.
- Section 6 discusses the possible timings and phasing for implementing carbon policies.
- Section 7 provides recommendations for an overall approach to industrial decarbonisation in line with the Climate Change Committee's Sixth Carbon Budget Pathways, that would most effectively mitigate any carbon leakage and competitiveness impacts and maximise upside opportunities to enhance competitiveness.

Carbon Leakage[2]

Carbon leakage is complex, in particular, due the multitude of factors that affect investment decisions, e.g. exchange rates, labour and capital costs, etc. as well as carbon policies. Carbon leakage can arise through four channels:

- **Short-term (output) competitiveness channel**, whereby firms covered by carbon policies lose market share to those in sectors or jurisdictions covered by weaker carbon policies.
- **Long-term (investment) competitiveness channel**, whereby carbon policies alter investment decisions by firms or investors (both domestic and international).
- **Fossil fuel price channel**, where carbon polices reduce the demand for fossil fuels by covered firms, which can reduce the price of globally traded fossil fuels. This, in turn, can increase demand by firms not covered by carbon policies. It can also impact investment decisions surrounding fossil fuels. However, reductions in UK demand are unlikely to be of sufficient scale to influence global fossil fuel markets and pricing.
- **Reverse leakage (technological spillovers) channel**, is the result of induced innovation by firms covered by carbon policy that spill over to other firms. This is similar to the Porter Hypothesis, where carbon policies can induce innovation that is productivity enhancing (see below for more detail).

Policymakers tend to focus on the first and second channels, however, the fourth channel (i.e. the upside opportunity of carbon policy) should not be neglected in the overall assessment of mechanisms.

Policymakers have generally used two main indicators to determine sectors at risk of carbon leakage:

- **Carbon policy impacts** captures the impact that carbon policies has on a particular firm or sector. As carbon leakage is driven by effective carbon price differentials between jurisdictions with and without carbon policies, the larger the impact of a given carbon policy on sectors or firms, the greater the risk of leakage.
- **Trade exposure** is a proxy for the ability of a firm or sector to pass costs without significant loss of market share, and hence their exposure to carbon policies.

This report does not seek to determine which firms or sectors are at risk of carbon leakage. There are a number of approaches to this that often vary with different carbon policies, e.g. under the EU ETS there is a carbon leakage list[3]. Vivid Economics, supported by Energy Systems Catapult, have separately assessed UK business competitiveness and the role of carbon pricing in a report for the Department for Business, Energy and Industrial Strategy (BEIS).[4] In particular, this work captured the dynamic impacts of carbon policy that is often overlooked.

Consumption Emissions

The UK's consumptions emissions footprint in 2017 stood at 772 $MtCO_2e$, significantly larger than the UK's territorial emissions of 505 $MtCO_2e$ in the same year.[5] This gap reflects the difference between imported emissions to meet UK consumption and the emissions embedded in UK produced goods. Carbon policies that seek to align with Net Zero as well as mitigate carbon leakage and competitiveness impacts can also aid a reduction in consumption-based emissions. In particular, policies imposed at the border on imports incentivise low carbon products entering the UK and penalise cheaper, higher carbon goods.

Competitiveness and Innovation

The potential negative impacts of carbon policy on industry competitiveness is well known and extensively discussed, however, the potential upsides (outside of emissions reduction) is less often deliberated.

Environmental regulation, including carbon policy, can induce innovation and increase competitiveness in the medium- and long-term. Described by the Porter Hypothesis (also known as an economic 'free lunch'), carefully designed and enduring environmental regulation can lead to 'innovation offsets', whereby the increased cost of complying with the regulation is partially (and sometimes more than fully) offset by productivity benefits arising from induced innovation.

The reasons that may lead to these outcomes include:

- Signalling firms about their likely resource inefficiencies and the potential technological improvements they can make to reduce emissions.
- Raising corporate awareness, especially where policy is focused on data gathering or use of standards/benchmarks.
- Reducing the uncertainty that investments to reduce or remove emissions will be valuable.
- Creating pressure that motivates innovation and progress.
- Levelling the transitional playing field.

A significant body of evidence suggests that carbon policies that are flexible and market-based are more likely to yield innovation compared to rigid command-and-control approaches (e.g. prescriptive technology standards).[7] Carbon policy that is phased in over time may also induce voluntary innovation in anticipation of more stringent regulation in future.

In considering the impact of carbon policies on competitiveness it is also important to account for the dynamic impact over time on productivity and incentives to innovate in affected sectors. Especially in the short-term, where innovation itself cannot always completely offset the cost of compliance. An extensive literature review examined the impact that carbon policies have on innovation and productivity in key sectors. Where literature is available, the evidence suggests that more stringent carbon policies if applied appropriately support the Porter Hypothesis. Table 1 is extracted from a Frontier Economics report commissioned by Energy Systems Catapult, which assessed the impact that carbon policy has on economy-wide productivity.[8]

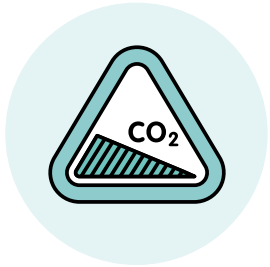


Table 1 Summary of evidence from a literature review examining the impact that carbon policy has on innovation and productivity.[9]

Research questions	Summary of Evidence
Through what mechanisms do carbon policies influence productivity?	• Theoretical effect is ambiguous. • Compliance costs reduce productivity as resources are diverted away from production. However, regulations may improve productivity if firms are not already optimising. • If innovation is induced, productivity could improve.
Does the choice and design of carbon policies affect the capacity of the economy to innovate?	• Strong evidence that market-based policies are associated with increases in innovation ('narrow' Porter Hypothesis). • Good evidence that strategic investment by government is associated with more innovation. • More ambiguous on the impacts of prescriptive standards and engagement.
Does the choice and combination of carbon policies have any particular implications for productivity over time?	• Substantial literature demonstrating that increases in innovation are associated with improved productivity. • Literature linking carbon policy and productivity directly is less available and very context-specific. • Literature generally finds small positive effects of market-based policies and less clear results of other types of carbon policy.
How important, in productivity terms, is it to have a coherent set of economic carbon abatement drivers and how could this be measured or quantified?	• Most of the literature uses micro-data linking very specific policies to firm-level outcomes. • Very difficult to extrapolate to the macroeconomic effects from this, but the few studies that exist suggest a small positive effect of up to 5% of productivity growth.

In general, to date carbon policies have been found to have had limited adverse impacts on industrial competitiveness.[10] This is a result of the currently too low effective carbon prices in some jurisdictions as well as the use of protective policy measures to limit the risk of carbon leakage and competitiveness impacts. Regardless, strong and carefully designed carbon policies have helped to accelerate modernisation and productivity improvements that enhance rather than harm competitiveness; this is evident in both the UK and Sweden[11], where industrial sectors and GDP have increased while emissions have decreased. This may not, however, completely describe the nature of growth experienced, for example, a decline in heavy industry due to offshoring can occur while other, less energy-intensive industries see significant growth during the same period.

Carbon Policies Impacting UK Industries and Associated Protection Policies

Industry are at risk of adverse competitiveness impacts when their outputs are traded in competitive international markets and where carbon policies add materially to their costs. Therefore, when protecting against competitiveness impacts the focus is often on energy-intensive manufacturing sectors where energy costs are a greater proportion of operating costs[12]. Those sectors also produce outputs that can be easily substituted by goods produced in other jurisdictions.

The key energy- and carbon-intensive industries are:

- Refineries
- Chemicals
- Iron and steel
- Cement and lime
- Paper, pulp, and printing
- Rubber and plastics
- Glass and ceramics
- Textiles
- Wood

In 2015, these accounted for 13% of UK emissions, around 2% of Gross Added Value (GVA), and 1.5% of jobs (around 485,000).[13] The degree to which UK industries are at risk of competitiveness impacts varies by sector, for example steel is considered at high risk, with cement, paper and pulp, and chemicals at medium risk. The risk also varies on a subsector level, for example, chemicals such as industry gases are less susceptible than fertilizers. In addition, other factors such as the local nature of competition in outputs impacts the level of risk ascribed to a sector where, for example, it may reduce the risk for cement and lime.

Current UK Policies

For industry directly participating in the EU Emissions Trading System (ETS), competitiveness impacts are mitigated mainly through the allocation of free allowances. Additional measures include exemptions and/or compensation for direct and indirect policy costs (e.g. low carbon support, carbon price support), and a reduction in energy consumption tax via Climate Change Agreements. Table 2 provides an overview of these protection policies.

Table 2 Overview of policies used in the UK to protect against carbon leakage and competitiveness impacts.

Protection Policy	Carbon Policy	Coverage	Operation	Extent of Price Mitigation	Impact on Incentives
Climate Change Agreements[14]	Climate Change Levy (CCL).	Energy intensive sectors.	Sector-specific voluntary agreements. Energy efficiency targets negotiated with BEIS via sector associations. Energy use and emissions are reported over four two-year target periods.	Discount on CCL:[15] • 92% for electricity consumption. • 81% for natural gas and other fuels.	Incentivises investment in energy efficiency. Receiving a discount is conditional on meeting energy efficiency targets. If targets are missed, organisations can pay a buy-out fee (£14/ tCO_2e) to remain in the scheme.[16]
Free Allocation of EU ETS Phase III[17] **Allowances – Fixed Sector Benchmarking**	Direct cost of ETS allowances.	EU ETS covered industry installations.	Installation-specific. Number of freely allocated allowances based on production quantity and benchmark value for a product. Product-specific benchmark based on average GHG emissions of the best performing 10% of EU installations.	Free allocation:[18] • 100% for sectors at a significant risk of carbon leakage. • Less exposed sectors received 80% for free, decreasing gradually to 30% in 2020.	Incentives to reduce emissions are embedded in ETS design through benchmarking as only the most efficient installations are able to get the maximum free allocation.
Low Carbon Support Exemption	Costs of Renewables Obligation, Contracts for Difference, and Feed-in-Tariffs.	Businesses most at risk of carbon leakage[19]	Individual business-specific. Certificate issued to successful applicants.	Level of exemption: • Up to 85%	Incentive to reduce consumption.
Carbon Price Compensation	Electricity cost increase due to EU ETS and Carbon Price Support (CPS).	Businesses most at risk of carbon leakage[20]	Individual business-specific.	Level of compensation: • Up to 75%	Incentives to improve energy efficiency is embedded in the compensation formula.

Protection Policy	Carbon Policy	Coverage	Operation	Extent of Price Mitigation	Impact on Incentives
Free Allocation of UK ETS Phase I Allowances (Proposed)[21]	Direct cost of ETS allowances.	UK ETS covered industry installations.	Free allocation calculations: Historical Activity Level (HAL) x Benchmark x Carbon Leakage Exposure Factor (CLEF). The total number of free allowances will initially be set at around 58 million in 2021 and will reduce annually by 1.6 million allowances.	Initial application of free allocation will follow EU ETS Phase IV:[22] • 100% for sectors at a significant risk of carbon leakage. • For less exposed sectors, it will be phased out after 2026 from 30% to 0% at the end of Phase I (2030).	Incentives to reduce emissions are embedded in ETS design through benchmarking as only the most efficient installations are able to get the maximum free allocation.

State Aid Provision

Currently, all polices above are considered a form of state aid under EU rules. State aid is in principle prohibited and can only be provided if it is in line with guidance on state aid provision and approved by the European Commission (EC). Aid in the form of reductions in or exemptions from carbon pricing and low carbon support are two types of measures falling under the EC's Energy and Environmental Aid Guidance.[23] Aid in the form of compensation for the indirect cost of the EU ETS is governed via a separate set of guidelines, the ETS State Aid Guidelines.[24]

Following the end of the transition period (from 1 January 2021), the UK Government – as of October 2020 – intends to follow World Trade Organisation (WTO) subsidy rules, replacing EU state aid law.[25]

Direct Funding

Government also provides direct funding for industry and associated technologies and vectors. While such funding pots are not intended to specifically mitigate carbon leakage, they can help prevent carbon leakage and improve industrial competitiveness in a low carbon economy by assisting carbon intensive industries to adjust or develop solutions that reduce emissions cost effectively. Funding pots include:

Carbon Capture and Storage (CCS) - Funding has been allocated for the development of CCS:

- £20 million has been recently allocated for the design and construction of CCS demonstration projects.[26]
- £15 million has been recently allocated for CCS innovation projects more broadly.[27]

Hydrogen - A £100 million fund was recently announced to support the commercial scale demonstration and deployment of low carbon hydrogen production.[28]

Other - In addition to technology specific support, funding is also available for:

- Industrial Energy Transformation Fund (£289 million).[29]
- Green Distilleries Competition (£10 million).[30]
- £20 million has been recently allocated for Industrial Fuel Switching.[31]
- £9.2 million has been recently allocated for Industrial Energy Efficiency.[32]
- £18 million has been recently allocated for Industrial Heat Recovery.[33]

Industrial Clusters - Emissions from the six largest industrial clusters (by emissions) total 33.2 $MtCO_2$. These are Grangemouth, Teesside, Merseyside, Humberside, South Wales, and Southampton.[34]

- This has resulted in £170 million of funding (via the Industrial Decarbonisation Challenge - Industrial Clusters Mission) being made available.

Sector Specific - A £100 million fund was recently announced to support the commercial scale demonstration and deployment of low carbon hydrogen production.[35]

Impact on the UK

In their implementation, existing carbon policies have included strong protection policies to mitigate carbon leakage and competitiveness impacts. The result is that these have not caused a major negative effect on UK manufacturing, with output 2% higher in 2015 compared to 1990.[36] In addition, case studies carried out on three sectors (aluminium, cement, and steel) also suggest that carbon policies with strong protection policies have had a relatively small impact on declines in production.[37]

Carbon Policies to Mitigate Carbon Leakage and Competitiveness Impacts

The fundamental role of carbon policy is to require or incentivise action to reduce or remove greenhouse gas emissions. In addition, for trade-exposed, energy-intensive industries carbon policies can be designed to also mitigate carbon leakage and competitiveness impacts. The choice of which mechanism is used depends on the nature of the base carbon policy being applied (e.g. free allocation of allowances is only suitable where there is an emissions trading system). In addition, a single carbon policy is unlikely to completely mitigate competitiveness impacts without significantly diluting the incentive to reduce emissions. Therefore, policies are often combined, including with complementary policies, to form policy packages.[38]

Figure 3 provides an overview of the evaluated carbon policy mechanisms that can be used to mitigate carbon leakage and competitiveness impacts.

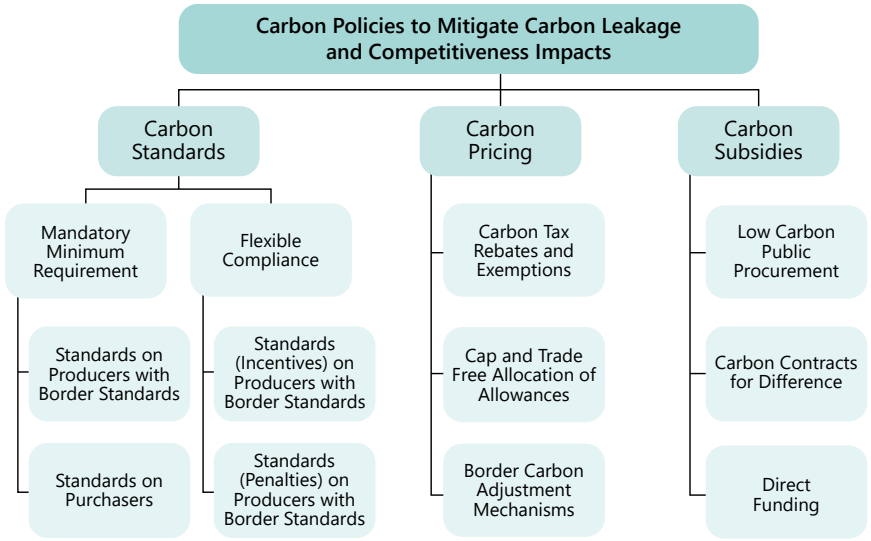


Figure 3 Overview of carbon policies used to mitigate carbon leakage and competitiveness impacts.

- In the case of carbon pricing, mechanisms tend to be implemented to directly alleviate a specific carbon price arising from a tax or emissions trading system.
- Carbon standards come in two forms:
  - » Flexible compliance standards on producers, which can be used within a carbon pricing system (e.g. for setting benchmarks for free allocation of allowances); and
  - » Mandatory standards on producers and purchasers, which set minimum requirements, for example, related to carbon.
- Finally, subsidies can be used to provide additional support during the transition.

All carbon policies require some form of transparent and robust monitoring, reporting, and verification (MRV) of emissions, either direct or embodied. In the case of the industries currently covered by the EU ETS, the data collected for determining the number of allowances that require surrendering could be used as a starting point for introducing flexible compliance or mandatory standards. Where data is unavailable, or collection is nascent, a period of mandatory disclosure could proceed.[39]

In its design and implementation, carbon policy should ideally not only address its short-term impacts on competitiveness, but also be enduring and provide certainty to prevent long-term leakage and encourage investment. This suggests a policy pathway, with clear timelines of phasing, aligned with carbon budgets.

Throughout this section of the report, the various carbon policies depicted in Figure 3 are described in further detail and their respective advantages and disadvantages are listed against the evaluation criteria (see Table 3) as applied in Section 5. Each of the carbon policies are considered in their complete implementation, for example, where specific policies are used to mitigate impacts of overarching policies, such as free allocation of allowances for cap and trade systems, then it is the sum of these parts that is discussed and evaluated rather than just the additional protection policy.

Carbon Standards

The term 'carbon standard' is used to encompass any regulation, standard, or policy mandate on an economic actor (e.g. firm or consumer) to meet a decarbonisation requirement or metric. Mandatory carbon standards obligate producers or purchasers to meet a minimum requirement, for example, related to carbon. Alternatively, flexible compliance standards obligate firms to meet a minimum requirement or pay others (e.g. purchase credits from other firms or pay a government buyout price) to meet the overall standard.

Standards can create a level playing field for industry, particularly if cross-jurisdictional, and create demand for low carbon industrial outputs. However, standards requires significant data on the carbon intensity or other relevant metrics of products and outputs, both domestic and imported, with reliable data from imports being much harder to obtain.

Mandatory Minimum Requirement: Standards on Producers with Border Standards

Standards on producers can be used to ensure that certain products or industry outputs comply with minimum requirements related to its carbon content (also known as a carbon cap, which can include carbon intensity). Alternatively, minimum standards can be set for other measures correlated with carbon, for example, by introducing requirements for use of recycled materials, which can enable a circular economy. Crucially, if such standards are to be aligned with Net Zero pathways, then it must also be imposed at the border on imports to provide protection against carbon leakage. In addition, it can enable a level playing field for exports if designed appropriately.

	Mandatory Minimum Requirement: Standards on Producers with Border Standards		
Criteria	**Advantages**	**Disadvantages**	**Rating**
Implementation Time		Mitigation benefits realised in the next 10-15 years.	
Technical Feasibility (including Measurability)		High administrative complexity to establish standards and MRV methodologies. Relies upon life cycle assessment that is verified and comparable across different products.	
Political and Legal Challenges		Imposing a standard at the border on imports is likely to receive significant political and legal challenge.	
Cost to Taxpayer	Does not come at a cost to the taxpayer.	Does not generate revenue.	
Effect on Cost of Capital	Creates clear signals that encourages industry to invest.	Does not address the increased capital and operational expenditure that may arise during the transition to Net Zero. Complementary polices are required to support industry during the interim period.	
Socioeconomic Distribution of Cost		Regressive, with all costs borne by industry and passed through to the consumer.	
Achieving Net Zero	Strong incentive to reduce emissions intensity in line with Net Zero. However, prescriptive standards based on the performance of individual products can yield unintended consequences. Using a framework that is outcome-based can prevent this.	Careful design required to address emissions intensity of exports.	
Consumption-Based Emissions	Strong incentive to reduce consumption-based emissions with implementation at the border.		
Carbon Leakage and Competitiveness Impacts	Strong protection against carbon leakage due to creating a level playing field for industry, including on imported products.	Requires careful consideration of the impact on upstream/ downstream markets where the primary product is just a part of the value chain. For example, it may create carbon leakage risk for other producers, if they themselves are at risk of carbon leakage.	

Example: Sustainability requirements for biomass.[40]

Mandatory Minimum Requirement: Standards on Purchasers

Standards on purchasers can be used to ensure a minimum standard for the procurement of materials and goods in relation to its carbon intensity. For example, mandatory low carbon public procurement guidelines. This alone would not enable emissions reduction for exported goods.

	Mandatory Minimum Requirement: Standards on Purchasers		
Criteria	**Advantages**	**Disadvantages**	**Rating**
Implementation Time	Mitigation benefits realised in the next 10 years.		
Technical Feasibility (including Measurability)		High administrative complexity to establish standards and MRV methodologies. Relies upon life cycle assessment that is verified and comparable across different products.	
Political and Legal Challenges	Generally, politically accepted and unlikely to come against legal challenges.		
Cost to Taxpayer	Does not come at a cost to the taxpayer, unless implemented through public procurement.		
Effect on Cost of Capital	Creates signals that encourages industry to invest.	Does not address the increased capital and operational expenditure that may arise during the transition to Net Zero. Complementary polices are required to support industry during the interim period.	
		Relies on purchasers being able to provide sufficient demand to incentive firms to switch to producing low carbon outputs.	
Socioeconomic Distribution of Cost		Regressive, with all costs borne by industry and passed through to the consumer.	
Achieving Net Zero	Strong incentive to reduce emissions intensity in line with Net Zero.		
Consumption-Based Emissions	Strong incentive to reduce consumption-based emissions.		
Carbon Leakage and Competitiveness Impacts	Strong protection against carbon leakage due to creating a level playing field for industry, including on imported products.	Requires careful consideration of the impact on upstream/ downstream markets where the primary product is just a part of the value chain. For example, it may create carbon leakage risk for purchasers, if they themselves are at risk of carbon leakage.	

Example: The 'Buy Clean California Act', which targets supply chain carbon emissions.[41] Only products with Environmental Product Declarations demonstrating lower GHG emissions than the category benchmarks will be eligible for use in state projects.

Flexible Compliance: Standards on Producers with Border Standards

Also known as performance standards or benchmarks, these set carbon emission levels (emissions per unit of output) tailored to energy-intensive industrial production processes against which a firm's emissions are evaluated. The standard is set at a level that represents best-in-class performance (top quartile or better). Such standards can be used to set incentives or penalties on actors and may be applied through various carbon pricing policies, e.g. a carbon tax or emissions trading system (see Figure 4).

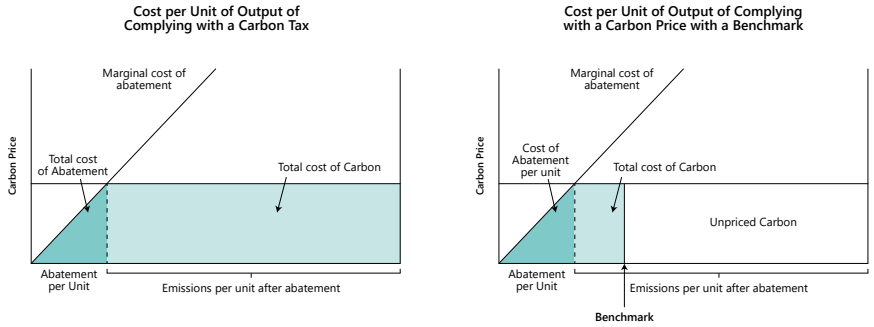


Figure 4 Cost per unit of output of a carbon tax versus a carbon price with benchmark.[42]

For example, firms with emissions in excess of their benchmark would be required to pay a buyout from the government, thereby generating revenue, which can be reinvested into industrial decarbonisation projects. Alternatively, performance standards can be designed to be tradeable, where in addition to a buyout, firms would have the option of purchasing surplus credits from firms that reduce emissions below their benchmark. The trading of surplus credits acts as an incentive to reduce emissions per unit of output below the benchmark. The design choice between providing incentives or setting penalties leads to different outcomes in the effectiveness of the policy.

Similar to the mandatory minimum requirement standards on producers, if flexible compliance standards on producers are set in line with Net Zero pathways, then these must also be imposed at the border on imports to provide protection against carbon leakage. In the interim period and without implementation at the border, the benchmark would have to be sufficiently low so that competitiveness impacts are minimised.

	Flexible Compliance: Standards (Incentives) on Producers with Border Standards		
Criteria	**Advantages**	**Disadvantages**	**Rating**
Implementation Time		Mitigation benefits realised in the next 10-15 years.	
Technical Feasibility (including Measurability)		High administrative complexity to establish standards and MRV methodologies. Where there are only a few firms competing in a market, data can be skewed if one of those firms installs a technology or has access to a resource not readily available to other firms.	
Political and Legal Challenges	Highly politically supported due to incentive-based nature.	Imposing a standard at the border on imports is likely to receive legal challenge.	
Cost to Taxpayer		Comes at a significant cost to the taxpayer.	
Effect on Cost of Capital	Creates clear signals that encourages industry to invest.	Does not address the increased capital and operational expenditure that may arise during the transition to Net Zero. Complementary polices are required to support industry during the interim period.	
Socioeconomic Distribution of Cost	Somewhat progressive, with some of the cost borne by the taxpayer.	Requires careful balance against other factors such as value for money considerations and minimising a transfer from the taxpayer to shareholders.	
Achieving Net Zero	Strong incentive to reduce emissions intensity by using benchmarks set against a best-in-class performance reference. It might be necessary to ensure the benchmark is Net Zero aligned.	Without careful monitoring, reduction in absolute emissions is less certain, because of the output benchmark metric. Careful design required to address emissions intensity of exports.	
Consumption-Based Emissions	Strong incentive to reduce consumption-based emissions with implementation at the border.		
Carbon Leakage and Competitiveness Impacts	Strong protection against carbon leakage due to creating a level playing field for industry, including on imported products.	Requires careful consideration of the impact on upstream/ downstream markets where the primary product is just a part of the value chain. For example, it may create carbon leakage risk for other producers, if they themselves are at risk of carbon leakage.	

	Flexible Compliance: Standards (Penalties) on Producers with Border Standards		
Criteria	**Advantages**	**Disadvantages**	**Rating**
Implementation Time		Mitigation benefits realised in the next 10-15 years.	
Technical Feasibility (including Measurability)		High administrative complexity to establish standards and MRV methodologies. Where there are only a few firms competing in a market, data can be skewed if one of those firms installs a technology or has access to a resource not readily available to other firms.	
Political and Legal Challenges		Imposing a standard at the border on imports is likely to receive significant legal challenge. Political opposition likely due to penalty-based nature.	
Cost to Taxpayer	Can generate revenue.		
Effect on Cost of Capital	Creates clear signals that encourages industry to invest if the signal to tighten benchmark over time is transparent.	Does not address the increased capital and operational expenditure that may arise during the transition to Net Zero. Complementary polices are required to support industry during the interim period.	
Socioeconomic Distribution of Cost		Regressive, with all costs borne by industry.	
Achieving Net Zero	Strong incentive to reduce emissions intensity by using benchmarks set against a best-in-class performance reference. It might be necessary to ensure the benchmark is Net Zero aligned.	Without careful monitoring, reduction in absolute emissions is less certain, because of the output benchmark metric. Careful design required to address emissions intensity of exports.	
Consumption-Based Emissions	Strong incentive to reduce consumption-based emissions with implementation at the border.		
Carbon Leakage and Competitiveness Impacts	Strong protection against carbon leakage due to creating a level playing field for industry, including on imported products.	Requires careful consideration of the impact on upstream/ downstream markets where the primary product is just a part of the value chain. For example, it may create carbon leakage risk for other producers, if they themselves are at risk of carbon leakage.	

Example: Without border standards and Net Zero levels of ambition, Canada Output-Based Pricing System for Industry (see Section 4.1 for case study).

Carbon Pricing

The term 'carbon pricing' is used to encompass any economic incentive that applies a direct cost on carbon. Complementary carbon leakage mitigation polices, such as rebates, exemptions, and free allowances can be used to protect industry from the full cost of a carbon, which can negatively impact competitiveness.

Broadly speaking, the policy mechanisms that fall within this category are designed to mitigate specific carbon pricing policies. For example, rebates or exemptions can be used for a carbon tax and free allowance allocation for a cap and trade system. Border carbon adjustment mechanisms can be used more broadly, but requires either an explicit carbon price arising from a tax or emissions trading system to operate in conjunction with.

A common disadvantage of these measures is that they rely on a carbon price, which may not be enduring or are susceptible to fluctuations. Carbon pricing can provide an incentive to reduce emissions for exported goods, but the level depends on the type of protection policy against carbon leakage implemented.

Carbon Tax Rebates

Rebates can be used to protect against carbon leakage by providing subsidies to firms (direct rebates) or via the reduction of other taxes (indirect rebates). Direct rebates, which is the equivalent to a subsidy, sees revenue raised from a carbon tax returned directly to firms in a lump sum or using an output-based methodology. Indirect rebates can be applied through, for example, reductions in corporate incomes taxes or employer national insurance contributions. These approaches have different impacts on the incentive to reduce emissions and address leakage.

	Carbon Tax Rebates		
Criteria	**Advantages**	**Disadvantages**	**Rating**
Implementation Time	Mitigation benefits realised within the next two years, assuming successful introduction of a carbon tax.		
Technical Feasibility (including Measurability)	Existing data and MRV methodologies can be used.		
Political and Legal Challenges	The inclusion of rebates increases political support and reduces the chance of legal challenge for the introduction of a carbon tax.		
Cost to Taxpayer	The policy can generate revenue, but the total potential amount is reduced due to the rebate.	There is potential for a net cost to taxpayer if not carefully designed. For example, the reduction in other taxes is higher than the amount collected via a carbon tax.	
Effect on Cost of Capital		The policy can result in an uneven pattern of effective carbon prices, which gives rise to wider uncertainty about long-term policy stability.	
Socioeconomic Distribution of Cost		Overall the policy is regressive, with a larger portion of costs borne by industry.	
Achieving Net Zero	Indirect rebates provide incentive to reduce emissions.	Direct rebates remove incentive to reduce emissions.	
Consumption-Based Emissions		Negligible impact on consumption-based emissions.	
Carbon Leakage and Competitiveness Impacts	Protection against carbon leakage largely depends on design (i.e. direct or indirect rebates), but both will provide a level of carbon leakage protection that might result from the total carbon price.		

Example: Sweden Energy Tax, where through the Program for Energy Efficiency in Energy Industry (PFE) firms could receive a rebate of the energy tax on electricity consumption in return for implementing an energy management system and applying energy efficiency improvement measures.[43] This is similar to the UK Climate Change Levy with Climate Change Agreements.[44]

Carbon Tax Exemptions

Exemptions can be applied to a carbon tax, whereby a firm is not required to pay the full carbon price. Exemptions can range from 0-100% of the carbon price.

	Carbon Tax Exemptions		
Criteria	**Advantages**	**Disadvantages**	**Rating**
Implementation Time	Mitigation benefits realised within the next two years, assuming successful introduction of a carbon tax.		
Technical Feasibility (including Measurability)	Existing data and MRV methodologies can be used.		
Political and Legal Challenges	The inclusion of exemptions increases political support and reduces the chance of legal challenge for the introduction of a carbon tax.		
Cost to Taxpayer	The policy can generate revenue, but the total potential amount is reduced due to the exemption.		
Effect on Cost of Capital		The policy can result in an uneven pattern of effective carbon prices, which gives rise to wider uncertainty about long-term policy stability.	
Socioeconomic Distribution of Cost		Overall the policy is regressive, with a larger portion of costs borne by industry.	
Achieving Net Zero		Removes incentive to further reduce emissions.	
Consumption-Based Emissions		Negligible impact on consumption-based emissions.	
Carbon Leakage and Competitiveness Impacts	The policy will reduce the impact on competitiveness and limit carbon leakage that might result from the total carbon price.		

Example: South Africa Carbon Tax (see Section 4.2 for case study).

Cap and Trade Free Allocation of Allowances

Free allocation of allowances is currently the main policy instrument through which carbon leakage and competitiveness impacts are addressed under a cap and trade system. Free allowances are usually allocated using one of following three methods:

- Grandfathering – Firms receive free allowances directly related to their historical emissions. This tends to be more appropriate when a scheme is in its earlier stages, where other administrative requirements are nascent (e.g. data collection).
- Fixed Sector Benchmarking – Firms receive free allowances related to their historical production and a product-specific benchmark of emission intensity of the whole sector.
- Output-Based Allocation – Firms receive free allowances related to their actual production and a product-specific benchmark of emission intensity of the whole sector.

EU ETS Phases I and II employed grandfathering, while Phase III used the fixed sector benchmarking approach. For Phase I of a UK ETS, which if implemented plans to initially use the same method to be used under the EU ETS Phase IV, free allocation will be better aligned with actual production levels.[45]

Careful consideration of determining benchmarks is required as not to impede innovation, especially if product-specific, which cannot easily account for often more expensive lower carbon alternatives.

For the remainder of this analysis, grandfathering is not evaluated as the UK has developed the necessary monitoring, reporting, and verification methodologies to use more advanced approaches of free allocation of allowances.

	Cap and Trade Fixed Sector Benchmarking		
Criteria	**Advantages**	**Disadvantages**	**Rating**
Implementation Time	This method of free allocation of allowances is currently used during Phase III of the EU ETS.		
Technical Feasibility (including Measurability)	Existing data and MRV methodologies can be used.		
Political and Legal Challenges	The inclusion of free allocation of allowances increases political support and reduces the chance of legal challenge with the introduction of a UK ETS.		
Cost to Taxpayer	The policy can generate revenue, but the total potential amount is reduced due free allocation of allowances.	Risk of windfall profits for firms.	
Effect on Cost of Capital		The policy can result in an uneven pattern of effective carbon prices, which gives rise to wider uncertainty about long-term policy stability.	
Socioeconomic Distribution of Cost		Regressive, with all costs borne by industry.	
Achieving Net Zero	The use of benchmarks provides reasonable incentives to reduce emissions, including for exports.	Without careful monitoring, reduction in absolute emissions is less certain, because of the benchmark metric. This is mitigated by the cap, however.	
Consumption-Based Emissions		Negligible impact on consumption-based emissions.	
Carbon Leakage and Competitiveness Impacts	The policy will reduce the impact on competitiveness and limit carbon leakage that might result from the total carbon price that arises from the system, but relies on closure rules to maintain minimal levels of output.		

	Cap and Trade Output-Based Allocation		
Criteria	**Advantages**	**Disadvantages**	**Rating**
Implementation Time	Phase I of a UK ETS proposes to better align free allocation of allowances with actual production levels; therefore, mitigation benefits could be realised within the next five years.	Establishing benchmarks and regular reporting creates complexity.	
Technical Feasibility (including Measurability)	Existing data and MRV methodologies can be used		
Political and Legal Challenges	The inclusion of free allocation of allowances increases political support and reduces the chance of legal challenge with the introduction of a UK ETS.		
Cost to Taxpayer	The policy can generate revenue, but the total potential amount is reduced due free allocation of allowances.		
Effect on Cost of Capital		The policy can result in an uneven pattern of effective carbon prices, which gives rise to wider uncertainty about long-term policy stability.	
Socioeconomic Distribution of Cost		Regressive, with all costs borne by industry.	
Achieving Net Zero	The use of benchmarks provides reasonable incentives to reduce emissions, including for exports.	Without careful monitoring, reduction in absolute emissions is less certain, because of the output benchmark metric. This is mitigated by the cap, however.	
Consumption-Based Emissions		Negligible impact on consumption-based emissions.	
Carbon Leakage and Competitiveness Impacts	The link between output and allocations reduces the impact on competitiveness and limit carbon leakage that might result from the total carbon price that arises from the system.		

Examples: Fixed Sector Benchmarking - EU ETS.[46] Output-Based Allocation - New Zealand ETS (see Section 4.3 for case study).

Border Carbon Adjustment Mechanisms

Border carbon adjustment mechanisms (BCAM) can be used by a country (or trading bloc) to address asymmetric carbon polices between jurisdictions. A domestic carbon price is applied on producers (e.g. via a carbon tax or resulting from an emissions trading system), which is also levied on products imported from countries that do not adopt equivalently stringent carbon policies. In addition, exports may be eligible for rebates. In their most basic form, a BCAM can be a tariff or other fiscal measure applied to imported goods. They can also be implemented by extending other regulatory obligations to imports, such as the requirement to purchase emission allowances or meet purchasing standards. Or they can be applied to exports, for example, through tax or regulatory relief. For the purposes of this report, the type of BCAM evaluated is when applying an equivalent domestic carbon price that arises from a carbon tax or cap and trade system on imports.

	Border Carbon Adjustment Mechanisms		
Criteria	**Advantages**	**Disadvantages**	**Rating**
Implementation Time		Mitigation benefits could be realised in the next 10-15 years.	
Technical Feasibility (including Measurability)		The policy would be administratively complex, especially in establishing the carbon content of equivalent products from other jurisdictions, with a reliance on international data. Complexity compounded by the need for agility in responding to market distortions that might emerge, e.g. impacts on supply chains.	
Political and Legal Challenges		Highly politically challenging, especially in the current global trade environment, because it could be seen as a form of protectionism. This could be alleviated with careful compliance with WTO rules, but this may raise legal challenges.	
Cost to Taxpayer	Can generate significant revenue.		
Effect on Cost of Capital		If relying on a carbon tax or cap and trade system, it can result in an uneven pattern of effective carbon prices, which gives rise to wider uncertainty about long-term policy stability.	
Socioeconomic Distribution of Cost		Regressive, with all costs borne by industry.	
Achieving Net Zero	Strong incentives to reduce emissions in line with Net Zero due to maintaining entire carbon price for domestic industry, including for exports (depending on design).		
Consumption-Based Emissions	Strong incentive to reduce consumption-based emissions with implementation at the border.		

	Border Carbon Adjustment Mechanisms		
Criteria	**Advantages**	**Disadvantages**	**Rating**
Carbon Leakage and Competitiveness Impacts	Strong protection against carbon leakage due to creating a level playing field for industry, including on imported products.	Some risks that state support from major competing markets (e.g. China and United States of America) could outweigh the impact of BCAMs, which would result in competitiveness impacts regardless.	

Examples: Untested internationally. The European Commission recently opened a public consultation on a carbon border adjustment mechanism, signalling its implementation by the mid-2020s.[47] California ETS uses a BCAM for imported electricity from neighbouring states, provided these are not linked to their ETS.[48]

Carbon Subsidies

The term 'carbon subsidies' is used to encompass any financial aid or support that enables or promotes the uptake or development of low carbon technologies, vectors, and materials.

In many cases, the primary objective of these kinds of subsidies is not to specifically address carbon leakage concerns. However, these approaches can indirectly prevent carbon leakage by directly paying for the cost of decarbonisation so that industry is not put at a competitive disadvantage. In addition, it can also provide confidence to invest in low carbon processes, as well as developing demand for low carbon outputs.

Carbon subsidies may also be seen as complementary policies, as it is unlikely that their implementation alone would be sufficient in mitigating carbon leakage. In addition, by enabling emissions reduction it is an effective way of providing a level playing field for exports.

Low Carbon Public Procurement

Public procurement often constitutes a significant share of national markets for industry supplied goods. Although not sufficient by itself, procurement practices that include carbon requirements for products can support creating a market for low carbon goods. Mandatory standard on public procurement is a potentially important instrument for creating lead markets in low carbon outputs and more broadly as an instrument to promote innovation. Public procurement can also be used as a test case for the development of broader mandatory standards, in particular, where the role of embodied carbon brings associated complexities, e.g. life cycle assessment.

	Low Carbon Public Procurement		
Criteria	**Advantages**	**Disadvantages**	**Rating**
Implementation Time	Mitigation benefits could be realised within the next five years.	There is potentially administrative complexity in establishing procurement coverage and criteria of standards.	
Technical Feasibility (including Measurability)		High administrative complexity to establish standards and MRV methodologies. Relies upon life cycle assessment that is verified and comparable across different products.	
Political and Legal Challenges	Highly politically supported.	Risk of picking winners, which can be prevented with careful design, e.g. avoid using prescriptive standards that determines the type of product, instead use outcome-based standards based on embodied carbon.	
Cost to Taxpayer		Comes at some cost to the taxpayer.	
Effect on Cost of Capital	Creates reasonable signals for industry to invest.	Public purchasing may only be a small portion of market share and would not yield the scale required to invest in change.	
Socioeconomic Distribution of Cost	Progressive with costs borne by the taxpayer.	Requires careful balance against other factors such as value for money considerations and minimising a transfer from the taxpayer to shareholders.	
Achieving Net Zero	Provides incentives to reduce emissions.		
Consumption-Based Emissions	Design of policy can incentivise a reduction in consumption-based emissions.		
Carbon Leakage and Competitiveness Impacts	It can help create a level playing field for affected industry by setting a minimum requirement for products. This in itself can provide protection against carbon leakage, but it requires careful design.		

Example: Buy Clean California Act.[49]

Carbon Contracts for Difference

Contracts for Difference (CfD) can be used on a range of different metrics. Carbon contracts for difference (CCfD) specifically applies to a carbon price, by setting a strike price for carbon for a project. For example, if at the end of the year the average effective carbon price is below the strike price, the project investor would be guaranteed that for each tonne of avoided carbon the government would pay the difference. If the average annual effective carbon price is at or above the strike price, the investor would receive no payments in that year. Such an approach could be designed to complement an ETS and would provide a sufficiently high and predictable effective carbon price on which commercial scale, long-term investment decisions could be taken.

	Carbon Contracts for Difference		
Criteria	**Advantages**	**Disadvantages**	**Rating**
Implementation Time	Mitigation benefits could be realised within the next five years.		
Technical Feasibility (including Measurability)	There would be some requirement for new data, but MRV methodologies do exist.		
Political and Legal Challenges	Politically supported, with precedent of existing CfDs in power.	There is a risk of picking winners, but this can be offset by being technology neutral as far as possible and balanced with the use of competition rounds.	
Cost to Taxpayer		Comes at some cost to the taxpayer.	
Effect on Cost of Capital	Creates reasonable signals for industry to invest.		
Socioeconomic Distribution of Cost	Progressive with most costs borne by the taxpayer.	Requires careful balance against other factors such as value for money considerations and minimising a transfer from the taxpayer to shareholders.	
Achieving Net Zero	Strong incentives to reduce emissions, including for exports.		
Consumption-Based Emissions	Design of policy can incentivise a reduction in consumption-based emissions.		
Carbon Leakage and Competitiveness Impacts	Directly subsidising firms provides carbon leakage protection.		

Example: CCfDs currently untested. There is precedent with power CfDs, which provides an example of a framework that uses competitive rounds of funding.

Direct Funding

Direct funding can provide targeted support for industry, in particular, when aimed at reducing energy costs and emissions through innovation, as well as bringing down the cost and lowering risk of investing in low carbon technologies. More recently, funding has been focused on industrial clusters. In addition to direct funding (or grants), other financial mechanisms such as tax incentives or import finance guarantees for low carbon imports can be used. In general, funding design and implementation must consider both the impact on capital and operational costs, with the latter being a particular issue where fuel switching is involved.

	Direct Funding		
Criteria	**Advantages**	**Disadvantages**	**Rating**
Implementation Time	Mitigation benefits from new direct funding could be realised within the next two years.		
Technical Feasibility (including Measurability)	Existing data and MRV methodologies can be used.		
Political and Legal Challenges	Politically supported, with precedent of previous direct funding.	Risk of picking winners, which can be prevented with careful design, e.g. avoid being prescriptive for use of funds, instead apply an outcome-based awarding system.	
Cost to Taxpayer		Comes at significant cost to the taxpayer.	
Effect on Cost of Capital	Creates reasonable signals for industry to invest.		
Socioeconomic Distribution of Cost	Progressive with all costs borne by the taxpayer.	Requires careful balance against other factors such as value for money considerations and minimising a transfer from the taxpayer to shareholders.	
Achieving Net Zero	Strong incentives to reduce emissions, including for exports.		
Consumption-Based Emissions	Design of policy can incentivise a reduction in consumption-based emissions.		
Carbon Leakage and Competitiveness Impacts	Directly subsidising firms provides carbon leakage protection. This could be slightly weakened if there is a requirement for match funding from industry.	May overprotect industries from the need to become internationally competitive or subsidise uncompetitive industries, with additional risk of politicisation.	

Example: Industrial Energy Transformation Fund.[50]

International Case Studies

The three international case studies presented here are extracted from Energy Systems Catapult's Rethinking Decarbonisation Incentives project.[51]

None of the carbon policies described in these case studies are sufficient to achieve deep decarbonisation, especially when implemented alone. It does, however, illustrate the current trade off that exists between incentivising emissions reduction and mitigating carbon leakage. They also highlight the considerations the UK has to address when designing policy. The additional challenge going forward is dealing with carbon leakage alongside a high-level of ambition in line with Net Zero. This will be discussed in the next sections.

Canada Output-Based Pricing System for Industry[52]

The Canadian federal government has developed the Pan-Canadian Framework on Clean Growth and Climate Change (PCF) as a way of establishing a coherent set of carbon policies across its territories and provinces, in order to meet emissions reduction targets and grow the economy, Canada's plan includes an economy-wide approach to pricing carbon and measures to achieve reductions across all sectors.[53]

Territories/provinces have the option to implement their own carbon policies, but they must meet the PCF benchmark, which establishes criteria to ensure that the carbon pricing adopted is sufficiently broad and stringent. The federal backstop is applied should a jurisdiction choose to adopt it, or where proposed policies do not meet the PCF benchmark. The backstop is made up of a federal fuel charge (i.e. a carbon tax) on fuel producers and distributers, and an output-based pricing system (OBPS) for certain industries that emit over 50,000 tCO_2e per year.[54]

The OBPS is designed to provide pricing incentives for certain industries to reduce their GHG emissions while maintaining their competitive position relative to international peers and avoid carbon leakage. Instead of paying a charge on the fuels that they purchase, industrial firms face a carbon price on the portion of their emissions that are above a specific level, which is determined based on relevant output-based standards (emissions per unit of output). The output-based standard is set at a level that represents best-in-class performance (top quartile or better) in order to drive emissions intensity reduction. The carbon price started at C$10/tonne in 2018 and will rise by C$10 each year to C$50 in 2022.[55] A firm that reduces emissions below its limit can generate and sell surplus credits. Firms that exceed their limit can pay a charge to the government of Canada at the same level as the fuel charge (e.g. C$20/tonne in 2019) or purchase surplus credits. The result is that firms have an incentive to cut pollution and support clean innovation while minimising the total cost they pay.

The revenues raised from OBPS is returned to the jurisdiction of origin, which may be used to further support emissions reductions in firms covered by the OBPS.[56]

Proposed output-based standards:[57]

- The vast majority of the 38 industrial activities across 23 sectors with 74 output-based standards included in the system will face a standard set at 80% of their sector's weighted average emissions intensity. The standard includes emissions from combustion and those generated from industrial or chemical processes.
- Standards for cement and lime sectors will be set at 95% given the higher risks of competitiveness impacts and carbon leakage.
- In addition, the standard for petrochemicals will be set at 90%.
- For electricity, the standard for coal-fired electricity phases down so that it reaches the level of natural gas electricity by 2030, aligning with Canada's phase-out date for traditional coal power.

South Africa Carbon Tax Exemptions[58]

South Africa is on a decade long journey to implement an ambitious carbon tax to reduce economy-wide GHG emissions. The carbon tax, which aims to cover 90% of emissions, highlights the challenges of designing a carbon policy that seeks to introduce a uniform carbon price throughout the economy. The tax design has evolved significantly, incorporating a number exemptions, phasing, offsetting, and revenue recycling, which results in a low effective carbon price for some sectors such as industry.

- Carbon tax allowances were developed by the National Treasury as a way of phasing in the carbon tax over time and protecting consumers:
- Basic tax-free allowance – most sectors of the economy have a 60% tax free allowance for energy combustion emissions. The basic allowance is a blanket technical threshold applied to all sectors as part of the phasing in of the carbon tax.
- Process and fugitive emission allowance – industries with process emissions (i.e. non-combustion) are granted a higher basic allowance of 70% (e.g. iron and steel, cement, lime, glass). A basic allowance of 70% is also available for industries with fugitive emissions (e.g. coal mining).
- Carbon budget allowance – an additional 5% allowance is provided to companies participating in Phase 1 of the carbon budget system, which is separate to the carbon tax.
- Offset allowance – carbon offsets may be used by companies to reduce their tax liability up to 10% of their combustion emissions and 5% of their fugitive or process emissions.
- Performance allowance – an additional allowance for top performers of 5% is provided as an additional incentive. This is calculated against an emissions intensity baseline for sectors or subsectors.

Additional tax-free allowances for trade-exposed industries were introduced as a way of addressing competitiveness impacts:

- Trade-exposed allowance – a further allowance of 10% is available for trade-exposed sectors. Trade intensity is used as a proxy for trade-exposure, which is determined at a sector or subsector level.

As a result, industries such as iron and steel, cement and lime, and glass can receive up to a 95% reduction in the carbon tax they pay.

New Zealand Emissions Trading System Output-Based Free Allocation of Allowances[59]

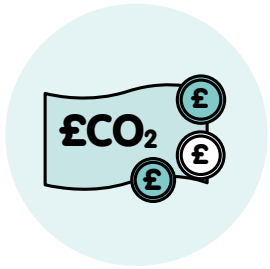
The New Zealand Emissions Trading System (ETS) was implemented in 2008 as the government's principal policy response to mitigating climate change. The initial aim was to cover all sectors and GHGs, but agriculture (~50% of emissions) was ultimately excluded owing to being judged less suitable for carbon pricing instruments and concerns of carbon leakage.

Free allocation of allowances is used as the main mechanism to protect EITE industries and led to an increase in industry acceptance of the ETS. These compensate for the cost of purchasing allowances while businesses adjusted to carbon pricing. There are three groups eligible for free allocation of allowances, including fishing, forestry, and EITE industries.

Industry allocation is based on protecting the competitiveness of certain industries against international peers that do not face equivalent carbon policies, mainly aluminium smelting, cement, iron and steel. A participant must pass two tests before being eligible:

- A trade exposure test – based on whether the sector output is traded between different countries and whether the output price currently includes carbon costs (e.g. dependent on if the price is set in countries where carbon is priced or new investments are made with a carbon price in mind).
- Emissions intensity test – only those participants over a threshold of 800 tCO_2e per NZ$1 million of revenue are eligible for free allocation.

In addition, an output-based allocation of free allowances is used (i.e. based on a firm's actual annual output or production), which means the marginal cost for increasing production does not change as a result of the carbon price, as allocations are proportionate to increased activity. Therefore, there is a full carbon price incentive for investments that improve efficiency, but none to reduce overall production. Free allocations for industry will be phased out by 1% per year.[60]



Evaluation of Carbon Policies

The carbon police described in Section 3 have been evaluated against a set or criteria (Table 3) using a rating system (Table 4), both of which have been co-developed between Energy Systems Catapult, the University of Leeds, and the Climate Change Committee. While the purpose of this report is to specifically assess carbon polices that enable deep decarbonisation of industry in line with Net Zero pathways while simultaneously mitigating carbon leakage and competitiveness impacts, it has also assessed other key characteristics covering feasibility and cost.

Inevitably there is a significant element of uncertainty that arises from using the rating system set out. In addition, for the purposes of this evaluation, the ratings have not been weighted and should be considered with this in mind. A policy's performance and overall effectiveness, including the ability to mitigate carbon leakage and competitiveness impacts, will ultimately depend on the detailed designed and precise implementation, with variation across different industrial sectors. Therefore, the evaluation has been carried out applying an overarching and balanced approach, which treats each criteria as if all else is equal. In addition, the nuance of specific policy design, in particular impacts on cost characteristics, will ultimately vary with the chosen approach. Timings of policy, especially where markets need to develop, is another nuance the rating system is unable to capture – this is discussed in more detail in the next section.

Criteria

Table 3 Grouping of criteria used for evaluation of carbon policies.

Grouping	Criteria	Notes
Feasibility and Deliverability	Implementation Time	Indication of policy complexity and implementation and mitigation timings
	Technical Feasibility (including Measurability)	Requirement of new metrics and monitoring, reporting, and verification methodologies.
	Political and Legal Challenges	Susceptibility of the policy to political and/or legal challenge.
Cost Characteristics	Cost to Taxpayer	Potential cost to the taxpayer or revenue generation.
	Effect on Cost of Capital	Certainty the policy can provide to industry to invest.
	Socioeconomic Distribution of Cost	Regressive (cost borne by industry/consumers) or progressive (cost borne by the taxpayer) nature of the policy.
Carbon Reduction Potential	Achieving Net Zero	Strength of incentive to reduce emissions in line with a Net Zero pathway.
	Consumption-Based Emissions	Coverage of consumption-based emissions.
Key Additional Challenges	Carbon Leakage and Competitiveness Impacts	Ability to mitigate carbon leakage and competitiveness impacts.

Rating System

The rating scales from red to blue with white being neutral, for example, for 'Cost to Taxpayer' a white rating means the policy does not come at a cost to the taxpayer, but nor does it generate revenue.

Table 4 Rating system used for evaluation of carbon policies for each criteria.

Criteria	Rating			
Implementation Time	• Mitigation benefits of the policy could be realised after 15+ years.	• Mitigation benefits of the policy could be realised in the next 10-15 years.	• Mitigation benefits could be realised within the next five years.	• Mitigation benefits of the policy could be realised within the next two years.
Technical Feasibility (including Measurability)	• The policy would require significant new data or metrics for implementation. • There are significant uncertainties in the monitoring, reporting, and verification methodologies.	• The policy would require new data for implementation, but metrics are relatively well established. • There are some uncertainties in the monitoring, reporting, and verification methodologies.	• The policy would require some new data for implementation and metrics are well established. • The monitoring, reporting, and verification methodologies are well established.	• Existing data and metrics can be used for implementation. • The monitoring, reporting, and verification methodologies are well established.
Political and Legal Challenges	• The policy is likely to be receive significant political and/or legal opposition/ challenge.	• The policy is likely to receive some opposition, but less likely to receive legal challenge.	• The policy is politically supported and there is no precedent for legal challenge.	• The policy is highly politically supported and there are no foreseeable reasons for legal challenge.
Cost to Taxpayer	• The policy comes at a significant cost to the taxpayer.	• The policy comes at some cost to the taxpayer.	• The policy can generate revenue.	• The policy can generate significant revenue.
Effect on Cost of Capital	• The policy creates uncertain signals that affects industry's willingness to invest highly in capital costs of projects.	• The policy creates poor signals that affects industry's willingness to invest in capital costs of projects.	• The policy creates reasonable signals that begins to encourage industry to invest in capital cost of projects.	• The policy creates clear signals that encourages industry to invest in capital cost of projects
Socioeconomic Distribution of Cost	• The distribution costs from the policy are highly regressive. • The cost is entirely borne by industry/ consumers.	• The distribution costs from the policy are somewhat regressive. • The cost is mostly borne by industry/ consumers.	• The distribution costs from the policy are somewhat progressive. • The cost is mostly borne by the taxpayer.	• The distribution of costs from the policy are highly progressive. • The cost is entirely borne by the taxpayer.
Achieving Net Zero	• The policy does not provide incentives for emissions reduction in line with a Net Zero pathway.	• The policy provides weak incentives for emissions reduction in line with a Net Zero pathway.	• The policy provides reasonable incentives for emissions reduction in line with a Net Zero pathway.	• The policy provides strong incentives for emissions reduction in line with a Net Zero pathway.
Consumption-Based Emissions	• The policy could significantly increase the UK's consumption-based account. • The policy encourages importing from emissions-intensive regions.	• The policy could increase the UK's consumption-based account. • The policy could encourage importing from emissions-intensive regions.	• The policy could decrease the UK's consumption-based account. • The policy could discourage importing from emissions-intensive regions.	• The policy could significantly decrease the UK's consumption-based account. • The policy discourages importing from emissions-intensive regions.
Carbon Leakage and Competitiveness Impacts	• The policy could significantly damage the competitiveness of UK industries in international markets. • The policy could induce carbon leakage in a number of sectors.	• The policy could damage UK industrial competitiveness in certain sectors and international markets. • The policy could induce some degree of carbon leakage in certain sectors.	• The policy could improve the UK's industrial competitiveness in certain sectors and international markets. • The policy could limit carbon leakage of UK industry.	• The policy could improve the UK's industrial competitiveness across most sectors in international markets. • The policy could prevent carbon leakage of UK industry.

Evaluation

Table 5 Evaluation of carbon policies to mitigate carbon leakage and competitiveness impacts.

Criteria	Carbon Standards				Carbon Pricing					Carbon Subsidies		
	Mandatory Minimum Requirement: Standards on Producers with Border Standards	Mandatory Minimum Requirement: Standards on Purchasers	Flexible Compliance: Standards (Incentives) on Producers with Border Standards	Flexible Compliance: Standards (Penalties) on Producers with Border Standards	Carbon Tax Rebates	Carbon Tax Exemptions	Cap and Trade Free Allocation of Allowances: Fixed Sector Benchmarking	Cap and Trade Free Allocation of Allowances: Output-Based Allocation	Border Carbon Adjustment Mechanisms	Low Carbon Public Procurement	Carbon Contracts for Difference	Direct Funding
Implementation Time												
Technical Feasibility (including Measurability)												
Political and Legal Challenges												
Cost to Taxpayer												
Effect on Cost of Capital												
Socioeconomic Distribution of Cost												
Achieving Net Zero												
Consumption-Based Emissions												
Carbon Leakage and Competitiveness Impacts												

Timings and Phasing of Carbon Policies

The timing and phasing of carbon policies to enable deep decarbonisation of industry are crucial for the success of mitigating carbon leakage and competitiveness impacts and must account for:

- The existing framework of policies, especially where additional measures may increase administrative complexity for firms. It may be desirable to streamline existing carbon policies or phase measures to minimise overlapping and additional administrative burdens.
- The variations in policy implementation times, taking account of technical feasibility and measurability, of the different approaches. The evaluation (see Table 5) points to an overall transition from subsidies in the near-term allowing time to overcome the technical, political, and legal challenges of implementing a border carbon adjustment mechanism and mandatory standards applied to both domestically produced products and imported products (i.e. at the border).
- Each industrial sector will decarbonise at different rates and cannot all move at the same pace, especially where implementation of low carbon technologies is limited in the near-term. There will also be variation between smaller sites and industrial clusters. This suggests Net Zero policy pathways that potentially vary for industrial sectors and regions.
- Ensuring incentives remain for low carbon products that are exported, especially in the near-term when global action remains relatively nascent, will continue to be a key consideration of policy choice and design.
- The dynamic variation in trade exposure of different sectors over time.

Providing detailed examples of policy pathways for the different industrial sectors is out of scope for this report, therefore, the following should be seen as a broad proposed direction of travel for policy. In essence, this sees a transition from subsidy-based support in the near-term to the longer-term use of standards, including at the border, to both mitigate carbon leakage and enable deep decarbonisation of industry in line with Net Zero. These should also be considered as part of wider policy packages, including a market for negative emissions. Figure 5 illustrates an example of overall timings and of phasing of carbon policies between now and 2050:

- Immediate steps can be taken to realise benefits in the near-term, including continuing to provide direct funding and by improving the methodology for allocation of free allowances under a UK ETS. These can build on existing policies, which is important for business continuity in the context of Brexit and impacts of COVID-19.
- Alongside these, design and implementation of additional support measures such as low carbon public procurement practices and carbon contracts for difference can play an important role for beginning to develop low carbon markets.
- In the interim, a border carbon adjustment mechanism could be developed as part of a longer-term pathway, which could be integrated with a UK ETS and form the basis for wider coverage of standards on producers.
- Over time, these could be phased down as longer-term policies are fully implemented, including standards on carbon for both purchasers and producers, with border standards eventually used for the latter.
- The phasing of these will enable industry to adjust, with a UK ETS and the wider set of standards tightening over time in line with carbon budgets.

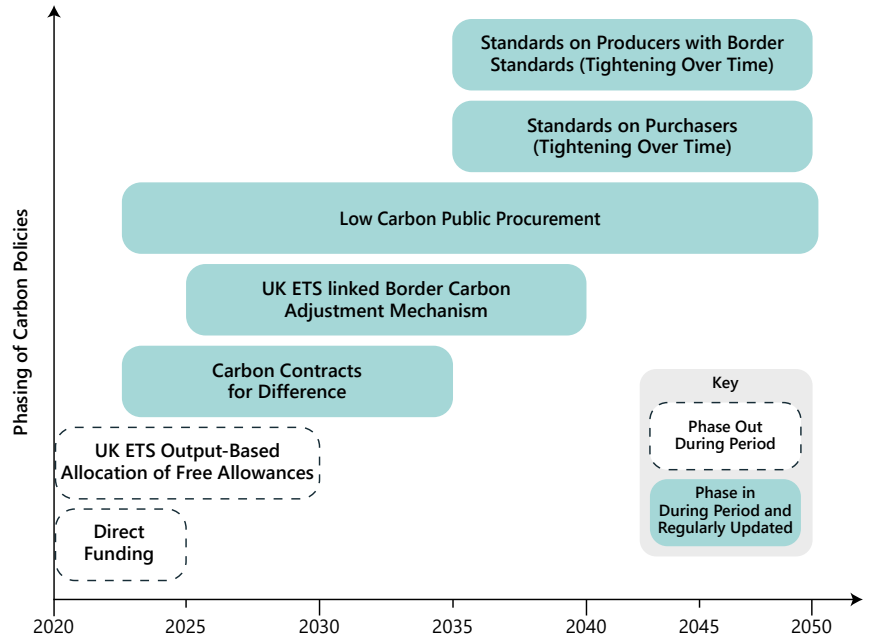


Figure 5 Potential timings and phasing of carbon policies to enable deep decarbonisation of industry in line with Net Zero and for mitigating carbon leakage and competitiveness impacts.

Recommendations for Policymakers

The decision over carbon policy coverage and stringency often involves balancing the trade-off between political economy considerations (i.e. generating sufficient acceptance for carbon policies) and the desire to avoid economic distortions (i.e. undermining the rationale for introducing the carbon policy in the first place). This trade-off is further emphasised when potential competitiveness impacts arise that could lead to carbon leakage and further offshoring of UK emissions.

Ultimately, the decisions surrounding the implementation of carbon policies will be made by policymakers that need to weigh feasibility and deliverability alongside cost and the political and diplomatic effort required to introduce more ambitious policies such as border standards. Above all, the policies that are eventually used must enable industrial decarbonisation in line with Net Zero while also, as far as possible, minimising negative and maximising positive competitiveness impacts for affected UK industrial firms.

The following recommendations are intended to provide the direction for an overall approach to industrial decarbonisation that would most effectively mitigate carbon leakage and competitiveness impacts in line with the Climate Change Committee's Sixth Carbon Budget Pathways:

1. Study the policy pathways required for industrial sectors, in particular, where competitiveness impacts affect investment decisions, including differences between cluster and non-cluster based firms.

2. In the near-term, continue to provide support to industry through direct funding and explore alternative policy measures, for example, carbon contracts for difference for low-regret projects.

3. During Phase I of a UK ETS, implement improvements in the methodology for allocation of free allowances, for example, by using output-based allocation. These should be phased down during the 2020s and potentially replaced with a targeted border carbon adjustment mechanism calibrated to align with the UK ETS price and phased in from 2025.

4. Explore the use of standards on both producers and purchasers as part of the long-term policy framework to enable industrial decarbonisation. To begin, standards on producers could employ a form of flexible compliance, for example, tradable performance standards. Standards on purchasers could be initiated through a low carbon public procurement programme providing initial demand for low carbon products, before expanding to cover other sectors.

5. In the long-term, to ensure that the implementation of standards is aligned with Net Zero levels of ambition while mitigating competitiveness impact, explore options to impose standards on producers at the border on imported products.

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