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POLICY BRIEF

BENEFITS OF A LONG TERM FLOOR PRICE FOR UKETS

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SUMMARY

The current design of the UK Emissions Trading System (UKETS) includes an Auction Reserve Price (ARP) for allowances, set at £22/tCO_2. This effectively establishes a minimum price, or price floor. The Government is now considering potential changes to the UKETS, including whether the ARP should be replaced with another mechanism, kept in its current form, or abolished.

This report examines the benefits of a carbon price floor in the UKETS. A price floor can improve the operation of the market, safeguarding against the risks of excessively low carbon prices, and enhancing the role of price discovery. It can do so without increasing total costs to consumers, and in the long term will reduce them.

This report concludes that the price floor in the UKETS should be extended rather than abolished. This would benefit a range of stakeholders.

For **investors in low carbon technologies** it:

- reduces the costs of low carbon investment by removing the risks of very low carbon prices, and so reducing cost of capital, while increasing expectations of average carbon prices; and
- increases the stability of the UKETS, thus enhancing its political sustainability and further reducing risks

For the **government** it:

- makes auction revenues more certain;
- reduces the risks of large payments under CfDs on the carbon price; and
- ensures that low cost abatement is incentivised, reducing the overall costs of meeting carbon budgets.

For **energy consumers** it:

- ensures that bills are lower over time than they would otherwise be, due to reduced costs of transition to a low carbon system; and
- compensates for any rise in prices to consumers as needed, by some combination of free allocation, direct financial compensation, and appropriate electricity market design.

For the **climate** it:

- reduces the effective cap if allowances unsold at auction are cancelled;

- reduces cumulative emissions over time, as enhanced action now helps ensure currently legislated carbon budgets are met, and enables tighter caps and more ambitious carbon budgets in future as emissions head towards net zero.

These benefits sit alongside a continuing need for policies complementary to the UKETS. These include measures to support the deployment of new low carbon technologies.

In contrast there are **no significant advantages to abolishing the current Auction Reserve Price (ARP**), which specifies the minimum price at which allowances may be sold at auction. Indeed, there would be substantial costs in the form of increased risks and loss of these benefits from abolishing the ARP. Although there is uncertainty about the appropriate level for a floor, the absence of a defined floor in effect sets the price floor at zero, which is certainly the wrong level.

Around the world, **the use of price floors in emissions trading systems is growing**, with almost a dozen examples to draw on. In contrast only the EUETS manages quantities without direct reference to price, using the market stability reserve. This reflects the particular history and circumstances of the EUETS.

Price floors can be imposed by **auction reserve prices, or by top-up taxes** that make up the difference between the allowance price and the floor. An auction reserve price is typically used when the floor applies across the whole ETS. A top-up tax is typically used when the floor covers only part of the system, for example one country in the EUETS.

Price floors should be set to increase over time in a pre-defined way, especially given the long time horizons for investment on operation in the energy sector and industry. All of the North American systems with price floor - California, Quebec, RGGI and Nova Scotia – include indexation of the auction reserve price. Defined trajectories for price floors to 2030 are included in the Netherlands carbon tax. The new German system has increasing prices during the initial fixed price period. The UK carbon price floor was originally set to increase over time, although this provision was subsequently eliminated.

Systems have been successful in maintaining prices at or above the floor. For example, the California system has been in place for approximately a decade. It has maintained the price above the floor except for brief periods in 2016, when there was uncertainty about the continued existence of the system due to political and legal challenges, and again in 2020 at the start of the Covid19 pandemic. In the UK, Carbon Price Support has led to higher minimum carbon prices in power generation, leading to substantial emissions reductions (see Annex 2).

It is beyond the scope of this report to suggest an appropriate level for the floor price. However we note that most of the reference points that could be used to set a floor price suggest a level higher than the current ARP.

INTRODUCTION

The current design of the UK Emissions Trading System (UKETS) includes an Auction Reserve Price (ARP) for allowances, set at £22/tCO_2. This effectively establishes a minimum price, or price floor[1]. The Government is now considering potential changes to the UKETS, including whether the ARP should be replaced with another mechanism, kept in its current form, or abolished.

A price floor can take the form of an ARP, as at present, or a top-up tax (see box). While the UKETS is standalone, an auction reserve price is likely to be a more appropriate mechanism for imposing a floor. However, if the UKETS were linked to the EUETS then a top-up tax may become more appropriate, depending on the form of linkage.

In either case the price floor should have a specified trajectory over time to give predictability to investors. Investments in energy and industrial production often take some years, and they may operate for decades. Longer term confidence in the carbon price is therefore helpful. Nevertheless, other policy instruments such as carbon contracts for difference will often be needed to secure investment.

This briefing describes:

- the benefits of enhancing the current arrangements by introducing a predictable long-term price floor;
- international experience of price floors; and
- Reference points for setting the level of the floor.

Annex 2 gives further details of individual systems.

[1] This is distinct from provisions to respond to rapid changes in relative price levels, which are also included in the UKETS.

DIFFERENT WAYS OF ESTABLISHING A PRICE FLOOR

Auction reserve price (ARP)

An effective carbon price floor can be introduced into an ETS by setting a reserve price, which specifies the minimum price at which allowances can be sold at an auction. This minimum price typically rises over a period of years, often with an explicit rate of increase. For example, California, Quebec and Nova Scotia all have price floors which increase at inflation plus 5% p.a..

An ARP automatically leads to a reduced quantity of allowances being made available in the market if the market price is below the reserve price.

The reserve price is not an absolute floor, as prices in the market can dip below the reserve price. However if prices remain below the reserve price, then the reduction in supply from unsold allowances at auction is likely to restore the price quickly, assuming that a large enough proportion of allowances is auctioned.

A further consideration for ARP design is whether any allowances unsold at auction are retained for future use, or permanently removed, for example immediately after the auction or at the end of each phase of the ETS. Allowances unsold at auction may be retained by holding them in a reserve for release in future if needed. This may result in a smoothing or a reduction of total cumulative allowance supply, depending on whether all allowances are later returned to the market.

Mechanisms to establish price floors can be extended to create a stepped floor, by setting different reserve prices for different tranches of allowances. This can in effect offer a supply curve into the market, representing different prices and quantities of abatement. Indeed, something like this already exists in the California system where the effect of the price floor is supplemented by a price containment reserve, which is released in stages at successive price thresholds.

Reserve prices in emission trading systems resemble similar features in many types of auctions for different sorts of products. Reserve prices are put in place, for example, to prevent an authentic Rembrandt selling for a few pounds, or an eBay offering selling for a few pence, or houses in property auctions selling for well below their normal market value. However these auctions often differ in that the reserve price is not published and so not known to the market. In contrast, in carbon market auctions the reserve price is usually published.

A top-up tax

An alternative approach to implementing a price floor is a tax that in effect "tops up" the carbon price when it is below a predetermined floor. When the allowance price is below the floor a tax is payable equal to the difference between the allowance price and the floor. However, if the allowance price is equal to or above the floor then no tax is payable. The price floor will, as with an auction reserve price, typically rise over a period of years. For example, the Netherlands carbon taxes have defined price floors increasing each year to 2030.

Top-up taxes are most commonly used where the floor applies to only a proportion of emissions covered by an ETS. In these cases an auction reserve price would have a minimal effect on the wider EUETS, so would not be effective in setting a price floor.

Allowance Buy-backs

The government (or other entity) may buy back allowances from the market at a specified price. However this risks imposing large costs of buybacks on government. It has been little used in practice, with the only example being some provisions under the Beijing pilot ETS. It was also discussed in New Zealand but never implemented. It seems unlikely to be used in the UKETS or EUETS, so is not reviewed further in this briefing.

SECTION 2. ADVANTAGES OF A PRICE FLOOR

Advantages of including a price floor within the design of an ETS have long been recognised. It has clear benefits when compared with a simple ETS, which allows prices to fall to any level[2]. A floor can remedy the risk of carbon prices which are too low to adequately incentivise investment necessary to meet targets, including net zero, and too low to reflect the environmental damage caused by emissions. Although there is uncertainty about the appropriate level for a floor, the absence of a defined floor in effect sets the price floor at zero, which is certainly the wrong level.

Excessively low carbon prices can arise if demand for allowances is lower than expected. This may be due to, for example, weaker economic growth, lower costs of technologies that reduce emissions, or greater effectiveness of complementary policies. Without a price floor such outcomes can lead to allowance prices falling to very low levels, as happened under the EUETS in the 2010s.

Further advantages of a price floor are becoming apparent as policy evolves. In particular, policies to establish contracts for difference on the carbon price (CCfDs) as a mechanism for supporting low carbon investment are being developed[3]. These require higher payments by government (or other parties) to investors if the carbon price is low. Under such a mechanism a carbon price floor can eliminate the risk of larger payments under the CCfD due to very low carbon prices.

The range of benefits

Benefits of price floors accrue to a range of stakeholders. The major types of benefits are summarised below. The advantages largely apply whether the price floor is in the form of an ARP or a top-up tax, but with some differences in detail noted.

[2] This paradigm of choice of instrument under uncertainty was first established in Weitzman, M. L. (1974). Prices vs. quantities. Review of Economic Studies, 41(4):683-691, one of the most cited papers the environmental economics literature. The advantages of hybrid instruments were originally set out in Roberts, M. and Spence, M. (1976). Effluent charges and licenses under uncertainty, Journal of Public Economic, 5(3):193-208). For more recent discussions of price floors, see the following and references therein:
Pizer, W. A. 2002. Combining Price and Quantity Controls to Mitigate Global Climate Change. Journal of Public Economics 85:409-434
D. Burtraw, K. Palmer, & D. Kahn, A Symmetric Safety Valve, 38 ENERGY POL'Y 4921 (2010);
P.J. Wood & F. Jotzo, Price Floors for Emissions Trading, 39 ENERGY POL'Y 1746 (2011). Energy Policy 39 (2011) 1746–1753. Grubb, M. (2012).
Strengthening the EU ETS. Creating a stable platform for EU energy sector investment. Climate Strategies Full Report (www.climatestrategies.org). When is a carbon price floor desirable? David M. Newbery, David M. Reiner, Robert A. Ritz* Energy Policy Research Group (EPRG) Judge Business School & Faculty of Economics Cambridge University, U.K. June 2018

[3] T. Gerres & P. Linares. (2020). Carbon Contracts for Differences: their role in European industrial decarbonization. https://climatestrategies.org/publication/carbon-contracts-for-differences-their-role-in-european-industrial-decarbonisation/

In all cases the benefits from stability and reduced risks are much greater if the price floor is specified in advance for a number of years.

Benefits to investors in low carbon technologies

Reducing costs of abatement by providing greater certainty for investors. A minimum carbon price can support investments in low carbon technologies by reducing or eliminating the risks that carbon prices will be low, and that investments will consequently be unprofitable.

This reduction in risks can facilitate the financing of projects and so reduce the cost of capital. This will in turn reduce the overall costs of investment. These effects are widely recognised by policy makers. For example, the European Commission has stated that "A stable carbon price signal is one of the elements that can improve the investment climate for low-carbon investments."[4] As noted, long investment cycles imply stability is needed over longer periods.

Increasing expected average carbon prices. A floor on the carbon price removes the lower part of a price distribution. Other things being equal, this will increase expected average prices. A price floor thus makes the price both less volatile, and so less risky, and higher on expected average. This will in turn stimulate additional investment. In contrast a price ceiling makes the price less volatile but lower on average, because the probability of very high prices is reduced or eliminated.

Greater political stability for the UKETS. A price floor improves the operation of the market and enhances the role of price discovery by building robustness to unexpected outcomes, such as very low prices, into market design. This robustness can lead to reduced price volatility and reduced risks for both investors and government. This can in turn help sustain the political acceptability of the system, and reduce the need for ad hoc, unpredictable changes or interventions. This will further reduce risks for investors.

Benefits for government

Providing more stable government revenue from allowance auctions. Low prices can lead to low auction revenue for governments, and potential disruption to funding of government spending programmes. In contrast, with a price floor government auction revenue is unlikely to fall to very low levels (unless very many auctioned allowances go unsold). The risk under an ARP that allowances will be unsold does not occur with a top-up tax.

Reducing risks for governments of high payments under carbon contracts for difference (CCfDs). CCfDs are planned to provide support for low-carbon technologies, including CCS, in both the UK and EU. Low allowance prices could lead to large payments by governments under CCfDs. A price floor prevents this, and so protects government against higher expenditure. This may in turn enable a greater volume of CCfDs to be issued, with consequent increases in the deployment of low carbon technologies.

Making sure that low cost abatement is incentivised. If prices can go to low levels there is a risk that emissions reductions will not be incentivised, even if they are clearly cost-effective (with environmental benefits greater than the cost of abatement), and clearly needed as part of a comprehensive programme of emissions reductions. A price floor avoids these risks, strengthening the market and providing a clear signal to investors to undertake low cost investments. This reduces the overall costs to the economy of meeting carbon budgets.

Benefits for consumers

Reducing bills for consumers. Lower costs for technologies, and signalling investment in low cost abatement from a price floor will reduce the costs of the transition to low carbon energy system. This will in turn benefit consumers in the form of lower bills from lower prices, and reduced consumption

[4] European Commission, Staff Working Document, Impact Assessment Accompanying the Document Proposal for a Directive of the European Parliament and of the Council Amending Directive 2003/87/EC to Enhance Cost-Effective Emission Reductions and Low-Carbon Investments, 15.7.2015 SWD(2015) 135 final

through greater energy efficiency.

Benefits for the climate

Reducing cumulative emissions by cancelling unsold allowances. If allowances are unsold at the auction reserve price they may be cancelled, reducing supply and tightening the cap. This mechanism does not apply to a top-up tax, where the number of allowances is not directly affected.

Reducing emissions by enabling more ambitious targets to be set. Reducing the costs of low carbon investment can enable future caps to be more ambitious, and thus to secure further environmental benefits in future. Both an auction reserve price and a top-up tax can reduce future emissions in this way.

These benefits sit alongside a continuing need for policies complementary to the UKETS. These include measures to support the deployment of new low carbon technologies. For example, the Government is currently in the process of establishing business models for industrial CCS and low carbon hydrogen, and these developments needs to continue.

Despite these advantages, some commentators raise objections to price floors. However, none of the objections have much force. The objections and responses to them are briefly summarised in Annex 1.

Protecting consumers from price rises

Carbon prices may in some cases be higher with a floor. This may raise prices to energy consumers. The effect of a price floor on residential consumers' bills is small - typically around a hundred times smaller than current price increases in the absence of government action[5]. Any concerns about higher prices for residential or business consumers can be readily addressed simply by modifying or extending existing and prospective solutions. This includes the following.

- Allocating allowances free of charge or introducing Carbon Border Adjustment Mechanisms can continue to reduce the risks of carbon leakage for emissions intensive trade exposed industry.
- Direct financial compensation to electricity consumers is in place for some consumers and could be readily extended, for example by using auction revenue to further compensate customers or to fund energy efficiency measures.
- Moving away from marginal cost pricing in wholesale electricity markets would reduce the extent of the effect of carbon prices, as renewables and nuclear do not incur any allowance costs in any case.[6]

[5] For example, if the price floor leads to carbon prices £23/tCO_2 higher than they would have been and full marginal cost pricing were retained in electricity wholesale markets (both of which currently seem unlikely, with typical electricity consumption of 2.9MWh p.a. then each consumer's bill would increase by around £27p.a., about 1% of the currently expected increase in bills for 2022/3 in the absence of government intervention.

[6] For discussion of this see: https://www.aldersgategroup.org.uk/publications/post/delivering-competitive-industrial-electricity-prices-in-an-era-of-transition/?origin=/key-policy-areas/
and https://www.ucl.ac.uk/bartlett/sustainable/research-projects/2022/sep/reforming-electricity-markets-low-cost-and-low-carbon-power#Publications

SECTION 3: INTERNATIONAL EXPERIENCE

The advantages of price floors have led a range of jurisdictions around the world to adopt them. There are now almost a dozen instances of price floors:

Auction reserve prices are found in:

- The **California** system. **Quebec**, has very similar arrangements.
- The **Regional Greenhouse Gas Initiative** (RGGI) in the north eastern USA.
- Carbon pricing in **Germany** for sectors not covered by the EUETS
- Price containment mechanisms in **New Zealand**
- The **UKETS** auction reserve price
- The **Nova Scotia** cap and trade system
- The previous **Australian** system

Use of taxes to create price floors are found in

- **UK** carbon price support
- The **Netherlands** carbon taxes in industry and power generation.
- The **Norwegian** carbon tax

Arrangements in each jurisdiction are reviewed in Annex 2. In addition, Canada has specified a national minimum price on carbon. However this is in practice implemented through systems in each province, which may be either emissions trading systems or carbon taxes.

The current price floors and scheduled increases are summarised in the table below. Some prices are currently at levels similar to the UK ARP, or below, though prices in Germany outside the EUETS, industry in the Netherlands, and Norway are already higher. Furthermore, all prices outside the UK are scheduled to increase over the next few years, with levels in European jurisdictions reaching well above the current UK ARP.

Jurisdiction	Level of Floor 2022 (per tonne CO2)	Scheduled increase
California	$17.90	Inflation plus 5% p.a.
RGGI	$2.44/short ton	2.5% p.a.
Germany	€30	€55 by 2025
New Zealand	NZD30	NZD39 by 2026
UKETS	£22	None
Nova Scotia	C$22.92	Inflation plus 5% p.a.
UK Carbon Price Support	£18	None
Netherlands industry	€40.56	€125 in 2030
Netherlands power generation	€14.48	€31.9 in 2030
Norway	NOK 705 (natural gas)	NOK2000 by 2030 (target for total of tax and EUA price)

A number of features of price floors are evident from this international experience.

The use of price floors is growing over time. For example, their use in current form in the New Zealand system is relatively recent, as are the German ETS and the Netherlands carbon taxes.

Choice between auction reserve prices and top-up taxes has depended on whether the floor applies across the whole ETS. An auction reserve price has been chosen where is covers the whole market, for example in California, Germany and the UKETS to date. A top-up tax has been chosen where the jurisdiction is a small part of the wider system (in practice the EUETS) as in the Netherlands, and for carbon price support in the UK, which was introduced when the UK was still a member of the EU. The top-up tax approach is needed because auctioned volumes in each jurisdiction are a small portion of the total.

Price floors increase over time in a pre-defined way. Indexation of the auction reserve price is found in all of the North American systems: California, Quebec, RGGI and Nova Scotia. Defined trajectories for price floors to 2030 and found in taxes in the Netherlands, (where there are separate trajectories for government and industry), and in Norway, where there is a target for the total of tax plus EUA prices. The new German system has increasing prices during the initial fixed price period. The UK carbon price floor was originally set to increase over time, although this provision was subsequently eliminated.

Price floors have been successful in maintaining prices at or above the floor. For example, the California system has been in place for approximately a decade. It has maintained the price above the floor except for brief periods in 2016, when there was uncertainty about the continued existence of the system due to political and legal challenges, and again in 2020 at the start of the Covid19 pandemic.

There are emerging examples of dealing with unsold allowances. In RGGI, the determination of what should be done with allowances that are withheld at the price floor is not clearly specified, but in practice they have been permanently cancelled. In California, allowances that are not sold at the reserve price are withheld from the market until the price in the quarterly auction has risen above the price floor for two consecutive auctions, and thereafter the withheld allowances can slowly be reintroduced in subsequent auctions. A primary motivation for this provision was to provide revenue stability for programs funded by the auction. In 2017, legislation that extended the cap-and-trade program through 2030 directed that some of the unsold allowances should be moved to the allowance price containment reserve and would enter the market only at high prices, as a form of cost containment.

Some systems have used different thresholds to create a stepped supply curve. For example, RGGI has different thresholds, although all are too low for efficient price signals. Some floors are

accompanied by price ceilings (see Annex 2).

In contrast there is only one instance of and ETS managing quantities directly, the EUETS Market Stability Reserve (MSR). Under this approach, quantities are managed by reference to a defined surplus of allowances, with no direct reference to price. For example, allowances are currently being withdrawn from the market and placed in the MSR despite the price of allowances being high relative to historic levels. The design of the MSR reflects the particular history of the EUETS, especially the emergence of a large surplus of allowances in the 2010s, and so provides limited lessons for other systems.

SECTION 4: SETTING THE LEVEL OF THE PRICE FLOOR

There are several reference points that can help set the level of a price floor. All are likely to be relevant to an assessment of the appropriate level of the floor. As with setting any carbon price or emissions limits, there will be an uncertain balance of costs and risks, including to the climate, with no unique optimum. There will therefore inevitably be a need to balance different risks involved.

A balance needs to be struck between starting level of the floor and increases over time. A higher starting point with lower subsequent increases can create more immediate signals. A lower starting point with higher subsequent increases can help smooth the transition to a floor.

Social Cost of Carbon (SCC). It is a well-established principle of environmental pricing that the price of emissions should reflect the costs of the damage they cause. This is the Polluter Pays Principle (PPP).

For carbon the cost of damages is referred to as the social cost of carbon (SCC). The US EPA has calculated a value of $51/ tCO_2[7], escalating over time. Other estimates are higher. A recent update of the Handbook on External Costs of Transport put a central value of the SCC at €90/tCO_2.[8] Other recent modelling suggests values of $300/$tCO_2$ (in $2015)[9].

Most estimates are likely to be an underestimate in practice, due to a range of factors including omitted costs[10]. Indeed, the concept of marginal damages that increase continuously with continuing emissions is fundamentally problematic for climate change, which is likely to result in discontinuities in damage ("tipping points"). The SCC may nevertheless form a reference point for a floor price, as there is confidence that it is at or (more likely) below the actual cost of damages, so prices should clearly not be below this level.

Costs of low carbon investment. A price floor could be set to reflect the marginal abatement costs from low carbon technologies, which provide alternatives to further emissions from existing carbon intensive processes. This might for example, be low carbon steel manufacture with hydrogen, CCS in chemicals, or switching to renewable electricity. This approach in effect seeks to use a Marginal Abatement Cost (MAC) curve to provide guidance on the minimum price.

Level needed to reach emissions targets. This involves a broader look at the costs of low carbon investment. Various estimates have been made of the carbon price needed to reach global carbon

[7] https://en.wikipedia.org/wiki/Social_cost_of_carbon#:~:text=the%20United%20States.-,United%20States,the%20US%20could%20be%20included.
[8] Ricardo-AEA, Update of the Handbook on External Costs of Transport: Final Report (Ricardo-AEA/R/ED57769, 2014). In the 2008 Handbook on External Costs of Transport, the value of €25 was used.
[9] https://www.repository.cam.ac.uk/bitstream/handle/1810/327715/pdf.pdf?sequence=3&isAllowed=y
[10] https://onclimatechangepolicydotorg.wordpress.com/carbon-pricing/8-the-social-cost-of-carbon/

targets. For example, the High-Level Commission on Carbon Prices[11] concluded that the carbon price should be between $40-$80 in 2020 and then between $50-$100/tCO_2 in 2030. The IEA has estimated carbon prices needed to reach net zero are $90-130/$tCO_2$ by 2030 and $200-250/$tCO_2$ by 2050[12]. The carbon price needed to stay below the 1.5 degree warming target has been estimated by the IPCC as $135 to $5,500/$tCO_2$ in 2030, and from $245 to $13,000 in 2050 (2010 US dollars).[13]

Historic prices. Efficient prices should increase over time as lower cost options are exhausted. Starting with past prices and escalating from there could ensure this. There will clearly be a need for careful selection of the relevant historical period to define the starting point.

Price floors in other carbon markets. Broadly similar prices in different jurisdictions can help provide consistent economic signals for emissions reduction. Many existing price floors, especially in North America, are currently low in comparison with the other reference points cited here. However, escalation provisions in most systems will increase prices over time, which may give more appropriate levels (see earlier table).

These reference points provide a wide range of evidence, and imply that setting a floor is entirely tractable, though subject to judgement. It is beyond the scope of this briefing to suggest an appropriate level for the floor price. However we note that most of the reference points suggest the need to reach a price floor above the current level of the ARP.

[11] https://www.carbonpricingleadership.org/report-of-the-highlevel-commission-on-carbon-prices

[12] International Energy Agency (IEA). 2021. "Net Zero by 2050—A Roadmap for the Global Energy Sector." Paris. Lower prices are found outside developed and major developing economies.

[13] IPCC SR15 Ch4 2018, p. 374

Annex 1: Limited validity of objections to price floors

Objections to price floors are sometime raised[14]. They usually centre around the view that the market achieves efficient outcomes by discovering a price that meets the cap, and interfering with this produces distortions that increase costs.

However, such outcomes are efficient only in the narrow sense that they meet the cap cost effectively. They do not always achieve pricing that allocates resources efficiently across the economy (allocative efficiency). Low prices will fail to signal appropriate low-cost abatement, and thus signal too little abatement and too many emissions[15]. Consequently, valuable abatement opportunities are missed. Prices which are too low indicate that the cap, which is set by political and administrative decision, is too high[16].

Carbon prices that are efficient in this broader sense of signalling efficient resource allocation need to be high enough to reflect the environmental costs of continuing emissions[17]. They also need to reflect the costs of emissions reductions required to reach emissions targets, including the eventual goal of net-zero[18].

More recently it has been argued that a price floor is superfluous given the increase in UK allowance prices. However there is always the possibility of future price falls (and if this does not happen the floor simply does not operate). A price floor removes this risk for investors, and consequently is valuable to them. In any case a floor may be above even recent EUA prices. For example, the minimum prices in the Netherlands and Norway (where the total of EUA price and tax is targeted) are set to reach €125/ tCO_2 and €200/ t respectively by 2030, above the EUA price prevailing in mid-2022.

Some of the most commonly made arguments against price floors are summarised in the Table 2, with brief commentary on why the objections are not valid.

[14] The material in this Annex draws extensively on: https://onclimatechangepolicydotorg.wordpress.com/2016/09/14/the-euets-and-the-need-for-price-floors-and-maybe-soft-ceilings/

[15] Because of the uncertainties in estimates or both costs and damages, it will be impossible to identify a single optimal price or optimal cap on the path to net zero. Instead there is a range of credible values for efficient carbon prices. A floor should at least stop the price falling below this range.

[16] Related to this, objections to price floors often fail to account for the lack of variability of supply with price under an ETS without a price floor. In almost all markets supply varies with price. The markets for tickets to major sporting events and for authentic works by dead artists are almost the only exceptions. This absence of a supply response to price in an ETS creates the corresponding risk of prices which are inefficiently low, failing to incentivise cost effective emissions reduction. An auction reserve price helps remedy this issue by reducing supply if prices would otherwise be below the floor. Top-up taxes don't adjust supply but do correct the price signal.

[17] Climate change depend on the stock of greenhouse gases in the atmosphere rather than the flow, and for any individual jurisdiction over limited period the damage from all emissions is similar (the damage function is almost flat). This is one reason favouring the use of price-based instruments such as a carbon tax or price floor.

[18] Complementary policies to achieve emissions reductions may have value, for example those to stimulate early deployment of new technologies. However carbon prices still need to be high enough to signal necessary investment, for example deploying more mature technologies. For example, the UK government is expecting investment in CCS to be increasingly signalled by the carbon price as deployment increases.

TABLE 2: OBJECTIONS SOMETIMES MADE TO PRICE FLOORS IN AT ETS

Objection to price floor	Reasons the objection is not valid
Arguments about economic efficiency	
"It's interfering with the market"	A price floor improves market design and operation, moving away from the rigidity of a single, administratively set cap. The supply of allowances (the cap) is set by political and administrative decision, and does not respond to price. Neither of these characteristics is a feature of most markets, where supply is set by costs and responds to price. An auction reserve price makes supply responsive to price, and so more like most markets where supply responds to price. In doing so it creates more effective and efficient pricing that stimulates more efficient resource allocation.
"It hinders price discovery"	Price discovery is about finding economically efficient prices through the interaction of supply and demand. Price discovery is still effective with a price floor. A price floor simply corrects allowance supply (or directly tops up the price) when the discovered price is below economically efficient levels.
"It runs counter to the quantity based nature of a cap and trade system"	An auction reserve price works through quantities, adjusting them in response to price. A system which includes both prices and quantities is more economically efficient.
"It reduces market efficiency"	It increases market efficiency by reducing the misallocation of resources arising from prices below the costs of damage, and below the costs of low carbon technologies necessary to meet emissions reduction goals. In effect low prices are the market is telling you that the current cap is too loose. With low prices there is a misallocation of resources towards too many emissions and too little abatement.
"If the cap is being met at low cost then low prices should be the outcome"	It will be better for the climate and more economically efficient to reduce emissions further by tightening the cap, as low prices indicate the availability of low-cost reductions.
Argument suggesting lack of benefits	
"It has no environmental benefit as the cap does not change"	Unsold allowances can be retired, reducing total emissions. Lower costs of investment due to the greater stability created by price floors, and the signalling of low-cost abatement, enable tighter caps now and in subsequent phases of the ETS.
"It is superfluous given current prices"	Current prices may not be sustained. Price floors need not be low compared with current prices.
Arguments about practicality	
"It is impossible to set the price at the right level"	Having both price and quantity limits increases robustness to the unexpected. With no floor prices can fall close to zero, which is clearly giving the wrong signal. Limiting the price recognises that future demand for allowances may be mis-estimated when setting the cap, or the level of the cap may be subject to biases, for example due to asymmetries of political risk from setting the cap too high or too low.

ANNEX 2: INTERNATIONAL EXPERIENCE OF MANAGING PRICES UNDER AN ETS

This Annex looks at how carbon price floors can be implemented in an emissions trading system (ETS)[19]. To provide additional context, it also looks at price ceilings. Price floors and ceilings are sometimes referred to as **price containment mechanisms**, or, if there is both a price floor and price ceiling, **price corridors**.

The examples considered here are from the following jurisdictions.

Mechanisms to manage auctions

- The **California** system. **Quebec** has very similar arrangements.
- The **Regional Greenhouse Gas Initiative** (RGGI) in the north-eastern USA.
- Carbon pricing in **Germany** for sectors not covered by the EUETS
- Price containment mechanisms in **New Zealand**
- The **UKETS** auction reserve price
- The **Nova Scotia** cap and trade system
- The previous **Australian** system
- The previous **Alberta** system

Use of Carbon Taxes to create price floors

- **UK** carbon price support
- The **Netherlands** carbon taxes in industry and power generation.
- The **Norwegian** carbon tax

Example 1: California – floors and ceilings

The California system has both a price floor and a price ceiling.

1.1 The auction reserve price sets the price floor.

Under the California ETS (Quebec has very similar arrangements) there is an auction reserve price set at $10/tonne in 2012, rising at 5% p.a. plus an inflation adjustment, reaching $19.70/tonne in 2022. Any allowances that are not sold at auction are retained by the regulator, the Air Resources Board (ARB), in an Auction Holding Account. The holding account allowances are not made available again through the auction until the price has exceeded the price floor for two consecutive quarterly auctions, and return is subject to a limit of 25% of the total allowances available at each regular quarterly auction. As a result, a surplus in the Auction Holding Account may take time to be drawn down.

The price in the California system has stayed above the auction reserve apart from a brief period in 2016 where there was political and legal uncertainty about the future of the system, and in early 2020 at the onset of the global covid-19 pandemic.

1.2 Allowance reserves to set a price ceiling

In California there is also an Allowance Price Containment Reserve (APCR) from which successive additional tranches of allowances are released if the price of allowances at auction exceeds certain thresholds or ceilings. Before 2021 this was at three price tiers of $40, $45, and $50/tonne in 2013, rising at 5% p.a. plus inflation thereafter. From 2021, allowances in the reserve were released at two price tiers with thresholds set at $41.40 and $53.20, and a price ceiling set at $65/tonne, all rising at 5% p.a. plus inflation. In 2022, these prices were $46.05 and $59.17, with a price ceiling of $72.29/

[19] The material in this section is largely drawn from here: https://onclimatechangepolicydotorg.wordpress.com/carbon-pricing/price-floors-and-ceilings/

tonne.

This is separate from the account used to maintain the price floor. Allowances are sold from the APCR on a quarterly basis if there is demand. The sale is held six weeks after the regular quarterly auction of allowances, allowing buyers to make up a shortfall after the auction. Buyers specify the number of allowances they want at any of the three fixed prices.

When the scheme began, 122 million allowances were scheduled put into the APCR for the period to 2020, equal to 4.5% of the overall cap across all years (including the maximum allowed offsets), and relative to a single year (2015) is 29% of the cap including the maximum allowed offsets. The APCR allowances were taken from within each year's capped total. The reserve was divided equally among the three price tiers.

1.3 The change from a soft to a hard ceiling

Price ceiling arrangements changed from 2021. Two price containment points triggered at increasing price levels are filled with remaining APCR allowances. A third price level is a price ceiling. At this level, allowances (or if no allowances remain, price ceiling units) can be bought in unlimited quantities, with the revenues having to be invested in additional emissions reductions of at least equal amount.

The ceiling has thus moved from being a soft ceiling with prices able to increase indefinitely, to a harder ceiling which prices should not exceed. This provision potentially somewhat weakens the environmental integrity of the cap but the provision to increase offsets to match helps maintain emissions reductions at an equivalent level.

Example 2: The Regional Greenhouse Gas Initiative (RGGI) – floors and ceilings but at price levels which are too low

The design of RGGI has both a price floor and a price ceiling. However prices for both are below levels likely to signal enough abatement.

2.1 Auction reserve price to set a floor

RGGI, which covers power sector emissions from several states in the north eastern USA, also includes an auction reserve price. However, the reserve price is much lower than in California, at $2.44/short ton in 2022 rising at 2.5% p.a. in nominal terms. Allowances unsold at auction prior to 2014 are retained by the authorities and can be auctioned again, but allowances unsold at the end of each 3 year control period (the scheme is currently in its fifth control period which lasts from 2021-2023) may be retired permanently at the discretion of individual states. This gives a mechanism for tightening the cap if there is a surplus of allowances at the price floor over an extended period.

2.2 An allowance reserve to set a price ceiling

RGGI also has a costs containment reserve (CCR) of additional allowances that can be released into the auction when the auction clearing price rises above a certain threshold. The prices at which allowances are released are much lower than in California, being $4/short ton in 2014 rising at $2/short ton p.a. to reach $10/short ton in 2017, escalating at 2.5% p.a. thereafter. The CCR allowances are in addition to the cap, and balances are re-set annually to 10 million tons (which is just over 10 percent of the 2014 cap of 91 million tons plus allowable offsets of 3% of the total) if allowances are drawn down from the CCR. The CCR trigger price is $13.91/$tCO_2$ in 2022 rising at 7% p.a..

An Emissions Containment Reserve (ECR) was introduced for RGGI from 2021. The trigger price at which allowances would be withheld from auction was set at $6, increasing by 7% p.a. thereafter. 10% of allowances are auctioned only if the price rises above this threshold (which rose to $6.42/$tCO_2$ in 2022. This has given RGGI, like California, a stepped supply curve.

Example 3: Germany – fixed price followed by price floor and ceiling

In 2021 Germany introduced a national ETS for transport and buildings, which are sectors outside the current scope of the EUETS . Allowances are sold at a fixed price, increasing annually from €25/t in 2021 to €55/t in 2026. In 2026 the system will transition to an auction based ETS, with a floor set at €55/t and a ceiling at €65/t. The floor and ceiling are imposed in the form of minimum and maximum auction prices. A decision on floors and ceiling from 2027 onwards will be taken in 2025, and may depend in practice on developments at EU level.

This type of system is broadly similar to the previous Australian system (see below).

Example 4: New Zealand – price floor and ceiling

With the start of auctioning in 2021, New Zealand's Government introduced an auction reserve price of NZD 20 ($14.15), increasing at 2% p.a. This was revised to NZD 30 ($21.22) for 2022 and will increase to c. NZD 39 ($27.59) by 2026.

New Zealand has also introduced a cost containment reserve that triggers the release of allowances if the unit price reaches NZD 50 ($35.37) in 2021, increasing at 2% p.a.. For 2022 the CCR trigger price was updated to NZD 70 ($49.51) following advice from the Climate Change Commission. The total volume in the reserve is approximately 7 million tonnes per annum, implying that this is a soft ceiling. The reserve volume will remain at 7 million tonnes per year until 2024 and will subsequently fall to 6.7 million by 2026.

Example 5: UKETS auction reserve price – price floor

The **UKETS** began operation in 2021. It replaced the EUETS following the UK's departure from the EU. It has a reserve price for early auctions of £22/tonne.

Example 6: Nova Scotia – price floor and ceiling

Under the Nova Scotia cap and trade system, for auctions held in 2022, the minimum price is $22.92. The minimum price per allowance will increase annually by 5% plus inflation, similar to the arrangements in the California and Quebec systems.

There is a cost-containment reserve to provide a ceiling. The price at which allowances are released was $50 per tCO_2e in 2020, rising annually by 5% plus inflation.

Since May 2018, Nova Scotia has been a member of the Western Climate Initiative (WCI), which provides technical services and support for the province's cap-and-trade program. However the system itself it is not linked to any jurisdictions.

Example 6: Former Australian system - fixed price with a subsequent floor

The former Australian system introduced in mid-2012 had a fixed price, at an initial level of AU$23/$tCO_2$, escalated at 5% p.a. nominal. It was intended to run for the first three years of the scheme. The fixed price was set by selling an unlimited number of allowances at that price. In practice it ran for approximately two years, until the scheme was abolished.

The system also had a planned price floor of $15/$tCO_2$, and a planned a price ceiling set at $20/$tCO_2$ above the prevailing international credit price. The floor and ceiling were both due to apply from the start of the floating price phase of the scheme, which was due to follow the fixed price phase in mid-2015. The floor was due to be implemented by way of a reserve price at permit auctions. This ran alongside a fee on imported emissions units to bring their cost up to the price floor, very like a top-up tax. It was thus intended to use a combination of auction reserve prices and top-up payments.

However, although these were included in legislation they were not implemented as the scheme was repealed before this phase began.

Example 7: Former Alberta system – a ceiling based on payment into a fund

The Alberta Specified Gas Emitters Regulation (SGER), which ran for approximately ten years until the start of 2018, was a baseline and credit system. It imposed a hard ceiling of $15/$tCO_2$ by allowing emitters to pay into a fund at that price rather than surrender allowances. This is broadly equivalent to issuing unlimited additional allowances at the ceiling price.

Use of carbon taxes to give a price floor

The following are examples of using taxes to set price floors.

Example 8: UK carbon price support – price floor in the power sector

The carbon price for fuels used in power generation in the UK consists of two components. The first is the price of allowances under the UKETS (and previously the EUETS. The second is the UK's own carbon tax for the power sector, known as Carbon Price Support (CPS). CPS came into effect on 1st January 2013.

The Chart below shows how the level of CPS (green bars on the chart) increased over the period 2013 to 2017[20]. These increases led to a total price – that is the CPS plus the price of EUAs under the EUETS (grey bars on the chart) – increasing, despite the price of EUAs remaining low over this period. The price floor is set by the level of the tax, as this would remain even if the EUA price fell to zero.

This increase had a huge effect on emissions from coal burning power generators, which reduced by more than 80%, over 100 million tonnes p.a., over the period (black line on chart). Various factors contributed to this reduction, including the planned closure of some plants and the effects of regulation of other pollutants. Nevertheless, the increase in the carbon price from 2014 played a crucial role. Analysis has shown the increase in the carbon price accounted for three quarters of the total reduction in emissions due to generation from coal achieved by 2016[21]. This was achieved by a price which remains moderate against a range of markers, including other carbon taxes. The trend continued in 2018 and 2019 (not shown on the chart). In 2018 generation from coal fell a further 25%, while total carbon prices were higher as the EUA price rose strongly, a trend which continued in 2019.

The net fall in emissions over the period 2012 to 2017 (shown as the dashed blue line on chart) was smaller, at around 62 million tonnes p.a.[22]. This is because generation from coal was largely displaced by generation from gas. The attribution of three quarters of this 62 million tonnes as due to carbon price support implies nearly 47 million tonnes p.a. of net emission reductions due to the carbon price. This was equivalent to a reduction of more than 10% of total UK GHGs. Other analysis has shown even larger effects, closer to the black line shown here.

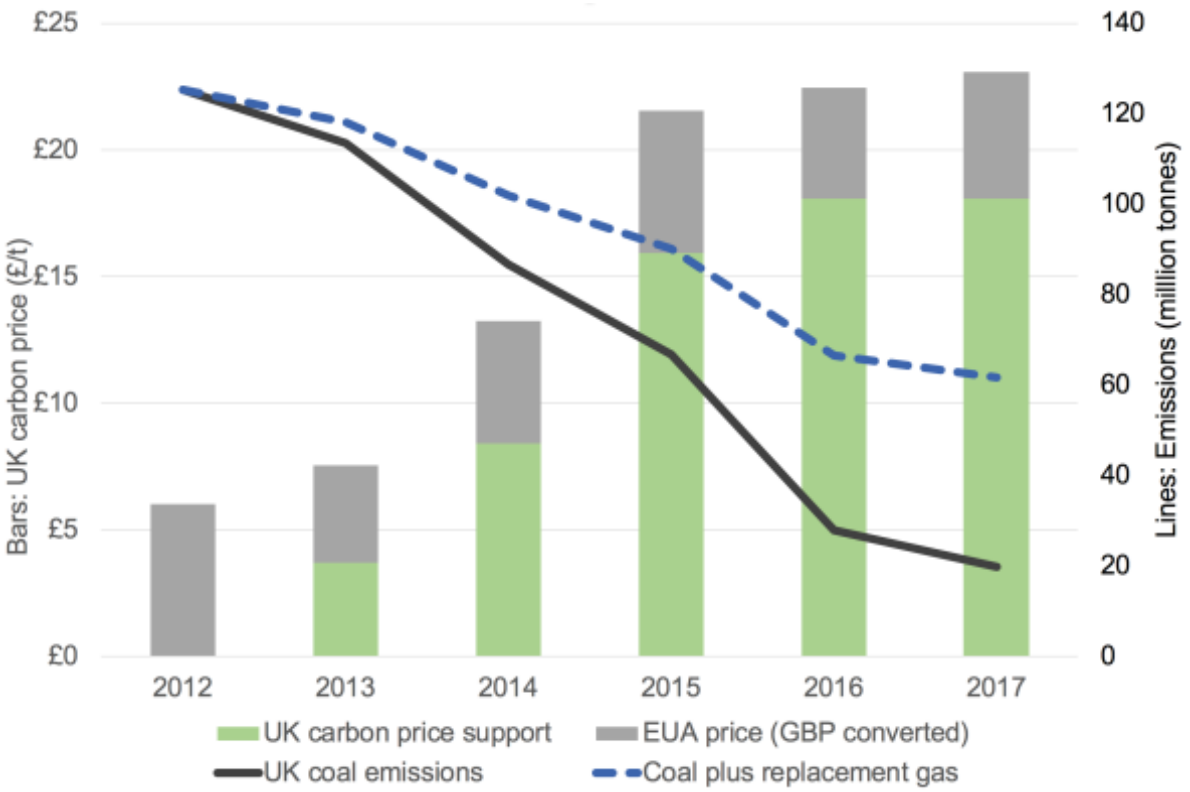
The UK tax thus proved highly effective in reducing emissions substantially and quickly.

Carbon prices and emissions in the UK power sector 2012-2017

[20] UK carbon price support reached at £18/tCO_2 (€20/tCO_2) in the fiscal year 2015/6 and was retained at this level in 2016/7. In 2013/4 and 2014/5 levels were £4.94 and £9.55 respectively. This reflected defined escalation rates and lags in incorporating changes in EUA prices. https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/293849/TIIN_6002_7047_carbon_price_floor_and_other_technical_amendments.pdf and www.parliament.uk/briefing-papers/sn05927.pdf

[21] https://www.auroraer.com/insight/carbon-price-thaw-post-freeze-future-gb-carbon-price-2/

[22] Based on UK coal generation estimated weighted average emissions intensity of 880gCO_2/kWh, and 350gCO_2/kWh for gas generation.



The tax was then set at a fixed level of £18/tonne. It was originally set around two years in advance, targeting a total price comprising the tax plus the EUA price. There was no guarantee that it would set a true price floor, as EUA prices could and did change a good deal in the interim. Indeed, in 2013 support was set at £4.94/tCO_2, reflecting previous expectations of higher EUA prices, leading to prices well below the original target for the year of £16/tCO_2 in 2009 prices (around £17.70 in 2013 prices).

Original intention of a top-up taxes

The original UK proposal was for a top-up tax (or rebateable tax), as now adopted by the Netherlands. The tax would have been charged on the difference between the floor and the EUA price whenever the EUA price was below the floor. (Or similarly, the tax could have been charged at the level of the price floor but the out-turn EUA price for the year could have been used to set a rebate on the tax.) This seems a superior design to that adopted because it gives a more stable and predictable floor. The mechanism adopted was nevertheless highly effective, as shown.

Example 9: The Netherlands Carbon Taxes – separate floors in industry and power generation

Something much closer to the original intention of the UK tax is found in the Netherlands, which has introduced top-up taxes to give price floors. In January 2021 the Dutch Government introduced a carbon tax on industrial emitters covered by the EUETS. A similar type of tax on power generation was introduced a year previously.

The taxes act as a top-up to the EUA price, effectively putting floors on the carbon price. If the EUA price is less than the tax, the amount of tax paid is the difference between the tax and the annual average EUA price for the year. For example, if the carbon price is set at €125/tCO_2 in 2030, as it is for industry, and the average annual EUA price in 2030 is €50/tCO_2 a tax of €75/tCO_2 is payable. If the EUA price is above the level of the tax no tax is paid.

The tax in industry is set at a much higher level than other price floors. The price rises linearly from €30/tCO_2 in 2021 to €125/tCO_2 in 2030. (For power generation the level is much lower, rising linearly from €12·30/tCO_2 in 2021 to €31·90/tCO_2 by 2030.)

Example 10: Norway's carbon tax

Norway has modified its carbon tax to try to achieve a target price which is the total of the tax and the EUA price. The target price is even higher than the Dutch tax, at NOK2000/tCO_2 (€200/tCO_2). However the tax is set in advance, so the total remains uncertain, and ultimately the floor is set by the

tax itself in the unlikely event of EUA prices falling to zero. In this respect it is closer to UK carbon price support than to the Dutch carbon tax.

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