An agenda for strategic reform of the ETS

What’s the future for EU carbon pricing?

sandbag
smarter climate policy

1. The EU ETS should be retained and enhanced, but requires further substantial reform to become effective.

2. Current caps and long-term targets need to be revised and upgraded in the light of the Paris Agreement.

3. Complementary measures will continue to be necessary as part of a comprehensive programme to reduce emissions, and the EU ETS must work alongside these, including coal phase-out policies and support for renewables and energy efficiency.

4. New mechanisms are needed to make the EU ETS resilient to unexpected events, including a price floor and automatic adjustments to the cap.

5. Other aspects of system design require continuing review and reform, such as uses of auction revenue, and measures to guard against carbon leakage.

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About this report

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Key findings and recommendations

This report considers the long-term future of the EU ETS. A major legislative reform process has just been completed. Nevertheless, there clearly remains a gap between the state of ETS (even with the current reforms) and what's necessary to achieve cost-effective pathways to a prosperous low carbon European economy consistent with the EU's international climate change obligations. This report recommends the following measures to enable the EU ETS to play a more effective role.

The need for continuing reform

1 **The EU ETS should be retained and developed.** It has a range of benefits. It sends a strong strategic signal, provides at least some low cost abatement across covered sectors, even at low prices, and may be made more effective in future. It also works as a backstop measure, can be made compatible with complementary policies, and can be aligned with the Paris process. Its abolition would send a very negative signal globally.

2 However **recent reforms have failed to adequately address the fundamental problems** with the EU ETS. A process of **further substantial reform** in the coming years is needed to turn the EU ETS into a more effective policy instrument, and so enhance its credibility within the EU and restore the EU's leadership internationally.

3 The EU ETS needs to be **revised in the light of the Paris Agreement**. The cap for the EU ETS needs to recognise the **importance of limiting cumulative emissions** for reaching Paris goals. This implies tightening the cap in the short and medium term to ensure that low cost abatement is not missed over the next few years.

The need to strengthen the cap and revise targets

4 The main priority for the EU ETS must remain **creating adequately tight supply of allowances in line with efficient and cost-effective long term decarbonisation pathways**. This will enable the EU ETS to play its role in achieving cost-effective emissions reduction. It will also help funds under the ETS secure their objectives by ensuring they have greater financial value.

5 The level of emissions allowed in 2050 is currently uncertain by a factor of four, and this is too wide a gap for effective system design. The EU's **overall emissions target** of 80-95% reduction by 2050 needs to be clarified to a single, specific emissions reduction target.

6 To reflect the **objectives of the Paris Agreement** a single, stringent long term target needs to be accompanied by a rapid path down towards this target, consistent with early peaking of global emissions, the need to severely limit cumulative emissions, and to achieve net zero emissions in the second half of this century**.**

The need to allow the EU ETS to respond to circumstances

7 A mechanism for **adjusting the cap** to account for the effect of complementary measures or other factors should be considered. This should be aligned with the process of establishing revised NDCs under the Paris Agreement, with inclusion of a clear ratchet mechanism. Any adjustment to reflect unanticipated events or complementary measures should take place at the EU level. Putting this responsibility on member states creates undesirable disincentives to action.

8 Adjusting supply of allowances in response to price by introducing **an auction reserve price to provide a price floor** would improve the economic efficiency of the EU ETS by creating more efficient price signals and stimulating investment. Similar measures have worked well elsewhere and there is every reason to suppose they would do so in the EU ETS. It is essential as part of this that the auction reserve price is at an adequate and increasing level.

9 The measures to **improve the Market Stability Reserve (MSR)** agreed in the latest reforms are welcome, especially the provisions to limit its size. Further MSR reform should include reducing thresholds. The rate of transfer, currently set at 24% for the next five years, should be further increased and extended.

10 The ways in which a price floor, a mechanism to adjust the cap and the MSR would interact will depend on their detailed design. These **interactions require further assessment**. It maybe that some of these approaches can reinforce each other or be effectively merged.

Other aspects of the EU ETS will require continuing review

11 **Free allocation** of allowances will need to be **phased out completely in the long term**. This may imply introducing border measures for sectors at risk of carbon leakage. This could start with electricity and cement with the possibility of subsequent expansion to iron and steel and oil refining.

12 **Uses of the revenue** raised by auctioning of allowances should be reviewed. There are several worthwhile uses for revenue. These include furthering emissions abatement, for example through supporting the development of new technologies and promoting energy efficiency for low income household. There are also strong arguments for using funds for adaptation, for compensating those adversely affected by climate change, and for distributing revenue directly to citizens.

13 As emissions continue to reduce, the advantages of **expanding sectoral coverage** of the EU ETS in the long term are likely to increase, and sectoral coverage should be reviewed in future. Other systems, notably in California, have shown that broad sectoral coverage can be easily implemented and can operate effectively.

14 **Complementary measures are essential** for putting the EU, including sectors covered by the EU ETS, on the appropriate emissions trajectory. Such measures will include accelerated closure of coal plant and continuing support for the deployment and integration of renewables. The presence of the EU ETS should not be used as an argument against introducing complementary measures at either the national or EU level. Indeed, such measures should be strengthened where they help establish a cost-effective long term pathway for decarbonisation.

15 **Linkage to other large systems** is unlikely for the foreseeable future. In any case the EU ETS would need to put its own house in order to enable linkage as at the moment EUAs would probably be (rightly) viewed as “hot air” or “junk credits”. Offsets do not seem likely to play a major part in the system for some time, although there may be potential for offsetting emissions from international aviation in future.

An agenda for strategic reform of the ETS

1. Introduction

For many of those involved the present reform process for the EU ETS has felt like running a marathon. There is thus a natural feeling, now that the finishing line has been crossed, that a rest is badly needed. But reform of the EU ETS, like the climate change problem itself, will require many such marathons to be run. This report maps out a route for the forthcoming legs of what is likely to prove a relay of successive marathons. Specifically, it considers how the EU Emissions Trading System (EU ETS) can be developed over the medium and long term to play a fully effective role in building a prosperous low European carbon economy.

The focus of this report is on the EU ETS as a whole, so individual issues are not treated in great detail and no detailed reform proposals are presented here. Indeed many of the topics covered in individual sections could be the subject of a complete report in themselves. Rather than presenting detailed proposals, this report instead looks to set out a broad agenda for reform.

Many of beneficial reforms identified here may prove politically intractable in the short term. Indeed, if they were more tractable many would already have been agreed. However over longer timescales reform may continue to progress as circumstances change, experience is gained, and political discourse develops.

1.1 EU climate goals and response

The EU has a well-established commitment to reducing greenhouse gas emissions. Council Conclusions from October 2009 established a long term EU goal for reducing emissions by 80-95% from 1990 levels by 2050[1]. This goal was incorporated in the Energy Roadmap for 2050, which was established in 2011[2]. Council Conclusions in October 2014 endorsed a binding target of at least a

[1] https://www.consilium.europa.eu/uedocs/complementarymeasures_data/docs/pressdata/en/ec/110889.pdf
[2] http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52011DC0885&from=EN

40% emissions reduction from 1990 levels by 2030, with a 43% reduction from 2005 levels in the sectors covered by the EU ETS and a 30% reduction from 2005 levels in other sectors[3].

The EU reinforced its commitment to limiting climate change by ratification of the Paris Agreement in 2016. The Paris Agreement commits the EU, along with other signatories, to holding the increase in the global average temperature to well below 2°C above pre-industrial levels while pursuing efforts to limit the temperature increase to 1.5°C above pre-industrial levels. In order to achieve those objectives, it was agreed that global emission would have to peak as soon as possible, and would then have to decrease rapidly in order to achieve net zero emissions in the second half of the century[4]. It was also agreed that developed country parties - such as the EU – should take the lead in this effort[5].

Under the Paris Agreement the EU has submitted its Nationally Determined Contributions (NDCs) to emissions reductions. The EU's NDC restated its previous contribution of a 40% reduction in emissions by 2030. However it did not strengthen its pre-Paris commitments to reflect the commitments to limiting temperature established in the Agreement. Climate Action Tracker, an independent observer of the effect of NDCs has assessed the EU's current NDC as inadequate[6]. The EU's targets will therefore need to be reconsidered in the light of the Paris Agreement.

Alongside these policy commitments there is widespread and increasing public support within the EU for action on climate change. A recent survey showed that nearly 75% of EU citizens now see climate change as a very serious problem and almost 80% believe that reducing climate change and using energy more efficiently will bring economic benefits[7].

The EU has established a range of policies to implement its emissions reductions goals. These include the EU ETS itself. They also include separate policies, for example Directives on Energy Efficiency and Renewable Energy, that affect emissions in sectors covered by the EU ETS. National policies, for example on the closure of coal plant, may also influence emissions in sectors covered by the EU ETS. Sectors outside the EU ETS are covered by the Effort Sharing Regulation, which is not considered in this report.

[3] http://register.consilium.europa.eu/doc/srv?l=EN&f=ST%20169%202014%20INIT

[4] http://unfccc.int/files/essential_background/convention/application/pdf/english_paris_agreement.pdf, see Articles 2 and 4

[5] http://unfccc.int/files/essential_background/convention/application/pdf/english_paris_agreement.pdf, see Articles 2 and 4

[6] http://climateactiontracker.org/countries/eu.html. This assessment rates most NDCs as inadequate or worse.

[7] https://ec.europa.eu/clima/news/eu-citizens-increasingly-concerned-about-climate-change-and-see-economic-benefits-taking-action_en

1.2 The EU ETS to date

Technical performance

The EU ETS has consistently been seen as a "cornerstone" of EU climate policy[8]. It has largely functioned well from a technical perspective. Administration has been smooth for such a large and diverse system, with high levels of compliance[9] and liquid trading. Legislation has recently been passed continuing the system until 2030, by which time it will have been in place for 25 years. It will thus have provided broadly consistent regulatory environment for the covered sectors over a long period. There have nevertheless been many changes to the system during the period. This has been as expected, given changing circumstances and the pioneering nature of the system as the world's first large-scale carbon market.

Surpluses and low prices

However the EU ETS has suffered from persistent weaknesses. In particular a large surplus of allowances has accumulated. By the end of the current Phase in 2020 Sandbag expects the total surplus to have risen to 3.8 billion allowances, including 2.0 billion in the Market Stability Reserve (MSR) and 1.8 billion available to the market[10]. This total is equivalent to approximately 2 years' emissions. The total is also 40% greater than the total cumulative reduction in emissions mandated over the whole of Phase 4, which runs from 2021 to 2030[11]. Emissions in 2016 were about 11% below the cap, and are likely to continue below the cap at least until the mid-2020s and perhaps until after 2030[12], implying a continuing lack of stringency, a persistent surplus and ongoing transfer of allowances to the Market Stability Reserve (MSR).

As a consequence of the continuing and growing surplus, allowance prices have been too low to stimulate effective action to reduce emissions. Where emissions have decreased this has most often been as a result of other measures, such as mandated deployment of renewables and improved energy efficiency, with little abatement driven by the persistently low carbon price. The EU ETS has thus failed to stimulate cost-effective emissions reductions in the short term, with continuing huge quantities of emissions from highly polluting coal and lignite plant. It has also failed to put the sectors covered by the EU ETS on a cost-effective path to decarbonisation in line with the Paris Agreement, with prices being too low to stimulate the development and deployment of new technologies. In the absence of further reform the surplus will persist through much or all of the 2020s and potentially beyond, resulting in another decade of ineffective operation of the EU ETS.

Low prices also mean that funds to aid the transition to a low carbon economy, including the Innovation Fund and Modernisation Fund, are less valuable than they need to be. They are therefore likely to be less effective than they would otherwise be with a stronger EU ETS[13], further endangering the ability of the EU to meet long term emissions reductions goals cost-effectively.

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[8] See for example https://ec.europa.eu/clima/sites/clima/files/factsheet_ets_en.pdf

[9] Each year around 99% of the emissions are actually covered by the required number of allowances. See https://ec.europa.eu/commission/sites/beta-political/files/report-eu-carbon-market_en.pdf , section 8.

[10] See previous Sandbag work https://sandbag.org.uk/2016/11/28/we-need-to-talk-about-the-msr/, https://sandbag.org.uk/wp-content/uploads/2017/02/The-three-billion-tonne-problem.pdf, https://sandbag.org.uk/wp-content/uploads/2016/11/161215-Comparing-options-for-ETS-reform.pdf

[11] If cumulative emissions continued at the 2020 level they would be 18.2 billion over Phase 4. With a 2.2% Linear Reduction Factor they will be 15.5 billion. The cumulative required emissions reduction over Phase 4 is thus 2.7 billion.

[12] https://sandbag.org.uk/wp-content/uploads/2017/02/The-three-billion-tonne-problem.pdf

[13] See https://sandbag.org.uk/project/a-tighter-cap-grows-the-funds/

Uncertainty around Brexit

The potential departure of the UK from the EU ETS adds uncertainty to the future of the system. It is currently unclear whether the UK will continue its membership of the EU ETS, especially beyond 2020, and what the consequences of any UK departure from the EU ETS would be. The cap will need to be adjusted and a range of parameters will need to be reconsidered, including the thresholds for the MSR and the size of funds. A previous report[14] by Sandbag has indicated that the surplus of allowances looks likely to be at best only slightly reduced as a result of the UK's departure. If the UK left the system and a target reduction of at least 43% were retained for the EU27 the surplus would decrease slightly because the UK has been particularly effective at reducing emissions and in its absence other countries would need to do more. However such as outcome is not guaranteed and the surplus may increase if the adjustment to the cap were smaller, although this would mean that the emissions reduction targets for the remaining EU27 would fall short of the required reduction of at least 43% established by the 2014 Council Conclusions (and even further short of a tightened target resulting from review of targets in the light of the Paris Agreement). There is thus a risk of further weakening an already weak system.

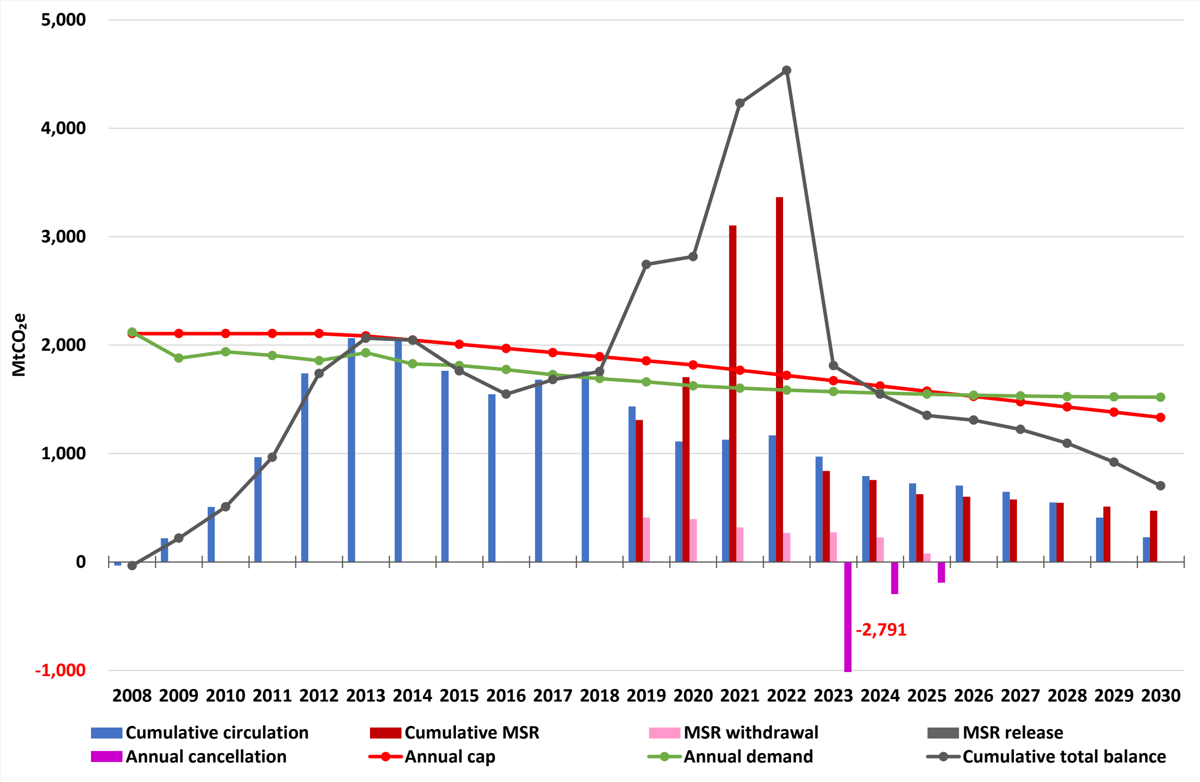
1.3 The effect of recent reforms

The EU has now completed the trilogue process, agreeing legislation to implement the target for the EU ETS. These reforms to the EU ETS have made some progress in addressing the weaknesses of the EU ETS. In particular several of the measures agreed by the recent trilogue process are welcome as valuable steps towards future effectiveness. The most important of the reforms is the provision to cancel allowances from the MSR from 2023 onwards if the number in the MSR is greater than the previous year's auction volume. Other welcome measures include introducing a higher MSR intake rate for five years and requiring a carbon market report to identify policy interactions. The LRF has also been increased from its Phase 3 level.

However these reforms have failed to correct the weaknesses of the EU ETS. This is illustrated in Chart 1, which shows the likely evolution of the surplus, and includes the effect of the reforms recently agreed following trilogue. With our base case scenario, emissions continue below the cap for much of the 2020s, and the market remains in surplus with allowances continuing to be transferred to the MSR. A total of around 3 billion allowances are cancelled.

[14] https://sandbag.org.uk/project/brexit-eu-ets-greater-sum-parts/ See section 3.

Chart 1: EU ETS volumes with final trilogue outcomes and Sandbag Base Case emissions projections



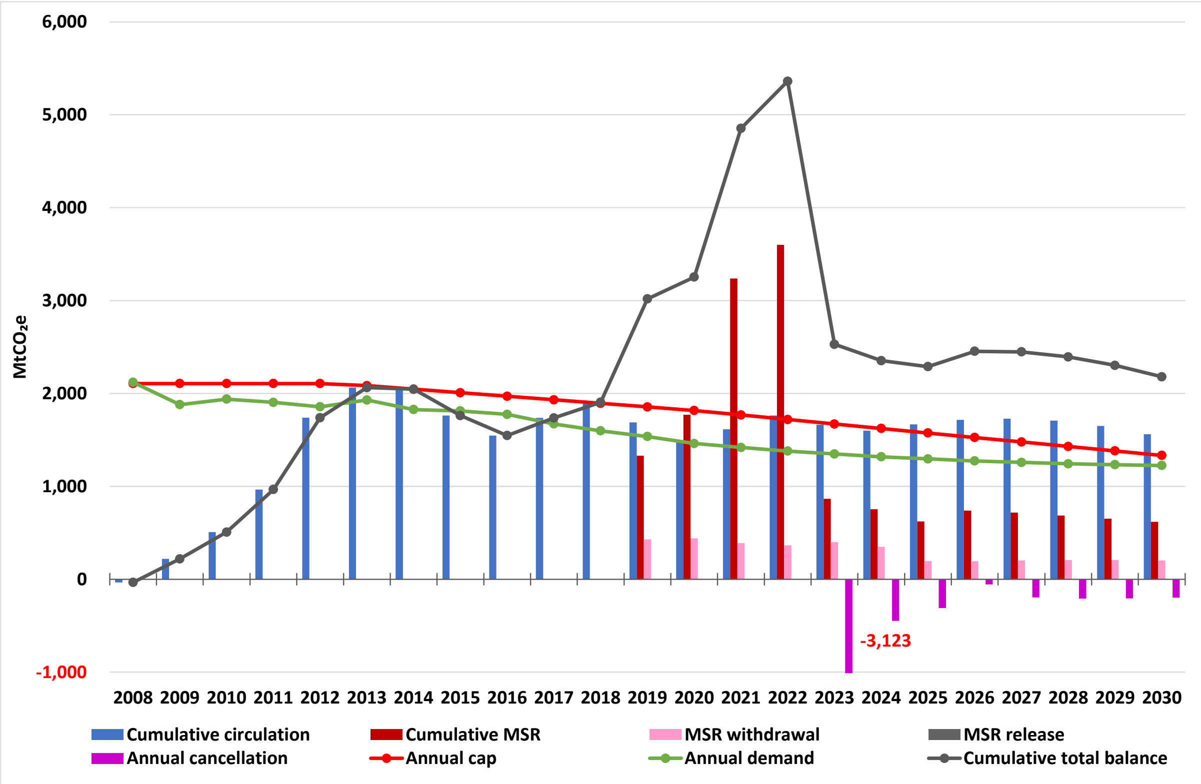
Note: Cumulative circulation is the surplus of allowances available to the market. The total balance is the total of cumulative circulation plus volumes in the MSR. MSR withdrawal is the annual transfer of allowances to the MSR. MSR release does not occur by 2020. See Annex 2 for the full set of assumptions for these calculations.

Our base case scenario is essentially an extrapolation of the existing trend in emissions. We consider it the highest plausible case for emissions, as it does not take full account of the reductions in generation from coal and lignite that seem likely over Phase 4. Indeed we consider it likely that emissions will tend to be below our base case and towards our low case, which among other things includes greater reduction in power sector emissions.

Some emissions projections show higher emissions than shown here. However we do not consider them to be plausible as they imply a slowing of the rate of emissions reduction to below the historical trend when there are many factors working in the opposite direction, notably falling costs of renewables and increasing pressure on coal use in electricity generation. However, even if emissions might turn out to be above the range shown here, which we do not expect to be the case, the ETS nevertheless needs to be robust against a full range of outcomes, including those shown here, which it is currently not.

The trend towards a large and persistent surplus is even more marked under our low case emissions scenario, which includes, for example, further reductions in coal burn. Emissions continue below the cap throughout the 2020s, and the surplus is correspondingly larger.

Chart 2: EU ETS volumes with final trilogue outcomes and Sandbag Low Case emissions projections



Note: Cumulative circulation is the surplus of allowances available to the market. The total balance is the total of cumulative circulation plus volumes in the MSR. MSR withdrawal is the annual transfer of allowances to the MSR. MSR release does not occur by 2020. See Annex 3 for the full set of assumptions for these calculations.

The agreed reforms thus fall some way short of addressing the weaknesses of the EU ETS.

As a result prices remain too low to be effective. They are currently about €8/tonne. In contrast the international High Level Commission on Carbon Pricing has stated that the explicit carbon-price levels consistent with the Paris temperature target are at least US$40–80/t$CO_2$ (€32-64/ tCO_2)[15] by 2020 and US$50–100/t$CO_2$ (c. €40-80/ tCO_2) by 2030[16]. Current prices are also well below the US Environmental Protection Agency's 2015 estimates of the Social Cost of Carbon[17], implying that the price of emission does not reflect the cost of the damage they do. While it is impossible to reliably predict future prices, the current very low market price suggests prices continuing at well below the required levels in the coming years. If very rapid price rises were expected on average by market participants in the next few years these would already be affecting current prices, given the expected returns that would be available from holding EUAs. This is not happening.

[15] An indicative exchange rate of 0.8€/$ has been used

[16] https://static1.squarespace.com/static/54ff9c5ce4b0a53decccfb4c/t/59b7f2409f8dce5316811916/1505227332748/CarbonPricing_FullReport.pdf More recent estimates by the EPA reflect inappropriate changes by the current US administration.

[17] See Annex 1 and references for more than this.

Low prices mean that the current cap does not allow for an effective trade-off between short and long term emissions reductions. In particular incentives for emissions reductions over the next few years are too weak. Low cost opportunities are missed now, implying more expensive abatement in future to stay within carbon budgets. This is especially problematic given the stringent temperature targets in the Paris Agreement (see Section 3). With weak abatement in the short term, the economy will not be put on an appropriate long term track, and economic dislocation is likely to result as targets begin to become more constraining after 2030.

The system is also still too rigid with inadequate responses to changing circumstances, risking both continuation and recurrence of these weaknesses. For example, just 18 installations in the power sector, of which half are in Germany, account for 14% of covered emissions. Any changes in the status of these installations could have a major effect on the EU ETS as a whole. Indeed if these plants ceased operation and were replaced by renewables that alone would be sufficient to achieve the 2030 target based on emissions being in line with our base case scenario in 2020, even if there were no further abatement at all in the 2020s[18]. Even though the MSR will be introduced and its design has now been strengthened it will not be enough on its own to adequately strengthen the market (see above Charts 1 and 2).

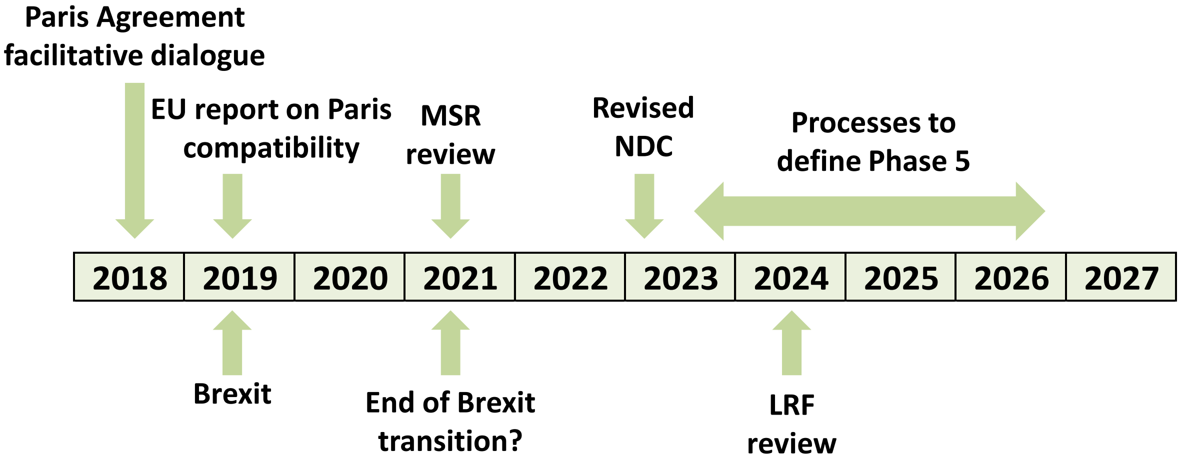
Finally the EU has not yet revisited its long term goals to reflect the Paris Agreement. Such reconsideration is necessary to establish a stronger basis for a reformed EU ETS.

1.4 Timetable for future reforms

Further reform of the EU ETS is needed to address its remaining problems and to continue to develop it as a cornerstone of EU climate policy. However, the remaining issues with the EU ETS are unlikely all to be resolved at once due to their depth and severity. Instead, further improvements to the system are likely to be needed over time to enable the system to fulfil the role that it should.

[18] Emissions in 2016 were 1744 million tonnes. This looks likely to reduce under our base case emissions projection to no more than about 1600 million tonnes by 2020 simply as a result of existing trends including deployment of renewables. Eliminating the emissions (at 2016 levels) from the largest 18 power sector emitters alone would save a further 256 million tonnes reducing emissions to 1344 million tonnes even if there were no other emissions reductions. This would be enough to get almost all of the way down to the 2030 cap of 1333 million tonnes. Even replacing generation with gas plant would leave a shortfall on only around 90 million tonnes needing to be found from all other emissions reductions over Phase 4.

Chart 3: How could the reform process work, what are the milestones?



There will be several opportunities examine and adjust the functioning of the EU ETS over the next few years, and others could be found. The major potential opportunities for review and reform are summarised in Chart 3 below. They include:

- Processes related to the Paris Agreement, including review of adequacy of the EU's policies and eventual submission of a revised Nationally Determined Contribution (NDC) following the Facilitative Dialogue.
- Changes around Brexit, which may require revision to the cap or other provisions,
- Reviews of parameters suggested by the current text, especially the MSR and LRF.

This report sets out what needs to be done during these reviews.

2. Role of the EU ETS

2.1 The spread of carbon pricing

The benefits of pricing emissions to help achieve efficient reductions in pollution have been recognised in the policy literature for many decades. In particular, the large number and diversity of sources of greenhouse gas emissions, and the consequent variation in abatement costs, can make carbon pricing an especially valuable tool for achieving cost-effective emissions reductions. This is because price signals can create effective incentives for abatement, and reveal information about abatement costs across a wide variety of emitters. A carbon price thus helps find and make use of the lowest cost ways to reduce emissions now, and also provides incentives to invest in the development of new technologies and processes that could further mitigate emissions[19,20].

The compelling arguments for carbon pricing, and, increasingly, the experience of implementation, have led to widespread adoption of carbon pricing around the world over the last decade and a half. Before the EU ETS was introduced in 2005 carbon pricing was largely restricted to carbon taxes in a few small northern European economies. Since then, over 40 jurisdictions have put a price on carbon, with a mixture of emission trading systems, taxes, and hybrid approaches[21]. A total of over 7 billion tonnes of carbon dioxide equivalent ($GtCO_{2e}$) are currently priced. This is about 20%of global GHG emissions[22] from energy and industry. This is likely to rise to around 30% of CO_2 emissions from energy an industry as the national emissions trading system in China enters operation, although there is uncertainty as the scope and timing of this system at the time of writing this report. A system of emissions trading for aviation is also under development and scheduled to begin from 2021. Meanwhile, many companies are setting an internal carbon price to help them manage their risks in this area.

Pricing emissions through the EU ETS is thus very much in line with international practice, and increasingly so. Indeed by acting as a pioneer the EU ETS has contributed greatly to this trend, with other systems learning much from the EU ETS. However with new experience from other systems to draw on the EU ETS can now in turn learn from others.

Among other things there is a continuing concern that carbon prices are too low for effective abatement in the EU ETS and elsewhere. Indeed 75% of emissions in carbon pricing systems around the world are priced at less than \$10/tonne, and 90% at less than \$20/tonne[23]. Further reforms to the EU ETS and other systems are needed to address these issues.

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19 http://www.robertstavinsblog.org/2011/10/30/the-promise-and-problems-of-pricing-carbon/ There is a vast literature on the benefits of carbon pricing, which we do not explore further here.

20 https://static1.squarespace.com/static/54ff9c5ce4b0a53decccfb4c/t/59b7f2409f8dce5316811916/1505227332748/CarbonPricing_FullReport.pdf

21 https://www.i4ce.org/wp-core/wp-content/uploads/2017/10/Global-Panorama-Carbon-prices-2017_FINAL_5p-2.pdf, https://www.ecofys.com/files/files/world-bank-ecofys-vivid-2017-state-and-trends-of-carbon-pricing.pdf

22 World Bank State and Trends of Carbon Pricing report (see previous reference) and Sandbag analysis. These totals include some initiatives which would fit only a broad definition of carbon pricing, but excluding these would not affect the overall conclusion.

23 World Bank State and Trends of Carbon Pricing report (see previous reference).

2.2 The desirability of continuing to develop the EU ETS

Despite the EU ETS pioneering large scale carbon pricing and its subsequent adoption of carbon pricing by many other jurisdictions, the problems with the EU ETS have led some to question whether it should be continued. Frustration that the EU ETS is not working as effectively as it could be and should be seems entirely appropriate given the pressing need for the EU to reduce its emissions.

However the appropriate response to the inadequacies of the EU ETS is to seek further reform, rather than its abolition. There are compelling reasons why the EU ETS should be retained, and considerable risks in its abolition. These include the following:

The EU ETS provides valuable signals for abatement …

- The declining cap, with its prospective continuing reduction through the Linear Reduction Factor (LRF), gives a strong strategic signal to all stakeholders about the need for continuing reductions in emissions. A legally binding cap gives this signal much more strongly than a carbon tax, or other policy instruments, would do.
- Although prices are currently low, both current prices and expectations of higher future prices will stimulate at least some emissions reductions, and will do so across the covered sectors. These will almost all be low cost, efficient abatement. Effectiveness in this respect could, of course, be increased by further reform.
- Low prices and emissions below the cap will likely not be sustained over the period to 2050, so the effectiveness of pricing will likely increase in the long term. The EU ETS remains a valuable long-term tool for reaching 2050 targets.

It is compatible with other policy instruments …

- There is nothing about the EU ETS that prevents other measures from being implemented, such as those to stimulate renewables, improved energy efficiency, or the reduced operation and closure of coal plant, although such measures may be easier and more effective with an improved EU ETS. Indeed a well-designed cap with mechanisms that deal with unanticipated outcomes can complement such measures (see Sections 4 to 6).
- Abolition of the EU ETS seems unlikely to increase the prevalence of other measures. Indeed the lack of a firm cap may lead to fewer such measures in future.
- If greater price certainty is considered desirable, as would be the case with a carbon tax, this can be achieved by putting a floor price or price corridor on the EU ETS. (See Section 4 for a discussion of this.)

It is aligned with the quantity based nature of the international policy framework …

- The obligations under the Paris Agreement for restricting average temperature rises translate naturally into allowed total cumulative quantities of emissions (a carbon budget). As such a quantity based system such as the EU ETS is well suited to give effect to the Paris Agreement if a compatible cap is set.

- A declining cap on emissions is also aligned with the Paris Agreement goal of net zero emissions in the second half of the century.
- The cap remains in place both as a backstop to ensure that targets for limiting the quantity of emissions are met, even if in practice other regulations are in practice achieving most of the emissions reduction.

Abolition would have a knock-on effect on emissions elsewhere …

- The EU ETS is the longest established large carbon pricing system in the world, and until the Chinese national system is fully operational it remains the largest system. To abolish the EU ETS would send a signal to other jurisdictions that experience had shown the premiere carbon pricing system had failed. This would be likely to impede the development of carbon pricing and emissions trading in other jurisdictions. This would in turn likely to reduce the pace and increase the cost of emissions reductions to the detriment of the climate and contrary to the Paris Agreement.

2.3 Objectives of a maintained and strengthened EU ETS

Carbon pricing and market mechanisms have, as noted, particular strengths in providing incentives for economically efficient abatement. However, while the ability of trading to enhance efficiency is generally agreed, there are differences of view about how the concept of efficiency should be interpreted. In particular some regard the requirement for efficiency as being limited to meeting the defined cap with the least cost mix of abatement, with no need to be concerned about other outcomes. However this narrow view fails to capture important aspects of economic efficiency and the role of carbon pricing in securing these aspects. In this report we adopt a wider definition of economic efficiency, which includes the following.

Efficient investment avoiding carbon lock-in

The ability to deliver cost-effective abatement over time is path dependent, and in particular depends on investment now. The EU ETS should give signals for investment consistent with an efficient pathway to longer term objectives as well as for the current phase of the system. In practice this means that prices must be high enough to give signals for investment to avoid carbon lock-in from building new high carbon production.

If there is inadequate investment now future emissions reductions will be more expensive. This will raise total costs. It may even endanger long term targets, because in the absence of adequate early investment achieving targets will be perceived as prohibitively expensive, and so targets will be missed and the EU's international obligations endangered.

Cost-effective distribution of abatement over time

The EU ETS should be consistent with efficiently achieving the temperature goals of the Paris Agreement. The temperature goals of the Agreement mean that cumulative global emissions must be limited (a fixed carbon budget), which in turn means that cumulative EU emissions must be limited. In achieving limits on cumulative emissions efficiently, total costs of abatement over time must be minimised (allowing for the time value of money, which is usually expressed as a discount rate).

In particular undertaking low cost abatement now is more efficient than missing opportunities for abatement now and having to implement very high cost abatement later. For example, low cost abatement available now, such as reduced operation of coal and lignite power plants, should be signalled by an efficient EU ETS now because the alternative within a fixed cumulative carbon budget is likely to be more expensive abatement later on.

If opportunities for low cost abatement are taken now there is likely to be a relatively feasible pathway towards limiting total emissions, with a "soft landing" because action now has created the space within the fixed carbon budget for some emissions later on. If opportunities are not taken now a "hard landing" is likely, with very limited remaining carbon budget and either very high cost abatement being required or targets being missed.

Even a well-designed EU ETS may fail to signal such efficient abatement in full. A credible cap lasting several decades is not possible, and in any case it would lie beyond most commercial planning horizons. For these reasons among others, complementary measures will always be necessary. However these problems are exacerbated by the current weakness of the EU ETS cap.

Signals that reflect the cost of the damage caused

The system should always adequately signal abatement where this is lower cost than the environmental damage being incurred. This is sometimes expressed as the Polluter Pays Principle. In practice this implies that the price should always represent the Social Cost of Carbon (SCC), which measures the environmental damage from a tonne of emissions. Although there is considerably uncertainty about the level of the SCC, it implies that very low prices, such as those currently prevailing in the EU ETS, are clearly inefficient, because they are signalling too little abatement and too much environmental damage. If emissions were further reduced they would create a net benefit because the cost of the abatement would be below the cost of the damage.

It is sometimes suggested that that low prices are due to an excess of complementary measures. However complementary measures are highly beneficial for a range of reasons (see below) and the low prices are is a sign of a cap that is too weak, not complementary measures which are too ambitious.

Robustness to changes in circumstances

The system should retain its efficiency if complementary policies overlap with the scope of the EU ETS, and if circumstances change, then the system should continue to operate consistent with the criteria set out here.

With these broader efficiency requirements the need for reform of the EU ETS is both greater and more urgent than with a narrower interpretation. Correspondingly the reforms suggested here are more extensive that they would be with a narrower definition of efficiency that erroneously restricted consideration to meeting the current cap at least cost.

2.4 The role of complementary measures

The desirability of complementary measures

There is general consensus that policy measures complementary to carbon pricing are necessary to achieve cost-effective decarbonisation. This remains true whichever framework is applied to policy assessment (see Annex 1 for more on frameworks for assessing policy).

Carbon pricing alone is inadequate to secure the large scale reductions in emissions required over time. This is because even strong carbon pricing will not stimulate all of the long terms transformational programmes that are needed. For example, grid systems and grid management will need to be developed to enable the operation of low carbon power generation. This will require modifications at the system level which a carbon price alone is unlikely to achieve. Similarly, many fundamental technical innovations are required in industry which individual firms will find impossible to achieve on their own as they will be initially high cost and individual market participants will not get the full benefits of innovation.

Furthermore, the responses to carbon pricing will inevitably limited by the time horizons of commercial decision making, which are often shorter than those involved in transforming to a low carbon economy, and there will always be uncertainty about future caps and prices because of the inability of governments to credibly commit over the very long term. Low carbon investment will therefore fail to be incentivised to the extent consistent with economically efficient decarbonisation pathways.

There are also political economy advantages to introducing a suite of measures rather than relying on carbon pricing alone. A set of complementary measures necessarily requires a variety of action. For example they may stimulate the development of renewables, or the installation of new more efficient equipment, or CCS. This in turn develops wider constituencies of interest in reducing emissions, creating new industries and new jobs. These constituencies will help counter other constituencies, notably energy companies and conventional power generators, who tend to be reluctant to engage in emissions reductions. With more active participants and advocates for reducing emissions, action will become more deeply embedded in the economy, to the benefit of both decarbonisation and Europe's industrial development.

Recognising the role of complementary measures can also allow individual member states to introduce policy innovation, or to go further with emissions reductions, in line with the principle of subsidiarity. While it will often be desirable to implement complementary measures at EU level, innovative policy measures introduced at member state level can be both justified in their own right, and demonstrate policies that can subsequently be adopted at the EU level.

Some of these issues can be addressed in part by modifications to the EU ETS described in this report. For example, the introduction of a floor price would help create more adequate investment signals. However for the reasons set out above these will not be enough to secure adequate and efficient decarbonisation. Complementary measures will still be necessary.

Suggesting that carbon markets are not the only appropriate means of reducing emissions does not preclude the use of markets in implementing complementary measures. For example, competitive market tenders are well established in the private sector and use markets to reveal information about costs. They have proved successful in a variety of countries in reducing the price of electricity from renewables, including notably solar in Germany[24] and offshore wind in the UK[25].

Complementary measures in practice

The view that complementary measures are necessary and desirable is supported by what happens in practice around the world. Complementary measures are invariably also put in place in the sectors covered by carbon pricing. For example, there is no major economy without measures to support the deployment of renewables[26]. Similarly every major economy has regulations that stimulate energy efficiency. California includes transport under its emissions trading system, but also has vehicle efficiency standards and taxes on transport fuels, although these taxes are at a lower level than the equivalent taxes in the EU.

Furthermore, there is now been enough experience and evidence for it to become clear that many complementary measures are highly successful in practice. Early support for solar PV in Germany and elsewhere was high cost at the time measured per kWh or per tonne of CO_2 avoided. However it stimulated large scale installation of solar PV, which in turn greatly reduced costs, and so greatly increased the growth of the market worldwide. As a result, solar PV has grown very rapidly globally, with a compound annual growth rate of about 50% p.a. over the last ten years[27]. Looking forward, solar PV it is expected to be one of the main contributors to reducing emissions globally over the next few decades. The policy of encouraging early high cost solar in Germany (and elsewhere) has thus proved one of the most material and effective contributions to long term global emissions reduction.

Other measures have also proved effective. For example, the Large Combustion Plant Directive and the Industrial Emissions Directive have been successful in limiting greenhouse gas emissions from coal plant, even though they were directed at other pollutants. At member state level, the UK carbon price floor has been highly effective in reducing coal generation (see Section 6.4).

The scale of benefits from complementary measures is potentially very large. For example, as noted above, the benefits of early solar deployment are large in a global context. Looking at the EU ETS itself, as noted previously, just 18 power sector installations accounted for 14% of emissions under the EU ETS in 2016[28]. Complementary measures that led to the closure of this small number of large emitters would have a large effect on the EU ETS as a whole. (A tighter cap leading to higher prices could of course have a similar effect.)

Why the waterbed hypothesis is not a good reason for inaction

The most commonly used argument against complementary measures, sometimes referred to as the "waterbed effect" hypothesis, is that they are ineffective in reducing emissions because supply of allowances is fixed so emissions always equal the cap. However separate analyses by Sandbag and by the Danish Climate Council suggest the argument is not valid in the EU ETS at least while the

[24] Auctions have contributed in Germany to a 40% reduction in tariffs since 2015 https://www.cleanenergywire.org/news/auctions-bring-german-solar-power-price-new-record-low

[25] http://www.windpoweroffshore.com/article/1444146/uk-offshore-falls-5750-latest-cfd-round

[26] http://www.ren21.net/gsr-2017/chapters/chapter_05/chapter_05/

[27] https://www.bp.com/en/global/corporate/energy-economics/statistical-review-of-world-energy.html

[28] See also separate Sandbag report on current state of the EU ETS.

surplus persists[29], as is likely to be the case over at least the next ten years. With a large and continuing surplus in the EU ETS, additional emissions reductions from complementary measures add to the surplus of allowances, are absorbed into the MSR over time, and then cancelled. This effect is particularly clear cut following the adoption of the size limit on the MSR in the final agreement from trilogue.

Even if allowances become scarce in future that will not be a valid reason for avoiding complementary policies. Future caps are the result of a political process that inevitably takes account, whether explicitly or implicitly, of current and prospective emissions and the cost of meeting future caps. If complementary measures reduce emissions now they are likely to enable tighter future caps. Similarly, they remain a necessity for effective long-term emissions reductions, so if they are not introduced it is likely that it will be too costly to achieve adequately tight caps, and emissions reductions goals will be missed.

Why the argument that carbon markets are efficient is not a good reason for avoiding complementary measures

It is sometimes argued that complementary measures are inefficient because they are more expensive abatement than that signalled by the carbon price. For example, the emissions savings from replacing a kWh of generation for coal with gas and solar is calculated. The cost of each is then calculated and divided by the avoided emissions to get a cost per tonne. This may show a higher cost for replacing coal with solar than with gas. The conclusion is then drawn that solar installation is inefficient compared with switching to gas.

However this calculation includes only the immediate benefits, the savings from that particular installation. It ignores the many other benefits from the installation of an innovative technology and in particular the benefits of cost reduction. Ignoring these benefits fundamentally misrepresents the nature of efficient pathways for of decarbonisation, where deployment of technology is highly dependent on a dynamic interaction between the scale of deployment and costs.

The argument that some make that the EU ETS has been inefficient is essentially an erroneous argument that Europe has deployed too many high-cost renewables. It is manifestly not the case that Europe has deployed too many renewables when the contribution of Europe's deployment to reducing renewables costs is taken into account, because this has enabled the very large deployment now happening elsewhere, including in many developing countries (see above). It takes time to grow industries to a scale that can make a material impact on global energy use and emissions[30]. European support was essential to get this process going. Furthermore it is the quantity of deployment that gets the costs down, and without large scale deployment renewables costs would not have fallen to the extent that they have[31]. Without European action prospects for decarbonising global power generation, which now look promising, would have looked very much worse.

[29] See reports from the Danish Climate Council file:///C:/Users/Adam/Downloads/working_paper_-_is_there_really_a_waterbed.pdf and Sandbag https://sandbag.org.uk/?s=waterbed
[30] Kramer,GJ and Haigh,M. No quick switch to low-carbon energy, Nature Vol. 462, December 2009
[31] Costs per kW have fall by over 20% for each doubling of cumulative deployment. See https://data.bloomberglp.com/bnef/sites/4/2015/04/BNEF_2014-04-08-ML-Summit-Keynote_Final.pdf

The problem is not that Europe has deployed too many renewables, it is that it is burning too much coal and lignite. This in turn reflects a cap that is too loose and had not been adequately adjusted to reflect changing circumstances.

The appropriate question is thus not whether complementary measures are needed, but how the EU ETS can be designed to better accommodate necessary, appropriate and efficient complementary measures.

3. Basis of setting future caps

Now that the operation of the EU ETS has become well established, setting the cap at appropriate levels, including designing flexibility and price containment mechanisms, is (by far) the single most important action for ensuring an effective EU ETS. This section considers the cap itself. Subsequent sections consider how mechanism such as the MSR, direct adjustments to the cap to reflect changed circumstances and price containment mechanisms can help the EU ETS adjust to circumstances.

3.1 Implications of the Paris Agreement

The cap for the EU ETS needs to be consistent with the Paris Agreement, and with setting a cost-effective pathway to meeting the EU's obligations under the Agreement. Several provisions of the Paris Agreement are relevant to setting the cap:

- Holding temperatures to well below 2 degrees while pursuing efforts towards 1.5 degrees (Article 2.1a) implies severe limits on cumulative global emissions (a restricted carbon budget), because temperature rises depend strongly on cumulative emissions, especially of carbon dioxide and other long-lived gases[32]. A limit on cumulative emissions corresponds to limiting the cumulative cap ("area under the curve") for the EU ETS.
- Early peaking of global emissions while recognising that this will be difficult for developing countries (Article 4.1). This puts a larger obligation on developed countries to reduce emissions more quickly.
- The requirement for reaching net zero emissions in the latter part of the century (Article 4.1) implies again that developed countries will need to head rapidly towards this goal.
- The principle of progressive tightening of limits (Article 4.3) implies among other things that overachievement of targets cannot be used to weaken ambition in future.

These provisions imply that cumulative emissions must be severely constrained. In addition, working towards the 1.5°C goal implies working towards global emissions of close to zero in the 2060s and approaching that level by 2050[33].

The extent to which the EU ETS cap needs to be reduced depends on how a global carbon budget is allocated between countries, sectors and gasses. This allows for a range of possibilities. However stringent limits are clearly implied in any case. Equity considerations suggest that convergence is required to levels of per capita emissions that are

- more similar between countries, on grounds of equity, and
- lower than current levels for developed countries, because total emissions need to be reduced[34].

Despite progress in recent years, per capita CO_2 emissions in the EU of 6.8 tonnes per capita remain about 40% above the global average of 4.9 tonnes per capita[35]. This, together with the recognition

[32] IPCC Fifth Assessment Report, Synthesis Report, Chapter 2.
[33] http://climateactiontracker.org/global.html
[34] This general perspective is sometimes referred to as "contract and converge". However the approach set out here, which is implicit in the Paris Agreement, does not imply any particular realisation of that principle.
[35] Data is for 2015. http://edgar.jrc.ec.europa.eu/news_docs/jrc-2016-trends-in-global-co2-emissions-2016-report-103425.pdf

of later peaking for developing countries, implies a rapid near-term reduction in emissions from developed economies[36].

3.2 The implications of a carbon budget for short and medium-term abatement

As noted in Section 2.3, the limit on cumulative emissions, consistent with the temperature goals of the Paris Agreement, implies that it will be cost-effective to reduce emissions in the short term where this can be done easily and cheaply. This will allow correspondingly more feasible caps in future, when additional abatement is likely to be difficult and expensive because emissions will already have been greatly reduced.

By far the largest of the opportunities currently being missed is reducing emissions from coal and lignite power generation, which current account for about 40% of all EU ETS emissions. Burning the very large amounts of coal and lignite that Europe does currently appears incompatible with any cost-effective pathway towards Paris Agreement goals. Examples of emissions reductions likely to remain more difficult and expensive than reducing coal burn include those in aviation, heating existing buildings in northern latitudes, process emissions from iron and steel production and other industry, and some emissions from agriculture and land use. This remains the case even allowing for technological advance and the effect of a discount rate on relative costs over time[37].

Furthermore, low prices and the possibility of using surplus emissions in future fail to set the economy on a cost-effective pathway towards, for example by failing to incentivise putting adequate low carbon infrastructure in place. This further increases the inefficiency due to the lack of an adequately stringent cap at present.

3.3 The need for greater long-term certainty in targets

To give additional certainty to investors, and to allow interim caps to be set appropriately, the EU's 2050 target of an 80-95% cut in emissions from 1990 levels needs to be made more specific. It currently has too wide a range. The allowed emissions in 2050 differ between the high and low end of the range by a factor of four. If applied pro rata to the EU ETS, the current target could imply emissions capped at anywhere between about 100 and 400 million tonnes p.a.[38]. This is too wide a range to give adequate guidance for the long-term investments that need to be undertaken in the coming decades.

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[36] This is true irrespective of differences on the more contentious issue of the extent to which cumulative historic emissions need to be accounted for, which is particularly contentious for China, which now has higher per capita emissions than the EU (7.7 t/capita for China compared with 6.8 tonnes per capita for the EU), but lower cumulative historic per capita emissions.

[37] Over 30 years at a typical societal real terms discount rate of 3.5% the discounting reduces the cost of future measures by a factor of 2.8, much less that the cost different between the cost of reducing emissions by reducing coal burn and the cost of emissions reductions likely to be required by 2050.

[38] This is estimated by applying an 80% and 95% reduction to EU ETS emission in 2005 of 2014 million tonnes. The 80-95% target refers to 1990 emissions. However total EU emissions were only 5% higher in 1990 than in 2005 (4.2 billion tonnes compared with 4.4 billion tonnes in 1990 – see *http://edgar.jrc.ec.europa.eu/news_docs/jrc-2016-trends-in-global-co2-emissions-2016-report-103425.pdf*). The effect of the different baseline years is therefore small, and could easily be balanced by a slightly different distribution of obligations between EU ETS and non-EU ETS sectors.

For example, four sectors, steel, cement, refining and chemicals emitted 561 million tonnes in 2016 (see Table 1). With a total cap of 100 million tonnes they would need to reduce emissions by over 80% from 2016 levels even if all other sectors reduced their emissions to zero, and by more in the likely case that other sectors continued with some residual emissions. With a total cap of 400 million tonnes they would require less than a 30% cut if all other sectors reduced their emissions to zero. These clearly have vastly different implications, which is especially important as 2050 is now likely within the lifetime of some investments currently being planned. A wide variation in implications for remaining sectors is also found even if refining emissions are substantially reduced by electrification of surface transport reducing demand for oil products.

Table 1: Emissions from large industrial sectors in 2016

Sector	Emissions in 2016 covered by the EU ETS (million tonnes)	Current emissions as a proportion of the 2050 cap (80% reduction)	Current emissions as a proportion of the 2050 cap (95% reduction)
Steel	160	40%	160%
Cement	142	36%	142%
Refining	133	33%	133%
Chemical	126	32%	126%
Total	**561**	**140%**	**561%**

There is also a need to extend targets to beyond 2050. When the current 2050 target was agreed it was more than 40 years in the future. It will soon be less than 30 years in the future. This brings it well within the time horizon for much long-term investment. An additional, longer term target would be valuable in giving the necessary investment signals.

There are broadly two forms of longer term target that could be introduced:

- A date by which emissions must reach zero, for example 2065.
- A target for 2060, which should be at or close to zero, for example a 95% reduction by 2060

Both approaches have the advantage of communicating the message that all sectors will be required to decarbonise effectively in full over the next 40 to 50 years. This gives a message that there is "nowhere to hide" – no sector can count on having access to a residual budget of emissions. Specifying a date by which emissions must be reduced to zero does this more clearly.

There would also be advantages in giving indications of targets for 2040. For example, is a linear decrease expected between 2030 and 2050?

3.4 Mechanisms for adjusting to circumstances

Setting the cap for Phase 4 of the EU ETS in a way that corrects for the weak caps in Phases 2 and 3 remains a matter of urgency. The current reform was completed without including this essential element. Furthermore, even if the current surplus were corrected, additional unanticipated changes in the demand for allowances may lead to the EU ETS becoming ineffective again in future.

There are several potential approaches to stabilising the EU ETS by adjusting the supply demand balance in response to circumstances, addressing the current growing surplus and dealing with future changes. These in turn would allow the EU ETS to make a fuller contribution to meeting the goals of the Paris Agreement.

The three main approaches to adjusting the supply of allowances are summarised in Table 2 below. The MSR responds to circumstances by withdrawing allowances when there is a surplus and potentially cancelling them. However it makes an adjustment only in part (only part of the surplus is transferred each year) and with a time lag. It also sets a fixed surplus administratively rather than leaving it the market, when in practice the optimal surplus is not known and changes over time.

A more direct approach is to reduce the cap in response to a surplus. This deals with the problem at source, and can be made compatible with the Paris Agreement mechanism of a five-yearly review and ratchet of emissions reduction commitments.

The most direct way of ensuring adequate incentives for abatement is to allow the quantity of allowances to vary in response to price (as would happen in almost any other market). This can be done for example by limiting sales of allowances through an auction reserve price. This has the advantage, among other things, of giving more stable signals to investors. In effect the cap is automatically adjusted in response to price, provided unsold allowances are eventually cancelled.

Each of these has merits, and can in principle run separately or alongside each other. How they would interact would depend on the details of the designs adopted. Further analysis would be needed to determine the implications of different combinations of these possible approaches.

Table 2: Approaches to adjusting the cap in response to circumstances

Type of circumstances on which supply adjustment depends	Existing or potential mechanisms
The surplus available to the market	The MSR (partial adjustment)
The effect of complementary measures or other factors such as variations in economic activity	Adjustments to the cap, both immediately and over time
Market prices[39]	Auction reserve prices, and allowance reserves

Each is considered in turn over the next three sections.

[39] There is currently some provision in the Directive under Article 29a for extra allowances to be released in the event of price spikes that are not due to market fundamentals, but the provisions examined in this report go well beyond this.

4. The MSR

4.1 Current Reforms to the MSR

The Market Stability Reserve (MSR), which is due to be introduced in 2019, is intended to manage fluctuations in demand relative to supply by removing allowances from the market in times of excess supply and returning them in times of scarcity. It removes a proportion of the surplus when the surplus is greater than 833 million tonnes. Following the agreement on the reform package the proportion transferred is due to be 24% until the end of 2023 after which is will be 12%. The MSR returns up to 100 million tonnes p.a. of allowances to the market when the surplus falls below 400 million tonnes.

Analysis by Sandbag and others showed a systematic annual surplus leading to the MSR growing to contain several billion allowances during the 2020s[40]. This very large quantity risked contributing to market instability.

To avoid this outcome Sandbag proposed in June 2016 limiting the size of the MSR by cancelling allowances above a fixed threshold, for example one billion tonnes[41]. Such measures were eventually adopted in somewhat modified form under the decision of the trilogue process. From 2023 the size of the MSR will be limited to the previous year's auction volumes, cancelling surplus allowances above this limit. This reform is very welcome.

However, even with the current reforms in place, the problem of the surplus of allowances available to market persists through much or all of the 2020s (see Section 1.3).

The MSR is due to be reviewed by 2021, and as part of this review there is a need to consider whether other changes could also increase its effectiveness. The Table 3 below shows the main parameters of the MSR. The rate of return of 100 million per annum looks unlikely to matter much for many years, because it is unlikely to be triggered until nearly 2030 at the earliest. However the current thresholds and further changes to the proportion of the surplus transferred are potentially relevant earlier and we consider here whether reform of these parameters could have a significant effect on the market.

Table 3: Current status of reform of MSR parameters

Parameter	Original State	Revised State
Maximum number of allowances	No limit	Previous year's auction volume
Proportion of surplus transferred each year	12%	24% for 5 years, then 12%
Number of allowance returned each year	100 million	100 million
Surplus above which allowances begin to transfer	833 million	833 million
Surplus below which allowances begin to return	400 million	400 million

[40] https://sandbag.org.uk/wp-content/uploads/2017/02/The-three-billion-tonne-problem.pdf
[41] https://sandbag.org.uk/2016/06/16/stabilising-the-market-stability-reserve/

4.2 Adjusting the thresholds for the MSR and further extending the increased transfer rate

We have examined the effect of the following sensitivities in turn.

- Halving the current thresholds, to 417 million tonnes for the upper threshold and 200 million tonnes for the lower threshold, so as to continue transfers to and from the MSR with a smaller surplus.
- Increasing the proportion of the surplus transferred to 36% to 2023, then 24% for the remainder of Phase 4.

The results of these changes are shown in Charts 4a and 4b for base and low case emissions respectively. With base case emissions the change in the thresholds has no effect for several years (the blue and orange lines are on top of each other) because the surplus remains above current thresholds. However with the halved thresholds allowances are transferred to the MSR for several more years (2026-2029). With the increased transfer rate and reduced thresholds, more allowances are transferred in the early years, but transfer ends earlier.

With low case emissions the change in thresholds has no effect, as the surplus remains above the existing thresholds throughout the period, even extending the analysis to 2035. The increase in the number of allowances transferred each year due to the higher transfer rate is sustained throughout Phase 4.

Chart 4a: Transfer of allowances to the MSR with halved thresholds (base case emissions)

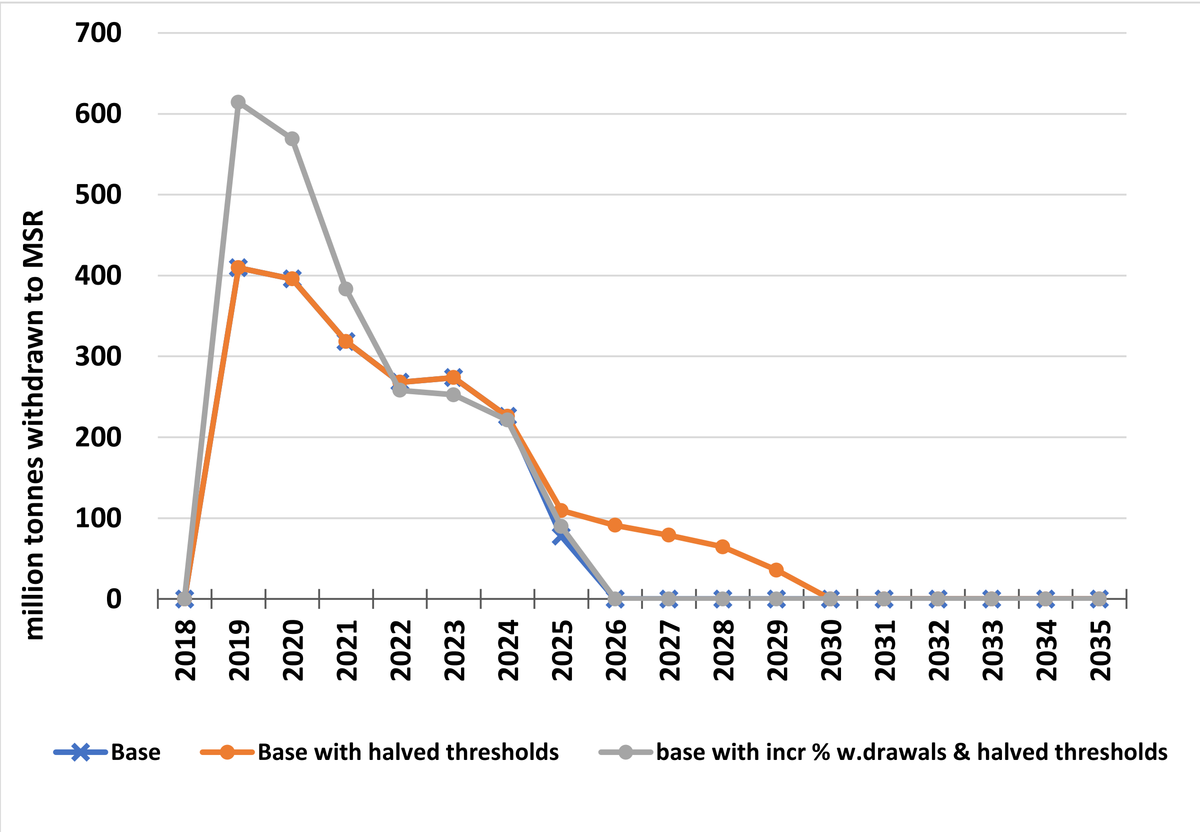
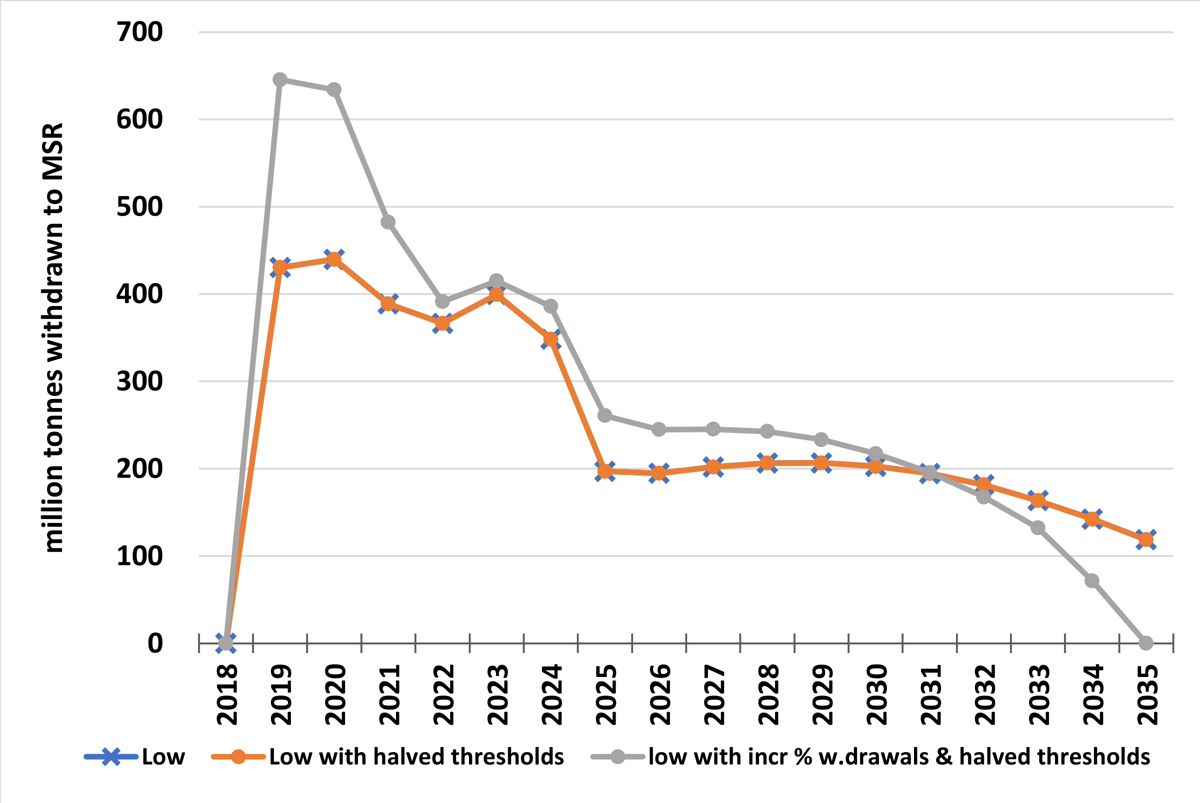


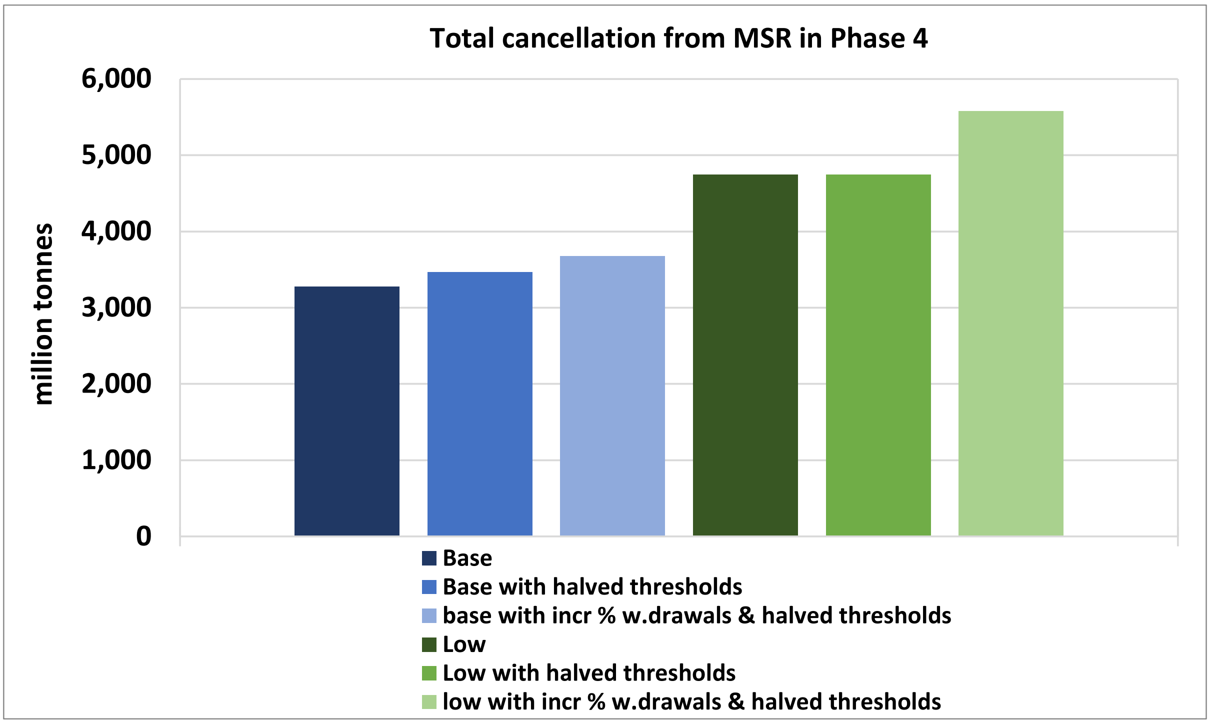
Chart 4b: Transfer of allowances to the MSR with halved thresholds (low case emissions)



There are further benefits from decreasing the thresholds in other circumstances. For example, if there were a surplus of around 600 million allowances, and an additional surplus of around 60 million were generated each year this could imply very weak prices, especially if hedging requirements by generators continue to reduce, yet the MSR would not be active. This would be mitigated with reduced thresholds.

The change in thresholds leads to some increase in cancellation with base case emissions, but not with low case emissions (see Chart 5 below). In the low case the same number of allowances is transferred to the MSR is unaffected by the change in thresholds (see above) so the amount of cancellation is unaffected. An increase in the transfer rate increases the number of allowances cancelled under both scenarios, but the increase is larger for the low emissions case. This implies that further changes to the MSR can enhance its effectiveness in tightening the market, and in particular reducing thresholds can have this effect at least in some cases. This in turn raises the question of whether the current thresholds have a clear rationale that would lead them to be retained, or whether changes are consistent with improved MSR operation, as the analysis here implies.

Chart 5: Effect of change thresholds and transfer rates on number of allowances cancelled in Phase 4 for Base and Low case scenarios



Lack of justification for thresholds

One of the weaknesses of the MSR is that the thresholds are set by administrative estimate, rather than allowing the market to determine the appropriate level of banking of allowances. This difficulty is compounded by a lack of clear rationale for the levels set. The only rationale given when the MSR was established was that they were set to accommodate demand for forward purchases for utilities (hedging), with no details published of the basis for these calculations. This based market design on the commercial strategies of a subset of emitters (fossil fuel generators), from which emissions are likely to fall over time, and who might well change their strategies over time. As such it is not a robust basis for market design.

At the very least, hedging requirements from the power sector will fall over time as it decarbonised. Indeed, emissions from power generation will likely be around 15% or more lower when the MSR begins in 2019 than they were when the thresholds were set in 2015, with consequent reductions in hedging requirements. Fossil fuel emissions from power generation are set to continue declining, perhaps strongly, through Phase 4[42]. Early consideration therefore needs to be given to reducing thresholds over time.

Furthermore, the current thresholds mean that the market is designed for the commercial advantage of a single set of players, and thus for their profiles of risks. These risks favouring fossil fuel generators over renewables, because they allow fossil generators to manage their risks while doing nothing to improve the position of renewables. While it is a perfectly legitimate commercial

[42] They would be further reduced if the UK were to leave the EU ETS.

decision for fossil fuel generators to hedge to guard against price fluctuations, it should not be part of the market design to facilitate this at the expense of other participants.

There are in any case options available for generators to manage their risks. They could simply absorb them, as commercial entities in all markets do in response to price uncertainty. They could engage in forward trading based on price expectations, and they could change their contracting strategies. There does not seem any reason why this market in particular should be designed to facilitate a certain type of risk management. This is especially so as the parameters of the market are fixed, and unlikely to be changed over the relatively short time horizons (typically 2-3 years) over which hedging typically occurs. Generators are thus not subject to any significant risk from arbitrary interventions by the regulatory authorities, as might be the case under some models.

These considerations all tend to point to a preference for lower thresholds for the MSR, and for these to be introduced at an earlier date.

Even if there is a desire to enable generators to manage their risks more easily this can readily be accommodated by allowing future vintages of EUAs to be bought at auction. So for example, an auction in 2021 would allow 2025 EUA's to be bought. This approach is already adopted in California.

4.3 Limitations of the MSR

Further adjustments to the MSR of the type described here may be valuable. However these are not a satisfactory substitute for adjusting the cap itself in the near term, because even with the increased intake rate the continuation of emissions below the cap means that the surplus is not addressed quickly enough[43]. Further adjustments to the cap are needed in the short to medium term.

The reason for this is that the MSR operates with two lags. Firstly there is some time between the surplus emerging and it being reflected in the calculation by the Commission. Secondly, surplus allowances are transferred out of the market only over time, so it takes several years for additional surplus allowances to be transferred (and indeed they are never completely transferred). If a surplus is being continuously generated because of emissions being below the cap, the MSR struggles to catch up and restore adequate scarcity to the market. This is because it does nothing to deal with the source of the problem which is a cap that is too loose. It also does not guarantee that prices will firm to adequate levels.

In the next two sections we review whether other mechanisms for adjusting the quantity of allowances in circulation can deal with not only the current surplus but the potential for a surplus to continue being generated through the 2020s.

[43] We have previously looked at this here: https://sandbag.org.uk/2017/09/01/sandbag-recommendations-can-ets-trialogues-trigger-meaningful-carbon-price/

5. Adjustments to the cap in response to complementary measures and outturn emissions

Section 2.4 described how complementary measures are necessary alongside carbon pricing to achieve a cost-effective pathway to a low carbon economy. This section looks at how they can most effectively be made to work together with carbon pricing, and also considers adjustment for other unexpected outturns.

If more (or fewer) complementary measures are put in place than expected, or they are more (or less) effective, there may be a surplus of allowances or unexpected scarcity. The present surplus in the EU ETS appears to be in part due to the success of complementary measures, although other factors, notably the prolonged recession in Europe and the availability of international offset credits, have also been major contributors[44].

The scale of the difference to emissions resulting from complementary measures can be very large. As noted, approximately 40% of emissions from the EU ETS are from burning coal for power generation. Complementary measures which affect these sources can therefore have a large effect on the market as a whole, and mechanisms to adjust for such changes can have a correspondingly large effect.

To account for unanticipated effects from complementary measures some observers have suggested adjusting caps. Such adjustments can be made on an individual basis ("a bottom up" approach), or using an alternative approach of looking at any surplus created in aggregate (a "top down" approach).

We now consider each of these. The issue of adjustments at the member state versus EU level is also considered.

5.1 Taking account of individual complementary measures while setting a cap ("bottom up")

One approach to adjusting caps to take account of complementary measures is to try to adjust for the effects of each measure individually through a bottom up calculation. For example, a recent report by Pöyry, Fortum Oyj, Statkraft and Vattenfall (referred to here as PFSV) suggested this type of approach[45]. For national complementary measures the member state responsible for the measure would cancel from its auction volumes an amount equal to the emissions reduction dues to the complementary measure. For measures at EU level auction volumes would be cancelled in line with current member state shares.

The suggested approach implicitly consists of several steps.

1. Defining which complementary measures affect emissions and so require an adjustment to be made.

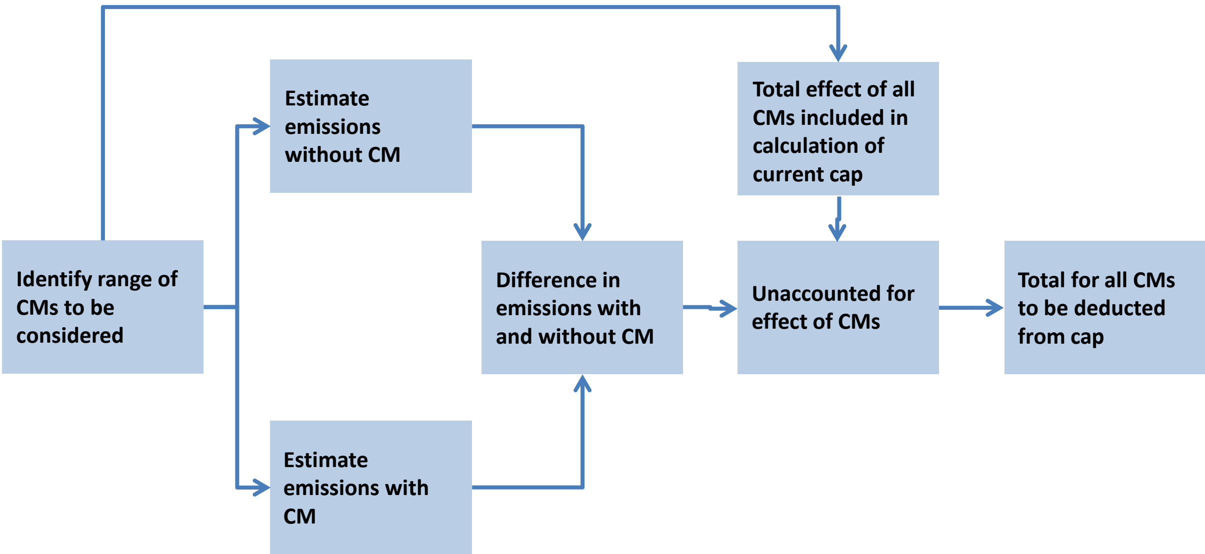
[44] https://sandbag.org.uk/wp-content/uploads/2016/10/ETS_Position_Report_240615_1_1.pdf, https://www.fortum.com/SiteCollectionDocuments/Public_affairs/20170615_ManagingOverlappingPolicies_EU-ETS.pdf

[45] See: https://www.fortum.com/SiteCollectionDocuments/Public_affairs/20170615_ManagingOverlappingPolicies_EU-ETS.pdf

2. Quantifying their effect, and thus the size of the adjustment that must be made, initially based on an estimate made before introduction of the measure and then based on actual outcomes.
3. Identifying the extent to which they have already been taken account of in setting the cap, so only the portion not yet accounted for is included in the adjustment.
4. Adjusting the cap accordingly.

Our interpretation of his process is illustrated in Chart 6 below.

Chart 6: Process for adjusting the cap to take account of Complementary Measures (CMs)



Each of these steps has fundamental difficulties and drawbacks. Some may be addressed by modifying the proposals, but others are more fundamental and apply to this type of proposal more generally. They cannot be solved simply with more resources devoted to estimation.

1. ***Which complementary measures are included?*** The proposal does nothing to take account of existing complementary measures. As such it does nothing to address either the current surplus or the continuing build-up of the surplus due to emissions remaining below the cap.
2. ***How large is their effect?*** The calculations of the size of the effect of each complementary measure are problematic in principle and likely to prove impractical in many cases, because it will not be clear what would have happened anyway and when (the counterfactual). In some cases the counterfactual can be estimated approximately, as for example in the case of incentives on renewables and the effect of national carbon pricing (see section 6.4 for an example of this). However in other cases this will not be possible. For example, the outcome of measures such as incentives to close an industrial plant and measures to promote energy efficiency will often be dependent jointly on many different factors. The effect of a single complementary measure is in practice impossible to separate out from the multitude of factors affecting a commercial decision.
3. ***How much have they been factored into the cap?*** It will always be impossible to assess which measures have been built into the cap to what extent, because the process for setting

the cap does not include any specification of assumptions in this respect. This makes calculating the extent to which the effect of a complementary measure has been included subject to arbitrary assumptions. For example, how much of the prevailing renewables targets will have been factored into setting the cap? Restricting the assessment to new complementary measures only does not adequately address this problem, because caps will likely be set in the expectation of at least some future complementary measures, including those contained in other Directives. If on the other hand it is assumed that the cap has been set with no account taken of complementary measures the adjustment will include all the reductions due to complementary measures, which is likely to lead to a very large adjustment to the cap.

4. ***How is the cap adjusted?*** The adjustments necessarily rely on estimates, which may mean that the cap is adjusted too little or too much.

In aggregate these are not simply difficulties that can be overcome with sufficient resources and judicious use of approximation. Instead they are collectively a fundamental obstacle to implementing a system of this type.

5.2 Alternative approaches based on an aggregate surplus ("top down") that corrects for a variety of unanticipated outcomes

An alternative approach

The difficulties raised by the type of approach described above have led Sandbag to consider an alternative approach. Sandbag has advocated that there should be a ratchet provision, with the effect of complementary measures and other unanticipated events potentially tightening the cap, but not loosening it. The proposed mechanism consists of an adjustment such that when emissions fall below the cap then the cap is adjusted accordingly. The cap then continues to fall for the remainder of the phase due to a Linear Reduction Factor (LRF), which may be modified if appropriate.

This approach avoids difficulties of the bottom up approach. Instead it treats the effect of complementary measures and any other unanticipated events as an unaccounted for residual. This is essentially replacing the highly disaggregated bottom-up approach described above with a single top-down calculation.

Details of the alternative approach

There is a range of detailed options for the design of such a mechanism. These include the following.

1. Whether the calculation to reset the cap is done annually or periodically, for example every five years.
2. How to adjust the cap, e.g. by setting a new starting point based on verified emissions or by substracting the difference between the cap and actual emissions in previous years.
3. How many years of previous emissions and cap are used to calculate the downward adjustment. For example does it just take into account the previous year, or does it cover a

longer period, for example three or five years, averaging the cap and emissions over that period?
4. Whether there is a threshold for the surplus, analogous to that in the MSR, so that the cap is reduced only by the difference above a certain threshold.
5. How is a new LRF specified? For example is the LRF retained unchanged for the remainder of the phase and then revised, or is it revised at the time of the adjustment, for example to keep the same end point?
6. Whether the reduction in the cap comes only from auction volumes, or some combination of auction volumes and free allocation. The former looks more likely to be politically tractable.

Charts 7a and 7b below show illustrative cases where the cap is reassessed every five years, based on a four-year average of verified emissions[46], no minimum threshold for adjustment, and no change in the LRF after adjustment. **There is no suggestion that this is an optimal or preferred set of choices – it is simply chosen to illustrate a possibility.** In Chart 7a emissions follow linear trajectory between latest verified (2016) emissions and -43% in 2030, which is similar to our base case scenario. In this case there is a single adjustment to the cap. In Chart 7b emissions follow Sandbag's low case trajectory and there is a second adjustment to the cap in the mid-2020s.

[46] For 2021-2025, the cap is based on a starting point in 2020 based on average verified emissions in 2016-2019, and then the Linear Reduction Factor is applied. For 2026-2030, a similar approach is applied (2025 starting point based on 2021-2024 verified emissions) only if this leads to a downwards adjustment.

Chart 7a: Illustration of mechanism adjusting the cap

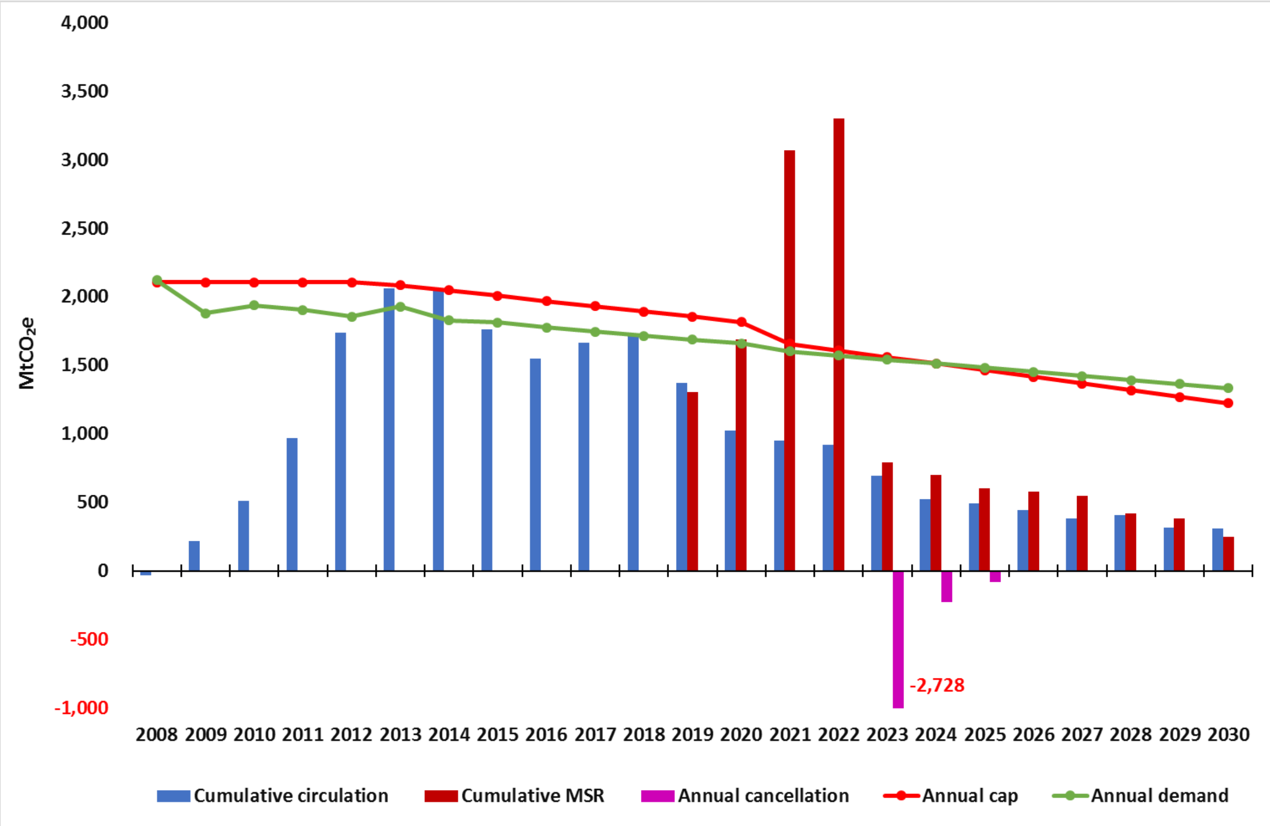
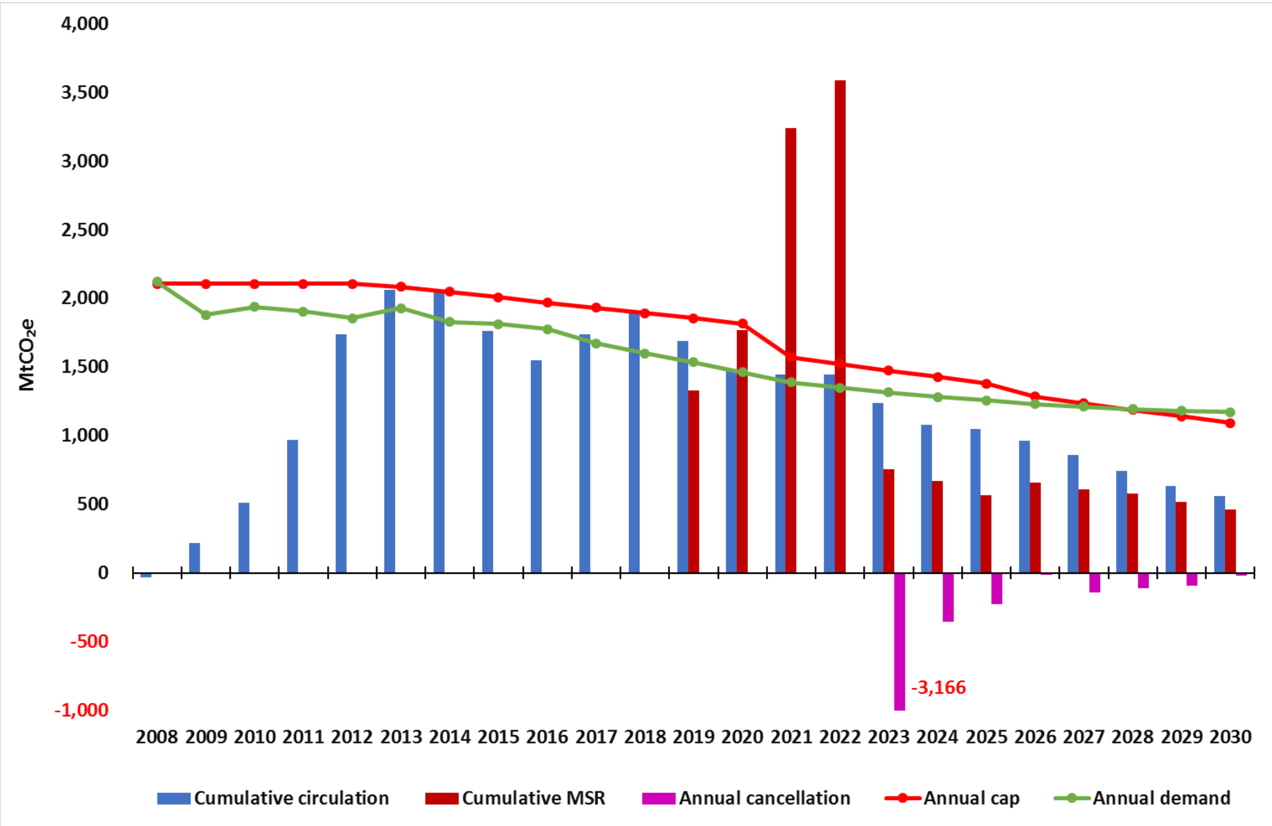


Chart 7b: Illustration of mechanism adjusting the cap



The choice of design parameters can help address potential concerns about the effects of such a mechanism. Some possible concerns and their mitigation are set out in Table 4 below.

Table 4: Potential issues with a cap adjustment mechanism

Potential issue	Mitigating choices
Creating uncertainty for investors	• Like the MSR it is rule based and predictable, so investors can take its operation into account. • By restoring the supply demand balance in the case of unexpected outcomes it can increase the stability of the market, and therefore increase certainty • If adjustments are taken from the auction share then free allocation to industry is unchanged so there is no additional risk from that source.
Creating uncertainty for government revenue	• It is rule based, so predictable • May help maintain prices, so maintaining government revenue
What if there were a cyclical surplus representing a temporary downturn in economic activity?	• This can be addressed by appropriate choices for the averaging period and the threshold for adjustment (items 2. and 3. on the above list of design parameters)
Does it allow for some necessary level of surplus	• Yes, through choice of threshold (see item 3. on the above list of design parameters)
What if emissions rise?	• The mechanism is not triggered
Would it duplicate the effect of the MSR?	• It would reduce the role of the MSR in dealing with a structural surplus. I can run alongside the MSR, but may eventually make the MSR superfluous.
Would it undermine the incentive for early action	• It would help secure the effectiveness of early action, for example by allowing adjustment to the LRF to more cost-effective long-term pathways.
Would there be a significant administrative burden?	• It would be a simple calculation carried out once every five years using well-established data. The administrative burden would be correspondingly small.

Benefits of an alternative approach

This approach will maintain the overall integrity of the cap and its consistency with long term emissions reduction goals. It is also in line with the principle of progressively tightening NDCs and the process for reviewing NDCs under the Paris Agreement, which is due to be implemented to include a ratchet mechanism[47]. Indeed the process of review and revisions could be explicitly designed to run in parallel with the ambition mechanism under the Paris Agreement. In that way it could directly influence the setting of the EU's NDCs under the Agreement. This may help achieve further reductions in global emissions by encouraging other parties to the Paris Agreement to strengthen their commitments.

[47] Paris Agreement Articles 4.2, 4.3 and 4.9.

This top down and bottom up approach also has advantages over a bottom up approach.

- It is much more tractable and all calculations of difference from the existing cap are based on data showing the reality of actual emissions.
- It automatically adjusts for other types of unanticipated outcomes, including for example variations in economic activity, so increasing the robustness of the system. In contrast the bottom up approach only takes into account the effect of complementary measures.
- This proposed mechanism, unlike the PFSV proposal, takes account of the continuing effect of existing complementary measures. It is essential to correct for existing complementary measures if the adjustment mechanism is to play an adequate role in restoring the supply demand balance in future. This is because emissions remain below the cap in part due to the substantial continuing effect of complementary measures such as renewables deployment, energy efficiency and measures to reduce coal burn such as the UK carbon price support and other environmental regulations. If these are not adjusted for emissions are in any case likely to remain below the cap until the late 2020s or beyond.

This “top down” approach is very similar to the approach of rebasing the EU ETS cap to reflect the reality of actual emissions that Sandbag advocated during the recent EU ETS reform process[48]. It differs principally in that it includes an explicit rationale for the adjustment, and defines it as a periodic process happening every five years, or on a rolling basis, rather than an adjustment taking place only at the beginning of a phase.

5.3 Adjustments at member state or EU level for national complementary measures

Complementary measures may be introduced at the national or EU level, or by local or provincial authorities or groups of countries. The adjustments to balance the effect of these measures can be made at the national level or at EU level, most likely by adjusting the auction volume. If adjustments are made at the EU level auction volumes are likely to be adjusted in line with member state shares under Article 10 of the EU ETS Directive, which would be similar to the approach already adopted for the MSR.

The PFSV proposal suggests that an adjustment should be made for complementary measures introduced at the national level by deducting an amount equivalent to the resulting emissions reduction from auction volumes of the member state implementing the complementary measure[49]. (The adjustment for EU wide complementary measures is envisaged as being at the EU level.) However putting the cost of the adjustment on and individual member state has the undesirable effect of creating a further financial disincentive for member states to introduce complementary measures, because the member state incurs a double cost: the cost of the measure itself, plus the cost of the foregone auction revenue.

[48] See for example https://sandbag.org.uk/wp-content/uploads/2017/02/ENVI-results-assessment-Sandbag-070217-1.pdf
[49] https://www.fortum.com/SiteCollectionDocuments/Public_affairs/20170615_ManagingOverlappingPolicies_EU-ETS.pdf

The incidence of costs is shown in Table 5 below, for an illustrative case of a measure that avoids 10 million tonnes of emissions at a cost of €20/tonne when the market price of allowances is €8/tonne[50], and the member state is assumed to account for 5% of total EU emissions. At €20/tonne the measure would clearly be an efficient contribution to meeting long term decarbonisation goals.

Table 5: illustration of the incidence of costs of a complementary measure

	Allowances withdrawn from auction by Member State	Allowances withdrawn from auction by all Member States
Cost of policy to member state	€200 million	€200 million
Cost to member state of removing allowances	€80 million	€4 million
Total cost to member state	€280 million	€204 million
Cost to other member states	0	€76 million

The PFSV report explicitly refers to the member state paying as the "policy pays" principle, implying that it is intended as a disincentive to introduce policies which reduce emissions, by analogy with the "polluter pays" principle. The justification for this approach is not explicitly set out. Indeed the assessment criteria used do not include any reference to incentives.

It appears to reflect the view that overlapping policies increase costs because abatement is not market driven (section 1.2 of the PFSV report). No further justification for this view is included. However, as noted in Section 2 of this report, complementary measures, far from being inefficient, are essential to effective and efficient decarbonisation. A mechanism such as the PFSV which deters member states from pursuing complementary measures will therefore inhibit effective and efficient reduction in emissions.

It is therefore more appropriate that adjustments to auction volumes or the cap should be made at the EU level. This is consistent with the present the operation of the MSR, which removes allowances at the EU level.

Suggesting an adjustment at the EU level to recognise the effect of complementary measures does not preclude voluntary cancellation by a member state.

[50] The assumption is that the withdrawal of volumes in response to the complementary measure exactly matches in timing and volume the effect of the complementary measure, so the supply-demand balance and price are unaffected.

6. The potential role and implications of managing quantity in response to price

This section considers managing prices by adjusting quantities when prices reaching certain thresholds ("floors and ceilings"). Allowing the quantity of allowances to vary in response to price would make the EU ETS more like almost all markets, where supply responds to price[51].

A floor is usually imposed by placing a reserve price in allowance auctions. This reserve price usually escalates over time at a pre-defined rate. While the price can drop below the reserve price for a while, which is why such a mechanisms is sometimes referred to as a "soft floor", it is unlikely to do so for very long in normal circumstances, especially if there is adequate escalation of the reserve price over time. However, if a surplus of unsold allowances is built up because the cap is persistently not binding, as under the EU ETS at present, it is important that these allowances are cancelled.

A ceiling is usually imposed by allowing additional volumes to be released from a reserve when the price reaches a threshold. The additional volume is usually limited to protect the environmental integrity of the system, so prices can rise above the ceiling in such cases. A system may have a floor or a ceiling or both. If both are present it is sometimes referred to as a price corridor. There may also be more than one threshold, with more allowances successively being released to create successive steps in supply.

There are elements of system design which need to be defined in implementing a price cap. These include the following.

1. The levels of floors and ceilings
2. How these escalate over time
3. What happens to allowances unsold at auction, including whether they are cancelled
4. What happens to unused allowances in a reserve, including whether they are cancelled if unused after a certain time
5. Whether there are any limits on banking or carry forward of allowances

These features have important consequences. In particular, to secure the environmental benefits of price containment it is important that there are adequate mechanisms for ensuring scarcity of allowances over time, including adequate provisions for cancellation and limits on carry forward.

6.1 Benefits of mechanisms for adjusting quantity in response to price

The benefits of mechanisms that limit the range of prices under an emissions trading system, commonly called price containment mechanisms, have been widely reviewed in the academic literature over several decades. This body of work shows the greater robustness and cost-effectiveness in an ETS of limiting both allowance prices, in the form of floors and ceilings, and quantity when uncertainty about both abatement costs and the cost of damages is present (as it

[51] In almost all normal markets if the price drops too low there will be less supply. Almost the only exceptions are tickets to major sporting or entertainment events, where the number of seats in the venue is typically fixed, and the supply of authentic art works by artists no longer alive.

always is) [52, 53]. This conclusion from the academic literature has also been noted by other observers advocating a price floor for the EU ETS[54].

For example, if a cap is set on certain expectations of emissions, and outturn emissions are very much lower than expected, then the price of allowances can drop to very low levels. This has been the case under the EU ETS, and would have been even more so without banking of allowances. This can lead to a weak price signal with too many remaining emissions causing environmental damage which it would be cost-effective to reduce by selling fewer allowances. Similarly, if a tax is put in place, but at too low a level it can fail to stop emissions rising above a damaging threshold. In contrast a cap in an ETS can prevent this as part of a broader international architecture[55]. Inclusion of a price floor to prevent excessive environmental damage from selling allowances too cheaply, and a cap to prevent emissions going above a defined level in any event can provide a robust and efficient system in the way a cap or tax alone fails to do.

Price containment can also help ensure a carbon price more in line with long term goals, which caps alone may fail to do. This will enhance its role, for example, in stimulating low cost abatement now and furthering the deployment of new technologies.

Furthermore, price containment has the advantage of giving greater clarity and certainty to investors, and so secure levels of investment more in line with efficient long-term decarbonisation pathways. The price range, and in particular the price floor, can be defined in advance, usually for a complete phase of the system. This gives investors additional certainty about the value of abatement.

Under the types of price containment mechanism described in this section is no arbitrary intervention in the market because the rules are defined in advance. In this respect it differs from proposals such as a Central Bank type mechanism, which give more flexibility to institutions to make interventions in the market.

Price containment mechanisms are entirely consistent with setting adequate caps. If the cap is adequate and circumstances are as expected then the price will remain within the range between the floor and the ceiling. Such a range will typically be quite large. The price containment mechanisms are there only in case the cap has not been set at appropriate levels.

A price floor does not usually guarantee that prices are at fully adequate levels compared with those recommended to achieve the Paris Agreement targets, or to adequately reflect the environmental damage caused (see Section 1). Instead they are usually intended to retain prices within ranges

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52 The literature on combining price and quantity management follows Roberts and Spence (1976). http://qed.econ.queensu.ca/pub/faculty/garvie/eer/roberts%20and%20spence.pdf A more recent analysis is Newell, R.G., Pizer, W.A. and Zhang, J. (2005). Managing Permit Markets to Stabilize Prices. *Environment and Resource Economics* 31:133-157

53 There remains a body of work arguing that a carbon tax adjusted over time is superior to an ETS. However the advantages of an EU ETS with price containment remain compelling, for example because of consistency with the international policy architecture and because of the strategic signal provided.

54 See https://www.mcc-berlin.net/fileadmin/data/C18_MCC_Publications/Decarbonization_EU_ETS_Reform_Policy_Paper.pdf

55 For a fuller but accessible discussion of the merits of difference approaches to carbon pricing see here. https://onclimatechangepolicydotorg.wordpress.com/carbon-pricing/the-choice-of-type-of-carbon-pricing-systems/

where they at least give more effective abatement signals than would be the case with a cap alone when demand for allowances is unexpectedly low.

6.2 Price containment in practice

The acknowledged advantages of price containment mechanisms have led to them being introduced in the WCI systems (California, Quebec and Ontario) and the Regional Greenhouse Gas Initiative in the North-Eastern USA. Both have an auction reserve price which restricts supply of allowances if price falls, providing a soft price floor. They also have a price containment reserve which increases supply by allowing extra allowances to be sold if the price rises above defined thresholds. Once the reserve is exhausted, no further allowances are issued, so at present prices can continue to rise and the environmental integrity of the cap is preserved.

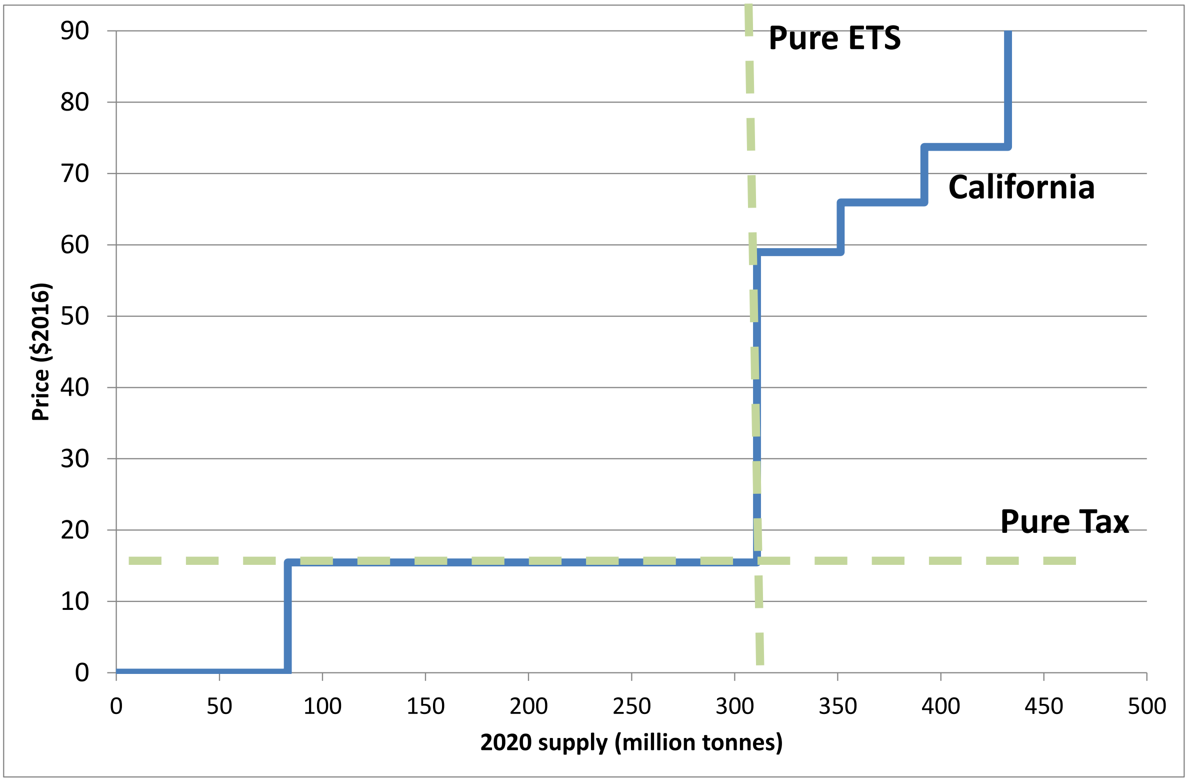
The mechanisms have succeeded in maintaining prices within a range. Prices have largely stayed within the bounds set by the auction reserve price and the upper bound, although prices have on occasion been outside the boundaries for a few months.

California

In the California system the Auction Reserve Price is currently \$13.57 per allowance, and increases annually by 5% plus inflation, as measured by the Consumer Price Index. There is also a price containment reserve triggered in three successive tranches in the event of high prices (\$40, \$45, \$50/tonne in 2013 escalated over time at the same rate as the floor). After 2020 it appears that there will be a further safety valve with, most probably, additional offsets being allowed in the event of very high prices. This provision somewhat weakens the environmental integrity of the cap but at present appears unlikely to be triggered in practice.

The multiple reserve thresholds give a stepped supply curve, with supply varying with price. This is illustrated on Chart 8 below for the last year of the current phase in 2020. Some allowances are allocated for free. After that supply is available at the auction reserve price. Above that level the price containment reserve is triggered in three steps. Once that is exhausted no further allowances are available. This differs from either a pure ETS such as the EU ETS, which has a vertical supply curve, and a carbon tax which has a horizontal supply curve. The tax and ETS lines on the chart are hypothetical only to illustrate the different characteristics of different systems.

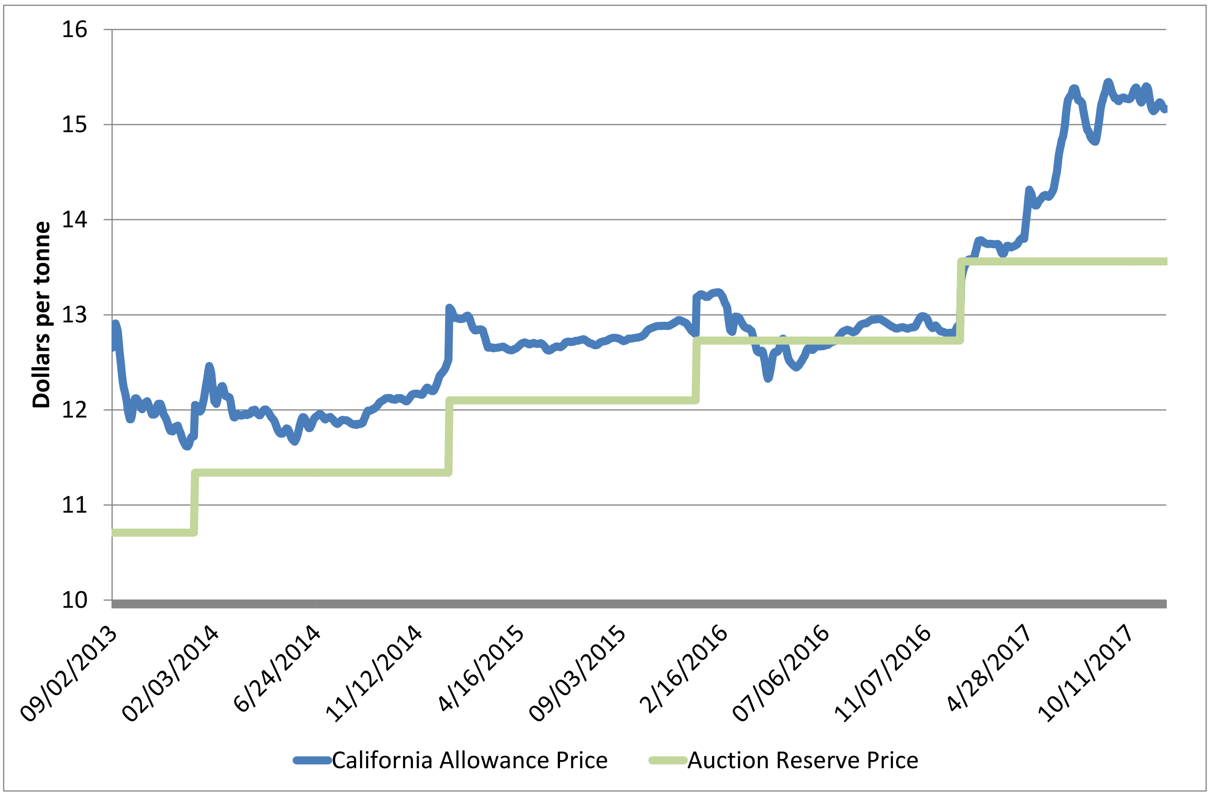
Chart 8: Indicative supply curve of allowances under the California ETS in 2020.



Price containment has largely proved effective. Chart 9 shows the prices under the California system. The market price has largely held above the auction reserve price with the exception of a three-month excursion in early 2016. This was due to oversupply and uncertainty about the future of the program after 2020 which resulted in lower prices on the secondary market[56]. Prices have since increased as political uncertainty has been resolved with the passage of legislation (AB398) which extends the ETS to after 2020. The upper price containment reserve has never been triggered because prices have remained well below the threshold levels.

[56] http://www.nortonrosefulbright.com/knowledge/publications/149991/uncertainty-and-surplus-allowances-dog-california-cap-and-trade-program

Chart 9. The effect of price containment mechanisms in California



Source: http://calcarbondash.org/ and CARB

RGGI

RGGI includes a reserve price that constitutes a price floor in the allowance auction, which is set at \$2.15 per ton in 2017 and is scheduled to rise at 2.5 percent per year going forward. RGGI also includes a cost containment reserve (CCR) that introduces up to 10 million additional allowances per year at prices above the CCR trigger price. The CCR price step price started at \$4.00 per ton in 2014, rising to \$6.00 in 2015 and \$8.00 in 2016. It is set at \$10 per ton in 2017 and is scheduled to rise by 2.5 percent per year thereafter[57].

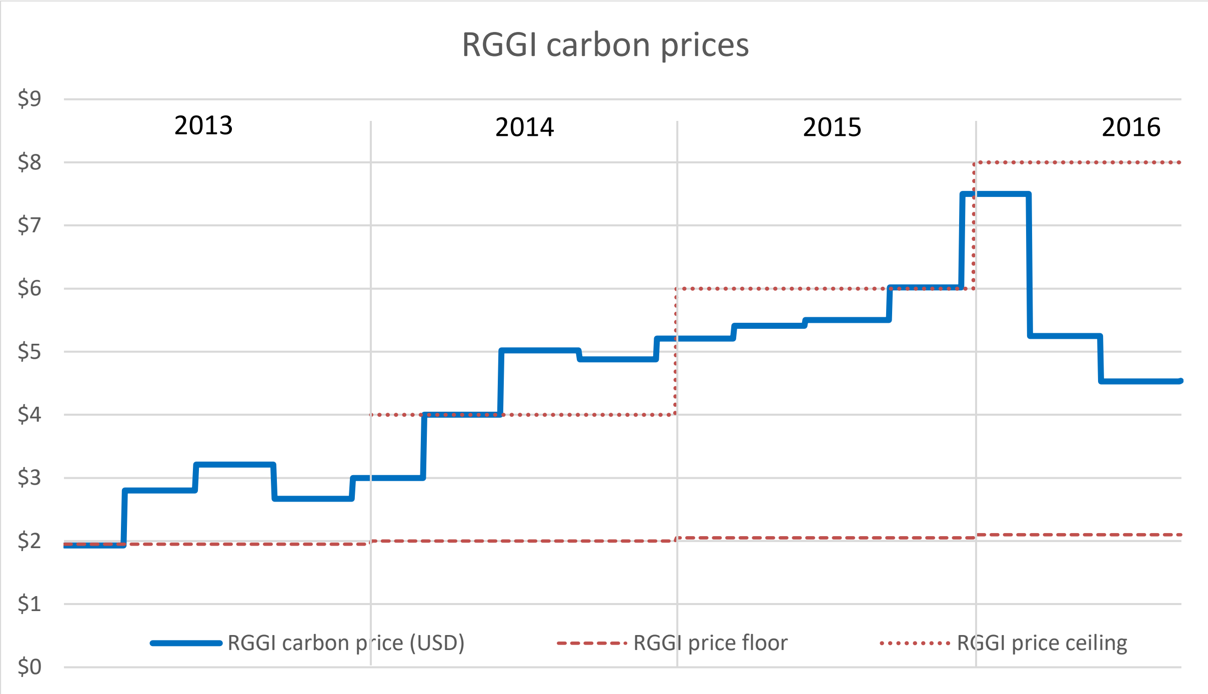
Prices in RGGI have mainly stayed within the defined corridor (see Chart 10 below). Prices have consistently remained above the floor price (which is low and increases slowly compared to WCI markets). However they rose above the allowance reserve threshold several times in 2014. This is consistent with the design mechanism allowing prices to go above the ceiling if the reserve is exhausted. However prices fell again in 2016.

RGGI is currently reviewing arrangements for after 2020. A draft design was agreed in August 2017. It is intended that from 2021 the CCR will have a trigger price of \$13/tCO2 rising at 7% p.a.. A new Emissions Containment Reserve (ECR is planned) where 10% of allowances will be auctioned only if

[57] http://www.rff.org/files/document/file/RFF-Rpt-RGGI_ECR.pdf

the price rises above a threshold of $6/$tCO_2$, rising by 7% p.a.. This will give RGGI, like California, a stepped supply curve.

Chart 10. The effect of price containment mechanisms in RGGI



Source: https://www.rggi.org/market/co2_auctions/results

6.3 Proposals and objections to such measures in the EU

Adjusting supply in response to price is broadly similar in principle to adjusting supply in response to other factors. It has now been demonstrated to be effective North America.

In the light of these successes and the persistently low price in the EU ETS price containment mechanisms have been proposed in the EU. In 2016 the French Government published a non-paper advocating modifications to the MSR to impose a soft price corridor with a design drawing on the examples in the North American systems[58]. More recently a report by the independent think tank Terra Nova[59] also advocated a price corridor**.** A recent report by Mercator Research Institute, which grew out of a stakeholder dialogue during 2017, advocates a price floor for reasons which overlap with those set out in this report to justify both price floors and complementary measures[60].

Objections are often raised to such proposals. The standard objections are summarised in Table 6 below. These have little or no validity in principle. Indeed, Sandbag has been unable to find a single substantive objection in principle to introducing price containment into the EU ETS. In practice objections to such measures seem be from those who simply don't want higher carbon prices, and those who fear the political difficulty of agreeing price levels.

[58] See http://carbon-pulse.com/16939/ and link therein
[59] http://tnova.fr/notes/accelerer-la-decarbonation-vers-un-prix-minimum-du-co2-pour-l-electricite-en-europe-de-l-ouest
[60] https://www.mcc-berlin.net/fileadmin/data/C18_MCC_Publications/Decarbonization_EU_ETS_Reform_Policy_Paper.pdf

Table 6: Responses to standard objections to price containment

Objection	Actual situation
"Price management is interfering in the market"	The market is a regulatory construct. Modifications to this construct are appropriate to correct shortcomings. The MSR is one such modification, price corridors would be another. Mechanisms are not ad hoc interventions. Varying allowance supply with price can make the market less susceptible to political interference by stabilising it.
"There is no environmental benefit to a floor price because the cap does not change"	There is, as unused allowances can be cancelled, either directly, or placing them in the MSR where they may be cancelled. Also the cap can be adjusted in the longer term to account for the effect of a price floor.
"If the EU is meeting its target at low cost the price should be correspondingly low"	No it should not. The low price signals that the target is not stringent enough. All emissions are damaging, even those within the cap, and if more abatement can be achieved at lower cost than the damage caused, which is the case with many current emissions, especially from coal, then this is what should happen. Greater abatement now allows for a smoother transition in the longer term (see section 2.3)
"It goes against the quantity based nature of the EU ETS" or "it's introducing a carbon tax"	Prices can be managed by automatically adjusting supply in response to price, for example by putting a reserve price in auctions. This is entirely consistent with the quantity based nature of the EU ETS, in that it works by adjusting quantity. Indeed, it makes the EU ETS more like almost all other types of market where the quantity of supply varies in response to market prices.
"It reduces market efficiency"	This confuses efficiency of trading with efficiency of the price signal created. The system has created prices which have failed to adequately signal efficient abatement (in effect the market is telling you that the current cap is too loose). There is thus a misallocation of resources towards too many emissions and too little abatement, a consequence of a price which is inefficiently low.
"The price may be set at the wrong level"	Having both price and quantity limits increases robustness to the unexpected. If the cap has been set at appropriate levels then prices will anyway lie within the range of any price containment, and price limits will not bind. However the existing EU ETS cap has been set at a sub-optimal level – too many allowances have been issued and the price is too low.
"It will never be possible to agree a price"	There are various reference points that allow sensible price triggers to be set. These include the social cost of carbon, where some value from the range of possibilities can be agreed, prices from other systems and prices identified by analysis and modelling. The procedure can be to some extent depoliticised by creating an independent advisor group as suggested in a recent report[61]. A price can be agreed if those involved want to agree.

[61] https://www.mcc-berlin.net/fileadmin/data/C18_MCC_Publications/Decarbonization_EU_ETS_Reform_Policy_Paper.pdf

6.4 Using a carbon tax to impose a floor price

A minimum price can also be imposed by a carbon tax. This is the approach currently pursued in the UK, where a tax on power generation (known as carbon price support) is levied in addition to the requirement to surrender EUAs.

The UK tax has proved highly effective in reducing emissions, producing a substantial environmental benefit. As such it has provided a useful illustration both of the value of a floor price and more broadly of the effectiveness of carbon pricing. This has been achieved by a price that, while set at a more adequate level than prevails in the EU ETS, remains moderate or low against a range of other markers, including other carbon taxes [62].

The level of the UK carbon tax in the power sector rose over the period 2013 to 2016[63]. This was accompanied by a nearly 80% reduction in emissions from coal generation, which fell by 100 million tonnes over the period (see Chart 11 below). Various factors contributed to this reduction in coal generation, including the closure of some plant and the effect of regulation of other pollutants. Nevertheless the increase in the carbon price in 2015 and 2016 played a crucial role in stimulating this reduction in emissions by making coal generation more expensive than gas[64]. According to a report by independent analysts Aurora, the increase in carbon price support accounted for three quarters of the total reduction in coal generation over the period[65].

The decrease in emissions of 100 million tonnes from reduced coal burn resulted in a net fall in emissions over the period around 60 million tonnes p.a.[66], taking account increased emissions from burning additional gas. The attribution of three quarters of this reduction to carbon price support implies around 45 million tonnes p.a. of net emission reductions is due to carbon price support. This is equivalent to about 10% of total UK GHG's and 3% of the annual Phase 4 cap for the EU ETS, and is a very large figure for a single complementary measure in one member state. The

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[62] UK carbon price support is £18/tCO_2 (€20/tCO_2), which led to a total price of around €25/tCO_2 in 2016 with the EUA price added on. This is, for example, below the levels either implemented or targeted for carbon taxes in France and Canada. In France the carbon tax, rose from €22/tCO_2e to €31/tCO_2e over 2016-2017. In Canada the federal government announced the pan-Canadian approach to carbon pricing. For provinces electing to adopt a carbon pricing initiative with a fixed price such as a carbon tax, the carbon price needs to reach CAN$50/tCO2e (€34/tCO2e) by 2022. See https://openknowledge.worldbank.org/handle/10986/28510?locale-attribute=en. The price is also below the levels expected to be needed to meet international goals (see section 1.2), and below the social cost of carbon as estimated by the US EPA (see https://onclimatechangepolicydotorg.wordpress.com/carbon-pricing/8-the-social-cost-of-carbon/ and references therein).

[63] UK carbon price support reached at £18/tCO_2 (€20/tCO2) 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

[64] http://www.theenergycollective.com/onclimatechangepolicy/2392892/when-carbon-pricing-works-2

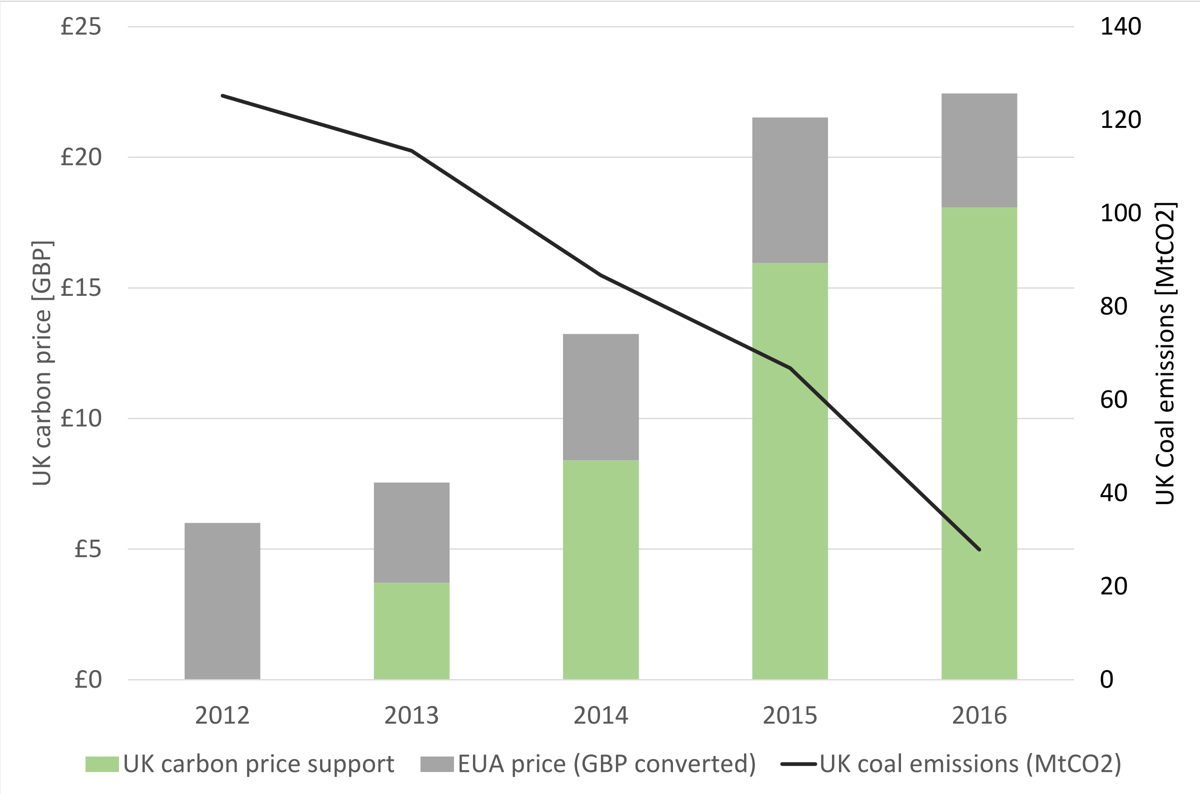
[65] https://www.edie.net/news/6/Higher-carbon-price-needed-to-phase-out-UK-coal-generation-by-2025/

[66] Based on UK coal generation weighted average emissions intensity of 880gCO2/kWh, and 350gCO_2/kWh for gas generation.

financial value of the avoided environmental damage from avoiding these emissions is approximately €1.8billion p.a.[67].

This type of low cost emissions reduction is exactly the sort of behaviour that a carbon price should be stimulating, but which is failing to happen as a result of the EU ETS because the EUA price is too low.

Chart 11: UK power sector carbon prices and emissions from generation using coal



Note: Calendar years are derived from fiscal years with simple 0.75 to 0.25 weighing
Source: Sandbag calculations based on HMRC, parliament and BEIS data.

Similar behaviour could be incentivised across the EU in response to higher prices. This seems more likely to be achievable by a tighter cap and an auction reserve price in the EU ETS than by an EU wide carbon tax following the UK model. An EU wide tax would be politically difficult to achieve, because it requires unanimity among members states. Attempts to introduce a carbon and energy tax in the 1990s were notably unsuccessful, and similar efforts in future are likely to prove intractable.

While an EU wide price floor at an adequate level is the best option, this may not prove achievable. It may nevertheless be possible for other member states to follow the UK's lead and introduce a floor in the form of a tax. Such an approach is reportedly under consideration in the Netherlands

[67] 45 million tonnes p.a. at a social cost of carbon based on US EPA estimates of $47/tonne (€40/tonne).

which is looking to impose a carbon price floor in the power sector rising to €43/tonne by 2030, with Portugal considering a tax on electricity from coal[68].

If introduced in member states with large amounts of coal generation and lignite, especially Germany, a price floor at an adequate level would likely be highly effective in reducing emissions from these sources. This would in the short term increase the surplus under the EU ETS, with more allowances going to the MSR, and then being cancelled. In the medium and longer term it would help enable tighter caps to be set. It would thus further the EU's progress towards meeting its Paris Agreement goals. The environmental benefits of such measures would be very large.

6.5 Conclusion on price containment

A price floor at an adequate level has a number of advantages that make it a promising reform to the EU ETS, alongside setting of a tighter cap. These include:

- Prices at more efficient levels, leading to additional abatement and stronger signals for investment compared with the present situation
- More certain prices, increasing certainty for investors in low carbon technologies
- Greater robustness to unexpected events in future
- Proven tractability of implementation and ensuring a minimum price in the WCI systems, RGGI and the UK
- Proven effectiveness in achieving substantial emissions reductions (the UK)

Achieving these benefits is however conditional on the auction reserve price being set at adequate levels, and for provisions to cancel any persistent surplus of allowances not sold at the floor price.

It would also be necessary to consider how a floor price would interact with adjustments to the cap, as set out in the previous section, and the MSR. As noted in Section 3, this requires further analysis.

[68] See Energy Post, 14th November 2017

7. Allowance allocation, competitiveness and funds

The need to maintain competitiveness and the perceived risk of "carbon leakage" - shifts of industrial production and investment to outside the EU without any reduction in global emissions - has consistently been the major concern expressed by industry in dealing with the EU ETS. This concern has achieved considerable political traction, with extensive measures to protect industry from leakage having been implemented since the start of the EU ETS in 2005. For example, for the first two phases the vast majority of allowances were allocated free of charge[69]. In the third and fourth phases many allowances continue to be allocated free of charge to industry, focussing on sectors defined as being at risk of carbon leakage. Currently some member states also provide compensation to reduce the effect of indirect emissions from electricity production.

There has been little or no evidence of leakage to date[70], although there appear to be few systematic recent studies of the topic. However a range of studies continue to point to a theoretical risk of future leakage[71]. This is consistent with measures to guard against leakage combined with low prices having been effective in preventing leakage to date, but the potential for higher prices and fewer measures against leakage in future still creating a risk of leakage.

The risk of leakage may reduce over time as more jurisdictions implement carbon pricing. In particular the implementation of carbon pricing nationally in China may reduce the risk of leakage for many industries. However eliminating the risk of leakage entirely would require the main competing jurisdictions to be covered by carbon pricing, and for the relevant industries in those jurisdictions to face a full carbon price. If one jurisdiction retains free allocation while the other removes it there former may retain a competitive advantage even if both have a carbon price. There are thus co-ordination difficulties in phasing out free allocation, so carbon price signals may not be felt in full for a long time.

However the current method of free allocation of allowances is likely to become increasingly difficult to sustain as caps tighten, and other approaches need to be considered. In the long-term innovation is needed to reduce emissions from all sectors to close to zero if global emissions goals are to be reached. Indeed Europe may be able to gain long-term competitive advantage through such innovation, and supporting such innovation through the use of revenue from EU ETS, for example through the innovation fund, may be appropriate. Nevertheless, developing innovative technologies and reducing their costs is likely to take several years, and while these new technologies are developed and deployed other measures, notably border adjustments, may be needed.

7.1 Allocation of free allowances.

The main tool used to reduce the risk of leakage from sectors covered by the EU ETS has been the free allocation of allowances to sectors at risk of carbon leakage (and to a lesser extent other sectors). Other emissions trading systems have used similar measures. Allocations under the EU

[69] The Directive made provision for some auctioning of allowances in Phases 1 and 2, but these were limited, and there was little take-up in practice.

[70] http://www.europarl.europa.eu/RegData/etudes/BRIE/2015/568334/EPRS_BRI(2015)568334_EN.pdf notes a 2013 study.

[71] http://www.vivideconomics.com/wp-content/uploads/2015/03/carbon_leakage_prospects_under_phase_III_eu_ets.pdf

ETS have been persistently too generous, and Sandbag has highlighted this on numerous occasions[72]. However we do not revisit this discussion here.

Instead, we highlight a more fundamental challenge to the use of free allocation to prevent leakage, which is set by the need to reduce emissions to much lower levels than at present, and eventually to net zero in line with the Paris Agreement[73]. This means that there are increasingly fewer allowances to allocate free of charge, and eventually there will be very few or none at all[74]. Alternative approaches to any remaining risk of carbon leakage will be required.

Consideration of the implications of current benchmarks if extrapolated makes this implication stark. Proposed benchmark reductions for free allocation range from 0.2% to 1.6% p.a. of the initial benchmark. This implies only a 6.4% to 51.2% reduction by 2050 (the reduction is assumed to stay constant in over the period). These benchmarks appear clearly inconsistent with the scale of reductions in emissions required by 2050, especially in view of the scale of emissions from large industry relative to the 2050 cap (see Section 3.)

Free allocation has the further drawback that by failing to include the full carbon price it fails to give adequate price signals for substituting lower carbon products for the existing high carbon products.

For these reasons other measures to protect competitiveness need to be considered.

7.2 The role of border measures

The main alternative to free allocation of allowances is the introduction of border adjustment measures (BAMs). These seek to impose a carbon price on imports. This is typically done by requiring importers to buy allowances or imposing a tax at the border. The number of allowances or the amount of tax payable is based on the emissions from producing the import, usually referred to as "embedded carbon content" of the imports. This may be measured or based on a benchmark, perhaps with the option to replace a benchmark with measured emissions if these are available. These provisions may be accompanied by rebates on exports of emissions intensive goods.

Border measures are already in place for electricity imports in the WCI systems. There were proposals to extend these to cement in California but so far these have not been realised. There may be some extension of the scope of border measures in California after 2020, but the situation in this respect remains unclear. The EU ETS Directive includes provisions that allow for border measures to be introduced[75]. Such measures were proposed for the cement sector during deliberations by the European Parliament in late 2016 and early 2017.

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[72] For example see *Carbon Fat Cats 2011: The Companies Profiting from the EU Emissions trading System, available* here*. 'Losing the lead?: Europe's Flagging Carbon Market', available* here*. 'Drifting toward disaster?: The ETS adrift in Europe's climate efforts', available* here*. 'Slaying the dragon: Vanquish the surplus and rescue the ETS', available* here*.*

[73] Paris Agreement Article 4.1

[74] The requirement for net zero emissions may be met by reducing emissions to very low levels balanced by "negative emissions" in the form of net removal of a carbon dioxide, for example from enhancing sinks and bioenergy with CCS. However the negative emissions will not be large enough to balance large scale continuing emissions, for example because of limits on the scale of bioenergy, and the cost of achieving some of the measures envisaged.

[75] Directive 2009/29/EC, Preamble point (25) states: Energy-intensive industries which are determined to be exposed to a significant risk of carbon leakage could receive a higher amount of free allocation or an effective carbon equalisation

7.2.1 Difficulties with Border Measures

There are a number of recognised difficulties with the imposition of border measures.

Compatibility with international trade. Border measures must be made compatible with GATT. This is likely to be achievable, but may raise perceived political risks. This may be accompanied by a fear of retaliatory measures. For example, the EU's attempts to impose a unilateral carbon price on international flights to and from the EU, which was closely analogous to a BAM, met fierce opposition from other jurisdictions.

Administrative complexity. Modern value chains are enormously complex, making embedded carbon in manufactured goods difficult to assess. Furthermore the value of embedded carbon is often only a relatively small proportion of the value of the product. For this reason proposals for border adjustments are usually limited to emissions intensive trade exposed bulk commodities. Even in these cases benchmark or average emissions may be used instead of measured emissions, at least initially.

Bypass. Import of bulk commodities may be replaced by import of semi-finished or finished products. For example, BAMs on imports of steel may be avoided by importing car body panels.

Changing destinations of products without reducing emissions (resource shuffling). Imposition of border measures in one jurisdiction only may lead low carbon production to flow to that jurisdiction while high carbon production is routed to another jurisdiction. This is known as "resource shuffling". It potentially results in the same products being produced in the same way but simply routed differently. For example, let's assume for illustrative purposes that high carbon aluminium currently flows from South Africa to Europe and low carbon aluminium from Canada to the USA. The EU may then impose border tariffs on aluminium while the USA has no such measures. The same aluminium could then be produced with the same emissions, but with the Canadian aluminium switched to going to Europe and the South African aluminium switched going to the USA. There may be no net reduction in emissions. Indeed there may be an increase in emissions due to increased transport distances. In the California system there are detailed rules to counter this type of behaviour for electricity.

These difficulties imply that border adjustments are likely to apply only emissions intensive commodities. This closely corresponds to the existing category of sectors at risk of carbon leakage plus the power sector. Even within these sectors careful design will be required.

Particular issues are likely to be raised by the position of UK. Increased electricity grid interconnection between the UK and the rest of Europe is currently being planned. There is consequently the potential for trade in electricity to become distorted, with carbon leakage as a result. This could in principle occur in either direction depending on relative carbon prices, raising

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system could be introduced with a view to putting installations from the Community which are at significant risk of carbon leakage and those from third countries on a comparable footing. Art. 10b-1b states that the Commission may consider inclusion in the Community system of importers of products which are produced by the sectors or subsectors determined in accordance with Article 10a.

the question of whether BAMs are required. If the UK retains the existing carbon price support, which is additional to and currently much higher than the EUA price, the danger would be of leakage from the UK. The UK would therefore potentially need to consider BAMs on imports of electricity from the EU. However whether this would be feasible would depend on the broader terms of the UK's departure from the EU, which remain uncertain.

7.2.2 Where might border adjustments be most effective?

Table 7 below lists sectors in approximately descending order of suitability, which is determined by emissions intensity and ease of attributing emissions to imports.

Table 7: Candidate sectors for border adjustments

Sector	Suitability for border adjustments
Electricity generation	• Highly emissions intensive, though limited imports from outside EU ETS • Imports by UK may become suitable depending on terms of UK departure from the EU
Cement	• Easy to attribute process emissions and set benchmarks for energy emissions • High transport cost implies resource shuffling less of an issue
Iron and Steel	• Emissions Intensive • Benchmarks relatively straightforward to set
Refining	• Emissions Intensive • Benchmarks relatively straightforward to set
Aluminium smelting	• Emissions Intensive if electricity production is high carbon • Attributing sources of electricity may be difficult.

Restricting the application of border measures to emissions intensive bulk commodities is less problematic than for the EU ETS than it may at first appear. This is because these sectors for which border adjustments are most likely to be appropriate account for over three quarters of EU ETS emissions and over two thirds of emissions from sectors at risk of carbon leakage (see Charts 12a and 12b). Border measures can therefore deal with a large proportion of the problem of emissions intensive industry even if only restricted to a few sectors. Other sectors are relatively small emitters, and so will be either less susceptible to leakage (because they are less emissions intensive), or easier to accommodate with very much reduced allocation of free allowances (because even though they may be emissions intensive the absolute quantities are small relative to the larger sector)s.

In the longer term when emissions must approach zero the only appropriate solution is new technologies and processes which allow emissions from these sectors to be largely eliminated.

Chart 12a: Sectors likely suitable for border measures account for over three quarters of EU ETS emissions

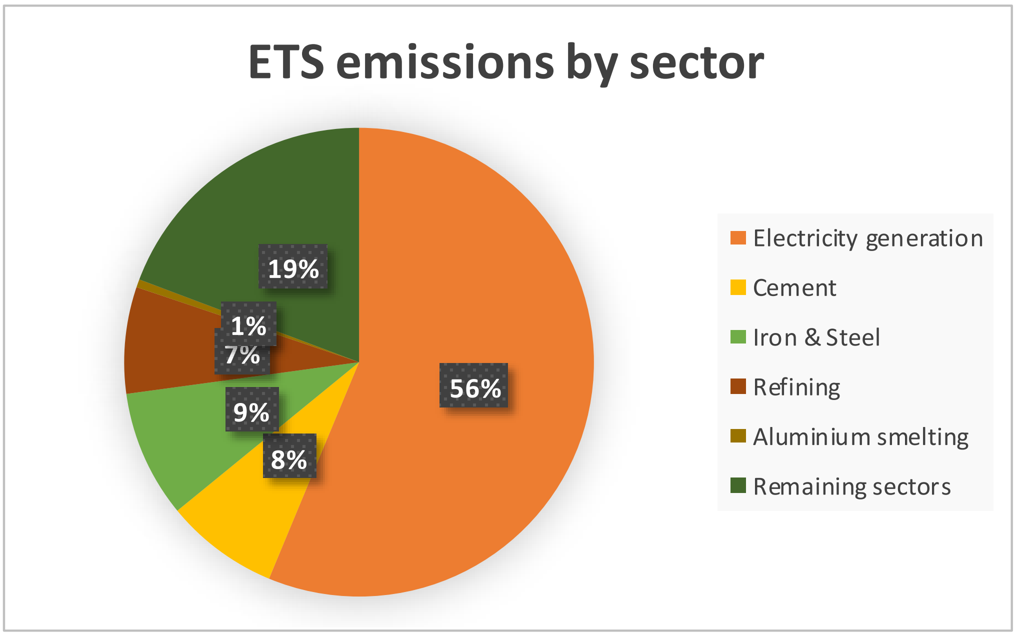
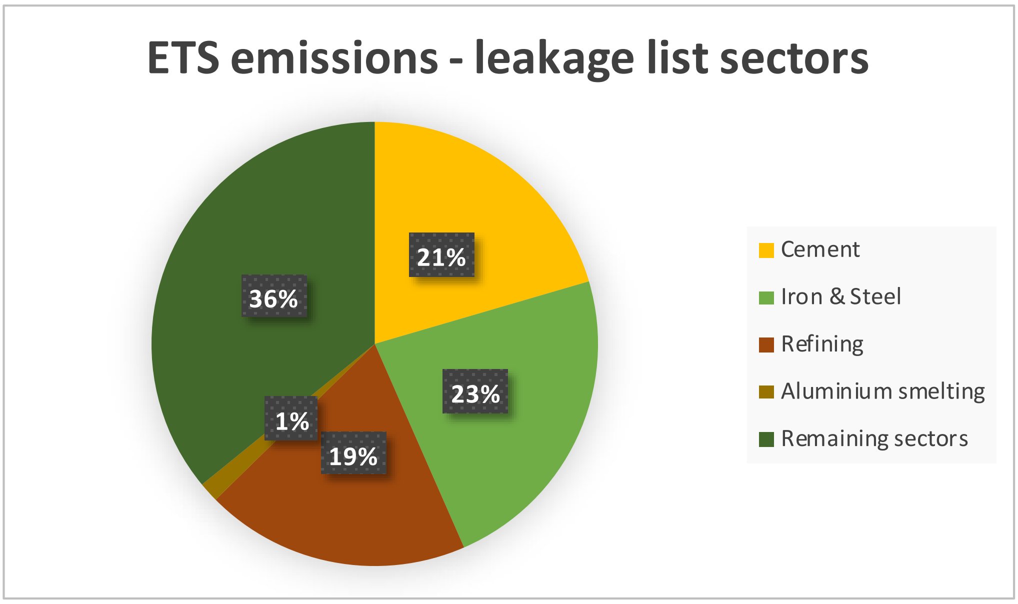


Chart 12b: About two thirds of emissions from sectors at risk of carbon leakage could be covered by border measures in just three sectors.



Note: emissions from aluminium smelting are direct emissions only and so exclude emissions from generating the electricity used in the smelting process.

8. Uses of revenues

Revenues from carbon pricing can be used for both climate change related purposes and to meet more general goals. The main types of ways in which revenues can be used are summarised in Table 8 below.

Table 8: Summary of potential uses of revenue raised by carbon pricing

General fiscal and social goals	Climate change related purposes
Support for vulnerable groups	Adaptation
Reduction of other taxes	Distribution to those affected by climate change
Government retention of revenues	Support for further emissions reduction, including for innovation and energy efficiency (Note: energy efficiency can also help vulnerable consumers, and indeed energy efficiency measures may be targeted at those groups).
Returned to citizens	

The EU ETS Directive has an advisory provision that Member States should use at least 50% of ETS auction revenues (and 100% of allowance revenues from auctions in the aviation sector) for climate action[76]. It has been estimate that in practice 85% of the 11.7bn total ETS revenues collected by member states were spent on climate action (the majority of which was in the EU)[77]. It is not clear how this compares to the rate of funding for climate change mitigation that would be available in the absence of the ETS.

Funds available under the EU ETS are lower than they otherwise would be because of low prices. Previous work by Sandbag has shown that tightening the cap grows the value of funds, because the increase in prices more than offsets the loss of volume from tightening the cap[78].

Around the world there is a variety of ways in which revenues from carbon pricing are used.

Support for vulnerable groups

The introduction of carbon pricing is often accompanied by concerns about the effects on energy prices to lower income households. Concerns include rises in electricity prices paid by households due to carbon pricing applying to power sector emissions. These can occur even under systems such as the EU ETS which do not directly cover households. Some proportion of revenue can be set aside to compensate vulnerable households. This was, for example, a feature of the former Australian system.

[76] http://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:02003L0087-20140430&from=EN
[77] https://www.ecologic.eu/sites/files/publication/2016/2584-maximiseretsfulltechnicalreport_final.pdf
[78] https://sandbag.org.uk/project/a-tighter-cap-grows-the-funds/

Reduction of other taxes

Other taxes can be reduced using revenue raised from carbon pricing. If this is done in full the carbon pricing system is usually referred to as revenue neutral. This is a feature of the British Columbia carbon tax.

Government retention of revenues

Governments can retain some or all of the revenue for general expenditure or deficit reduction. This is, for example, the case in the UK, where the Treasury has a long history of viewing taxation and expenditure as a whole, and there is resistance to earmarking ("hypothecation") of specific sources of funds to particular uses.

Returned to citizens

A payment can be made to all citizens in a jurisdiction. The Swiss carbon tax returns a portion of revenue equally to all citizens in the form of reduction to health insurance costs. Such an approach has been included in proposed legislation at federal and state level in the USA.

Adaptation

Measures to adapt to climate change can be funded either within the jurisdiction that raised the revenue or internationally. For example, in its July 2015 proposals for the next phase of the EU ETS, the European Commission included provisions for Member States to use some of the revenues from the EU ETS to finance actions to help other countries adapt to the impacts of climate change. Some EUA auction revenue now helps fund mitigation and adaptation efforts in developing countries[79]. The Colombia carbon tax introduced in 2017 funds activities such as watershed protection and ecosystem protection.

Distribution to those affected by climate change

Funds can be provided to those adversely affected by climate change. There is a continuing debate on this issue and how it relates the "loss and damage" agenda within the UNFCCC process, including the large overlap with the issue of adaptation. However there has been little practical progress on this to date.

Support for further emissions reduction and for innovation

Funds may be provided for measures such as retrofitting homes and businesses for greater energy efficiency, and the installation of renewable energy technologies. Revenues may also be used to fund research, development and deployment of new low carbon technologies.

These types of uses for revenues have proved politically attractive in a number of jurisdictions. In particular several systems in North America include provisions of this type, including California, RGGI and Alberta.

- **California**: 25% of proceeds must benefit disadvantaged communities[80,81]. California will spend USD $413 million on programs to do with air quality (excluding administrative costs)[82]. Spending under the Greenhouse Gas Reduction Fund has been directed largely towards

[79] http://www.consilium.europa.eu/en/press/press-releases/2017/10/17-climate-finance-eu/
[80] https://www.c2es.org/us-states-regions/key-legislation/california-cap-trade#Revenue
[81] http://calcarbondash.org/
[82] http://www.ebudget.ca.gov/budget/2017-18MR/#/Department/3900

projects in the transport sector and, to a much lesser degree, waste management[83]. In September 2017 California approved a $1.5 billion plan with most of the money going toward financial incentives to replace polluting vehicles with cleaner alternatives[84].

- **RGGI**: In 2015, 64% of RGGI revenues went to energy efficiency, 16% was spent on clean & renewable energy, and 10% on direct bill assistance[85].
- **Alberta**: The Climate Change and Emissions Management Council (CCEMC) has supported 121 emissions reductions projects to date to date with total funding of CAD 349m[86]. These projects have delivered 8 $MtCO_2$ of reductions. This implies an average CO_2 abatement cost of CAD 43.6/tCO_2. The majority of revenues have been spent on reducing the carbon footprint of fossil fuel supply, low carbon electricity supply and biological resource optimisation.

The EU ETS also included support for new technology from the sale of 300 million allowances from the new entrant reserve (the "NER 300") in Phase 3. However funds raised from this were less than originally expected due to lower allowance prices. Phase 4 includes an Innovation Fund and a Modernisation fund aimed at some member states that need to transition their power sectors, both to be funded by the sale of allowances.

Many uses of funds from auction revenue have merit, and the choice will depend on local political and economic circumstances. However some seem to have particular arguments in their favour, with a mixture of these often likely to be preferred.

- Supporting further emissions reduction, including by supporting the development and deployment of new technology is likely to be both valuable and, based on international evidence, politically tractable. Using revenue to fund additional emissions reductions, especially with a component of assistance for the disadvantaged, has proved understandably attractive in a number of jurisdictions in North America and to some extent in the EU.
- Supporting adaptation and potentially also providing recompense to those adversely affected by climate change has a strong appeal on grounds of justice, and may form a valuable element of future programmes.
- Returning funds equally to citizens has advantages of building a constituency of support for carbon pricing, and in the EU naturally fits with the principle of subsidiarity, where all citizens benefit from the value of the common atmosphere. This could be accompanied by providing additional support to some vulnerable groups.

[83] https://arb.ca.gov/cc/capandtrade/auctionproceeds/auctionproceedsmap.htm
[84] http://www.latimes.com/politics/essential/la-pol-ca-essential-politics-updates-california-will-spend-big-on-clean-1505506448-htmlstory.html
[85] https://www.rggi.org/rggi_benefits
[86] http://eralberta.ca/projects/

9. Scope of the EU ETS – sectors and gases

The coverage of the EU ETS could be extended to include other sectors, and potentially other gases. The coverage of the EU ETS has already been extended by the inclusion of intra-EU aviation (flights within the European Economic Area) from 2012[87]. Legislation has also been introduced to include international aviation. However, this is currently pending, with a "stop the clock" provision in effect. This postpones introduction while wider negotiations proceed on mechanisms to offset the growth in emissions from international aviation. Such wider mechanisms may in due course become the preferred method for addressing international aviation[88].

There have been various proposals to include surface transport in the EU ETS, including recently by the German Monopolies Authority[89]. Over time it would be possible to extend coverage more widely still, extending scope to a much higher proportion of total greenhouse gas emissions.

9.1 Advantages and drawback of wider coverage

Many commentators favour wide coverage of carbon pricing in principle. It creates price signals across the economy, and so incentivises abatement irrespective of which sector opportunities arise. This reduces the cost of achieving emissions reductions goals.

Having a single unified cap can also help give effect to longer term targets, such as those for 2050, which are usually economy wide. It will mean the cap is more closely representative of the target, although there will still likely be some emissions which are not covered. This can help by, among other things, automatically adjusting the balance of reductions between sectors. When there are unexpected outturns in any individual sector emissions in other sectors adjust automatically to meet the cap without the need to intervene. For example, if industry progresses more or less quickly than expected the power or transport sectors can adjust accordingly. This increases the ability to sustain a co-ordinated emissions reduction programme.

There is a risk that unanticipated outcomes in some sectors can cause problems for others. For example a failure to reduce emissions from surface transport may reduce the available supply of allowances to power generation or industry. However this risk is there in any case if targets are not to be missed and wider coverage of the ETS is likely to focus attention on mitigating such risks, for example with industry having a stake in encouraging measures to reduce transport emissions.

A wide cap can also encourage policy makers to examine complementary measures across the range of sectors, for example looking at the need for new technologies or networks, if they wish to avoid excessively high carbon prices. This may make it more difficult to ignore sectors which may be harder to decarbonise.

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[87] https://ec.europa.eu/clima/policies/transport/aviation_en

[88] In October 2016, the International Civil Aviation Organization (ICAO) agreed on a Resolution for a global market-based measure to address CO_2 emissions from international aviation as of 2021. The agreed Resolution sets out the objective and key design elements of the global system, as well as a roadmap for the completion of the work on implementing modalities. The Carbon Offsetting and Reduction System for International Aviation, or CORSIA, aims to stabilise CO2 emissions at 2020 levels by requiring airlines to offset the growth of their emissions after 2020. https://ec.europa.eu/clima/policies/transport/aviation_en

[89] http://www.monopolkommission.de/index.php/en/press-releases/192-energy-2017

However even with a wider cap complementary measures are still necessary. So, for example, extending carbon pricing to transport would not imply abolishing existing fuel taxes or fuel efficiency standards.

There are nevertheless potential drawbacks to extending the scope of the EU ETS. Extending the EU ETS to other sectors may increase complexity. Furthermore the gain from including other sectors may be less than in power and industry because price mechanisms are less effective in other sectors[90]. For example in the commercial buildings sector carbon prices are relatively ineffective at improving standards for new build, because construction methods are largely driven by other costs and by the need to meet schedules, and the costs of any decrease in energy efficiency will be paid by future tenants rather than the developer. Similarly choices in transport are strongly influenced by available technologies, and there is in any case a high existing tax of fuel which is equivalent in some member states to hundreds of Euros per tonne of CO_2.

9.2 Scope of systems around the world

Looking internationally, there is substantial variation of coverage between systems, with no single approach becoming predominant. Some pricing is restricted to the power sector, including RGGI and UK carbon price support (which gives a floor price for the UK power sector – see Section 6.4). The EU and Korean systems and the Chilean carbon tax cover industry in addition to power generation, but are still limited to large single sources of emissions. The Chinese regional systems have varying coverage with most covering power and industry and some including transport. The French carbon tax covers sectors outside the EU ETS, so carbon pricing covers a large proportion of the French economy, but is not uniform. The WCI systems (California, Quebec and Ontario) have wide coverage, including transport and natural gas distribution in addition to the power sector and industry. The repealed Australia system also had wide coverage. As a result of these variations in coverage the proportion of emissions covered can vary from less than 30% to over 80%[91].

Inclusion of gases other than CO_2 has been a minor component of systems to date, with many systems excluding them. Exclusion of other gases reflects difficulties of measurement, and in some cases concern about the limitations of the Global Warming Potential (GWP) as an "exchange rate" between different gases. It also reflects the greater suitability of different forms of regulation for other gases. However fugitive methane emissions were included in the repealed Australian system, and industrial gases are included in the EU ETS.

The type of activities priced can also vary. For example the British Columbia carbon tax applies only to emissions from combustion.

There is thus no clear consensus at present on an optimal scope of a carbon pricing system.

9.3 Future coverage of the EU ETS

The lack of a predominant model for coverage suggests that the arguments on coverage are finely balanced. The balance of arguments about the scope of the EU ETS needs to be assessed given the

[90] In terms of the framework of different domains (see Annex 1) the existing EU ETS targets second domain sectors, and the advantages of extension to first and third domain activities is less clear cut.
[91] The California ETS covers approximately 85% of GHG emissions. See http://www.c2es.org/us-states-regions/key-legislation/california-cap-trade#Details

system's particular history and circumstances and in the context of the EU's wider decarbonisation agenda.

When the EU ETS was established, as the first major greenhouse gas emissions trading system anywhere, concerns about the tractability of measurement would naturally have been among the factors leading the EU ETS to be restricted to large stationary sources. It was ambitious in its scale and scope, and restriction to large emitters would have seemed prudent. There was also a focus on those sectors where prices seemed most likely to be effective. The choice of scope thus reflected the circumstances then prevailing.

However wider coverage has now been demonstrated to be tractable. The California and Quebec systems operated with coverage broadly similar to the EU ETS when they were introduced in 2013, then expanded their coverage to include transport and natural gas distribution in 2015. (This expansion was included in the initial design.) Emissions from smaller sources such as vehicles and small commercial and residential energy consumers are captured at the wholesale level. The experience gained since the EU ETS was introduced of running emissions trading systems and the success of the implementation of wide coverage in other systems are likely to influence assessments about the tractability of wider different coverage.

Narrower coverage continues to be favoured by simplicity, including for example the ability to rely on now well established compliance processes. It also continues to be favoured by the likely lower effectiveness of carbon pricing as an incentive in sectors such as buildings and transport compared with industry and power generation.

However as emissions decrease over time, and eventually towards the 2050 target, the balance of the benefits may shift. There will be a greater need to pursue emissions reductions vigorously wherever they can be found. As part of this there seem likely to be advantages to having a clear economic signal in the form of a carbon price incentivising abatement wherever it can be achieved at low cost. This would complement other measures such as efficiency standards which may be sector specific.

Furthermore the advantages of a more broadly drawn cap, especially in allowing automatic redistribution of targets between sectors in response to different outturns, may help achieve targets. It will also help make it clear that all sectors require attention.

In this context, expanding the scope of the ETS cap to more closely represent the overall target appears likely over time to have a greater preponderance of advantages over drawbacks, in particular in the 2030s and 2040s as caps decrease and achieving emissions reduction goals becomes more challenging. It will therefore be appropriate to keep the scope of the EU ETS under review. In the longer term it may be appropriate to extend coverage of the EU ETS to those sectors covered by the ESR. However any decision will need to reflect circumstances at the time, including whether the EU ETS is functioning effectively.

There will still necessarily be a political dimension to any distribution of effort because the burden will fall differentially on different sectors and thus on different member states. However this can be accommodated through a variety of means, including complementary measures and use of funds under the EU ETS Directive, including modifying the role of those funds as necessary.

10. Links with other systems

10.1 The potential for linking different carbon pricing systems

Linking carbon pricing systems means that one system's allowances or other trading units can be used by a participant in another system for compliance. Carbon pricing systems can be linked in different ways, as noted in previous work by Sandbag[92].

Linkage between emissions trading systems has been extensively discussed in the policy literature over a number of years. This work has identified a range of benefits to linkage that could in principle apply to the EU ETS.

- The inclusion of more participants entails a greater diversity of sources and more abatement options. This results in a more efficient allocation of resources, directing them to least-cost abatement measures and thus lowering the overall costs of achieving a given collective level of emission reductions[93].
- Linking can reduce the volatility of trading systems when subject to economic shocks. This is particularly important for smaller systems linked to larger systems, for example the EEA countries and Switzerland linking to the EU ETS. It is especially beneficial for different types of economies subject to different types of shock[94].
- Linking, and in particular the common carbon price that will result, may reduce concerns about industrial competitiveness, though probably only where the linked systems together account for a large proportion of trade in sectors at risk of carbon leakage.
- There may be opportunities for improving and harmonising administration and governance, and the number of different compliance regimes with which international companies face may be reduced, reducing their costs.

However linkage has not been widely adopted in practice. Several trading systems have now been in place for a number of years. For example the EU ETS began in 2005, RGGI in 2009, and the California and Quebec systems in 2013[95], and the Korean system in 2015. This has given time to develop links, or at least to be well progressed in planning links. Despite this at present linkages between systems are limited, with few others planned. There are mechanisms for information exchange and building of technical expertise, including for example between China, Japan and Korea[96]. These allow some preliminary discussion of linkage, but these do not appear to have developed beyond this at present.

Existing links consist mainly of:

- small jurisdictions linked to much larger jurisdictions, for example Norway and Switzerland to the EU; and
- Systems that are essentially designed to function as a unified system with very closely aligned rules, as in the case of the WCI which links California, Quebec and Ontario.

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[92] https://sandbag.org.uk/project/brexit-eu-ets-greater-sum-parts/
[93] Grubb (2009) http://www.tandfonline.com/doi/pdf/10.3763/cpol.2009.0665
[94] http://www.lse.ac.uk/GranthamInstitute/wp-content/uploads/2015/09/Working-Paper-208-Doda-and-Taschini-August2016.pdf The authors defined the conditions under which this does and does not apply.
[95] The California system formally began in 2012, but compliance obligations began in 2013.
[96] World Bank State and Trends report p.47

It is possible that linkage may be given further impetus by Article 6 of the Paris Agreement. However the lack of progress appears to reflect some intrinsic difficulties associated with linkage which may continue to prove difficult to resolve.

- Jurisdictions often go through extensive debates to reach their own conclusions about preferred scope, basis, and levels of ambition, costs and cost control, and their proposed use of various internal and external offset credits. There is no common view on what constitutes a 'good' design, and some characteristics are incompatible[97]. Such differences of preferred design may limit potential for linkage, because common design may be suboptimal for one of the jurisdictions.
- There may be concerns about sovereignty or regulatory control, and dependence on others for important policy decisions.
- There is a potential incentive on each separate jurisdiction to issue more allowances. Cost savings of trading do not necessarily lead to lower emissions. In particular, environmentally more concerned countries may choose fewer allowances if these are tradable, but this may be offset by the choice of more allowances on the side of environmentally less concerned countries[98]. Agreeing a common, stringent cap may prove challenging.
- Transfers of funds between linked jurisdictions ("paying for abatement abroad") may prove politically contentious.
- There will often be administrative costs to establishing linkage.

Such concerns seem likely to inhibit further linkage. For example, while the EU has given substantial technical assistance to China in developing its emissions trading systems there are as yet no firm plans for linkage, and indeed any linkage seems a distant prospect.

The difficulties of linkage are compounded in the case of the EU ETS by the surplus of allowances, which seems likely to persist for at least another ten years or so. While this surplus is in place linking is likely to be problematic for other systems. EUAs will likely be perceived as "junk credits" or "hot air". This is because if EUA's are allowed for compliance in other systems, an EUA bought to cover emissions in a linked jurisdiction will not correspond to emissions reductions in the EU but instead simply reduce the surplus, weakening the environmental integrity of the linking system.

The general difficulties of linkage and the compounding difficulties caused by the surplus in the EU ETS imply that linkage is at most a distant prospect for the EU ETS, with the exception of whatever relationship is developed with the UK. Sandbag's previous report on Brexit covered the specific case of possible UK linkage[99].

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[97] Grubb (2009)

[98] Moreover, if the establishment of a trading system requires the unanimous approval of all countries, there may be no agreement on trading even if it were to lead to less pollution overall. Conversely, a trading system may find unanimous approval even if it induces more pollution. See Carsten Helm (2003) International emissions trading with endogenous allowance choices, Journal of Public Economics. http://www.sciencedirect.com/science/article/pii/S004727270200138X
See also Carbone et. al. (2009) The case for international emission trade in the absence of cooperative climate policy who find advantages of linking small groups of countries.
http://www.sciencedirect.com/science/article/pii/S0095069609000382

[99] https://sandbag.org.uk/project/brexit-eu-ets-greater-sum-parts/

The advantages of linkage are broadly similar in principle to expanding the scope of the EU ETS to other sectors (see Section 9), because expanding sectoral coverage is essentially a form of internal linkage. However the drawbacks of linkage don't tend to apply to expanding coverage of sectors. For this reason expanding sectoral coverage seems likely to be more tractable and advantageous than establishing linkage with other systems.

10.2 Indirect linkage of carbon pricing systems

Even if systems are not directly linked there may be a limited degree of indirect linkage through the use of common types of offsets across systems. However offset protocols differ widely between systems at present. For example, the EU ETS has allowed international offsets while North American systems tend not to. Consequently, although the Clean Development Mechanisms was intended to provide common offsets, in practice acceptance was primarily limited to the EU ETS.

As with direct linkage, the problem of securing indirect linkage is compounded by the current surplus in the EU ETS. While the EU ETS is in surplus there is no need for offsets, and indeed at present there is a large continuing surplus even without offsets. The current surplus again means offsets are unlikely to be needed in the EU ETS for many years.

We therefore do not discuss the possibility of indirect linkage via offsets any further.

Annex 1: The rationale for complementary measures under different policy assessment frameworks

Various frameworks are commonly used in defining, selecting and assessing policies for reducing emissions. These vary in their approach. Nevertheless they all imply that carbon pricing alone is not enough to achieve decarbonisation goals effectively and efficiently, and that complementary measures are needed. The need for complementary measures is therefore not an implication of one particular perspective, but comes out of all the main approaches to climate policy. This consistency reinforces the case for continuing and strengthening the role of complementary measures in sectors covered by the EU ETS.

For example, a framework of decarbonisation pathways highlights the need for new technologies in industry. A framework recognising different domains of policy highlights the transformations that will be needed in electricity networks to accommodate increased use of renewables and storage. Similarly, an economic perspective that emphasises the role of addressing market failures highlights the spill-over benefits of developing new technologies.

Even the most rigid application of a neoclassical economics, which in any case is not a sound basis for policy making, needs to acknowledge the limitations of carbon pricing due to the presence of other market failures, the incompleteness of markets over the long term, and the additional risks created by political uncertainty, all of which imply the need for measures that go beyond carbon pricing to adequately address these problems. Indeed there does not appear to be any substantive approach to policy making that would exclude complementary measures or that would suggest that an effective and efficient policy package should only include carbon pricing.

A1.1 Decarbonisation pathways and marginal abatement cost estimates

Decarbonisation pathways are usually specified by analysing total emissions, looking at policies through subdividing emissions by sector and within sector. Emissions reductions are then specified in terms of what needs to be done in each subsector, either in terms of low carbon technologies or policies that are needed, or both. This is for example the approach adopted by the UK Committee on Climate Change in its analysis of how to achieve the UK's legally binding carbon budgets. Certain types of measure, notably encouraging energy efficiency and renewable energy, may apply across a range of sectors though perhaps in different forms.

A common tool in this type of approach is the use of marginal abatement cost (MAC) curves, which show the quantity of emissions reductions that can be achieve through certain means, for example switching from coal to gas, and the cost of each. The options are arranged in order from cheapest to most expensive to form a supply curve for abatement. This approach has been common for several decades in the academic literature, government policy making and in some cases corporate decision making.

This approach is sometimes used as a way or prioritising emissions reductions. However the approach of simply moving up the MAC curve ignores dynamic aspects, in that it may be necessary for long term optimisation to invest in new technologies that are currently high cost.

A variant of the MAC curve approach is often implemented by setting quantity limits and estimating minimum abatement costs. This approach is adopted in many simulation models. Many models informing the IPCC's Working Group 3 reports adopt this type of approach. It is also implied at least at high level by the EU's division of target and policy instruments between the EU ETS and the ESR.

However, examining decarbonisation pathways in this way, while a valuable part of policy formulation, is intrinsically based on planning, and has corresponding weaknesses in its very large information requirements and the limited incentives it provides. The range of different processes leading to emissions is vast. For example, while industrial emissions may be considered together as a single sector there will in practice be many different types of industrial activities resulting in emissions. It will be impossible to know what the costs of reducing emissions in each case will be. This difficulty is all the greater because much decarbonisation requires technological innovation. It is often impossible even in principle to accurately estimate what a new technology will cost and how it will evolve over time.

These problems are found in practice even in sectors such as power generation where the range of technologies is relatively small. For example, many models and much policy making have been based on the expectation of a major role for CCS in power generation. These expectations have not yet been fulfilled, and seem unlikely to be so at least over the next decades or two. Conversely many models have substantially underestimated the growth of solar and fall in costs by, in some cases, an order of magnitude or more[100]. Onshore wind has also seen large recent cost falls which appear to have been largely unanticipated by planning and modelling.

The other main limitation of this approach is that it does not in itself provide incentives to achieve the reductions in emissions or to go beyond them. Policy still needs to be designed to achieve them.

Despite its limitations the decarbonisation pathways approach emphasises that there are many different sources of emissions and abatement technologies (while not capturing the full range). It thus highlights that different approaches may be required in different sectors, for example drawing attention to building efficiency standards as more likely to be effective than carbon pricing in that sector. The emphasis of marginal abatement costs tends to emphasise the need for cost reduction for higher cost technologies. They thus can provide some valuable insights.

A1.2 Market failures

The weaknesses of the planning approach based on carbon budgets have led many, especially economists, to advocate for a major role for markets in both revealing and incentivising cost-effective emissions reductions. In the absence of policy mechanisms the costs imposed by climate change are not normally counted in individual production decisions. This constitutes a market failure, so pricing the emissions is necessary to correct for this, usually referred to as internalising the externality. The 2006 Stern Review of climate change adopted this perspective, characterising climate change as the biggest market failure ever seen[101].

[100] The Underestimated Potential for Solar PV Energy to Mitigate Climate Change, Creutzig et. a. Nature Energy, Published 28/08/17

[101] http://webarchive.nationalarchives.gov.uk/20100407172811/http://www.hm-treasury.gov.uk/stern_review_report.htm

In justifying the carbon price in these terms, attempts are sometimes made to judge the cost-effectiveness of policy measures in terms of whether the cost of abatement is greater than the cost of damage, referred to as the social cost of carbon[102]. This approach in particular has been used extensively in the USA, and the US Environmental Protection Agency (EPA) has made detailed estimates of the SCC. There are some weaknesses to this approach, including:

- There are very large uncertainties in the calculation of the SCC, and it is very sensitive to the discount rate used to compare costs and benefits at different times.
- It ignores the possibility of large non-marginal effects ("catastrophes")
- It typically leaves out damages to which it is difficult to attach a cost, or which are highly uncertain, such as displacement of populations ("climate refugees").

The uncertainties have led some to question the value of its applicability, but it remains a useful reference point, at least as a lower bound on the appropriate levels of prices.

The vocabulary of market failures is often extended to cover other problems. For example, it is widely recognised that there are spill-over effects from technological innovation which are difficult or impossible for an individual investor to benefit from, so an uncorrected market will show insufficient innovation.

The logic of market failures is usually taken to imply carbon pricing as a policy instrument. Carbon taxes, emissions trading and hybrids of these two can all provide a carbon price. As such they work through the market and are market based instruments, although that term is sometimes reserved for carbon trading itself.

The logic of carbon pricing is compelling and has led to its introduction around the world, as noted in Section 2 of this report. However few now advocate it as the sole approach to reducing emissions. As noted, there are other market failures that need to be addressed. Furthermore the framework gives a centrality to markets that effective policy may not warrant, because they may not prove effective in some respects. Specifically:

- It is difficult or impossible for governments to credibly commit to markets and carbon pricing over the very long timescales of investment decisions
- There are some areas, for example in domestic consumption, where markets do not function very well, or where there are monopoly characteristics that work against a competitive approach, for example in electricity and gas networks.
- Markets ignore ethical dimensions of the issue, including for example intergenerational equity.

Furthermore, the framework of market failures also points to the existence of other market failures, and the need for policies to correct those. The following appear particularly prominently in much of the policy literature:

- The need for policies to encourage innovation to capture the value of spill-over effects and the difficulties of appropriating the full value of investment in innovation.

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[102] https://onclimatechangepolicydotorg.wordpress.com/carbon-pricing/8-the-social-cost-of-carbon/

- The need for standards particularly for energy efficiency to address the lack of information and problems with agency, including between landlords and tenants. For example, those constructing new buildings often have little incentive to increase energy efficiency to optimal levels, especially if this increases the complexity or time of a build.
- The need to address the problems of natural monopolies such as distribution grids.
- The climate change problem extends over timescales that are beyond those for which markets and their accompanying price signals exist, so no market-based approach can be complete. The intergenerational nature of the climate change problem, with future generations unable to express their preferences through the market, compounds this problem.

Therefore even the most market orientated framework must recognise the need to go beyond carbon pricing and to use complementary measures to address the shortcomings of markets, and recognise the need to address other market failures.

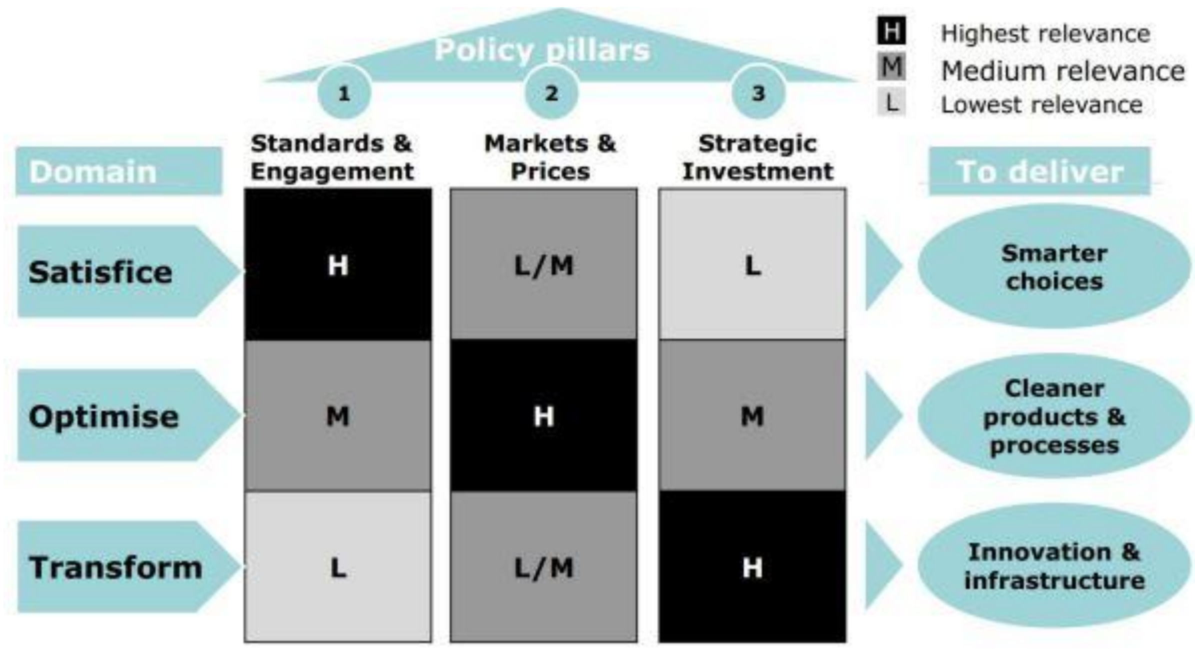
A1.3 Policy domains

Part of the problem with the vocabulary of market failures is that it is grounded in neoclassical economics, a particular perspective within the economic literature, and one with considerable weaknesses. An alternative framework seeks to ground policy in a broader range of economic thinking. This is illustrated in the diagram below.

It divides policy into three pillars which conform to three different domains of economic behaviour. Action to address all three domains is essential if efforts to reduce emissions to the extent necessary to avoid dangerous climate change are to succeed. These domains and the corresponding policy pillars are illustrated in the chart below.

This framework is comprehensive, simple in conception, rich in implication and well founded in a variety of scholarly disciplines. As such it provides a valuable guide to policy.

Three domains of economic behaviour correspond to three policy pillars



In the first domain people seek to satisfy their needs, but once this is done they don't necessarily go further to achieve an optimum. Policy design needs to draw on disciplines such as psychology, the study of social interactions, and behavioural economics. This domain of behaviour relates particularly to individuals' energy use, and the corresponding policy pillar includes instruments such as energy efficiency standards and information campaigns.

The second domain looks at optimising behaviour, where companies and individuals will devote significant effort to seeking the best financial outcome. This is the domain where market instruments such as emissions trading have the most power. Policy making here can draw strongly on neoclassical economics.

The third domain is system transformation, and requires a more active role from governments and other agencies to drive non-incremental change. The policy pillar addressing this domain of behaviour includes instruments for technology development, the provision of networks, energy market design, and design and enforcement of rules to monitor and govern land use changes such as deforestation. Markets may have a part to play but the role of governments and other bodies is central here. The diversity of policies addressing this domain means that it draws on a wide range of disciplines, including the study of governance, technology and industrial policy, institutional economics and evolutionary economics.

As one moves from the first to the third domain there is increasing typical scale of action, from individuals through companies to whole societies, and time horizons typically lengthen.

This framework implies that EU policy is right to include energy efficiency, emissions trading and renewables – broadly first, second and third domain policies respectively – as well as to be active in third domain measures such as improving interconnection, rather than relying exclusively on emissions trading (although as the EU ETS covers larger emitters, so first domain effects are less relevant for the covered sectors). Step technology change is crucial in industry, which is unlikely to happen as a result of pricing alone and so also requires policies aimed at the third domain. However pricing does have a very valuable role.

Annex 2: Assumptions underlying calculations

The following assumptions are made for the form of the EU ETS in Chart 1. Other charts adopt assumptions which are different where noted.

- no cap flexibility (i.e. 2.2LRF continuing from 2020)
- 25 million carryover from Phase 3 to Phase for fund for Greece (diverted from MSR)
- estimated 75 million carryover of unused Article10c in Ph4 (instead of auctioning in 2020)
- maximum available increase in Article10c derogations taken (not same for all entitled member states)
- European Council cancellations from MSR starting in 2023
- no harmonised indirect cost compensation fund
- Modernisation Fund of 2% of ongoing phases caps
    - released to market evenly across ongoing phases
- 450 million Innovation Fund (400 from Ph4 free allocation share plus 50 from Ph3 carryover diverted from MSR)
    - released to market 50 from MSR in 2020, 200 2021, 200 2022
- 350 NER from used Ph3 allowances (diverted from MSR)
    - only 50% released to market; none in 1st year, rest gradually building up across each phase
- auction share reduced to 54%
- no additional voluntary allowance cancellations by member states
- double MSR intake up to and including 2023
- 833 and 400 MSR thresholds
- aviation demand increasing by 2.5% p.a.
- base case emissions

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