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# Puncturing the waterbed myth

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sandbag

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The value of additional actions in cutting ETS greenhouse gas emissions

October 2016

## Summary

Additional actions to reduce greenhouse gas emissions are being taken across the EU in sectors covered by the EU Emissions Trading System (EU ETS). These actions include implementing energy efficiency programmes, deploying renewables, replacing lignite and coal plants with less carbon intensive generation, and introducing national carbon pricing. Such actions are essential if the EU is to put itself on the most cost-effective long term emission reduction pathway to deliver its goal of an 80-95% reduction in emissions by 2050.

It is sometimes argued that such additional actions do not reduce total emissions, because total emissions in the EU ETS sectors are set by the fixed cap, irrespective of what other action is taken. This is sometimes referred to as the “waterbed effect” by analogy with the fixed volume of water in a waterbed - squeezing a waterbed at one place immediately leads to it bulging out in another.

While this argument is often repeated, our analysis shows that it largely does not hold true in the EU ETS sectors. Only 2-8% of allowances (EUAs) freed by additional action will be used, resulting in additional emissions in the short term. The remaining 90%-plus will add to the surplus of allowances that has developed over the last few years. These will almost all eventually end up in the Market Stability Reserve (MSR), which is due to operate from 2019. This result is consistent with current market behaviour where present emission reductions are manifestly not being replaced in full by emissions elsewhere, as annual emissions remain 10% or more below the cap.

This means that additional actions, particularly while there continues to be a surplus of allowances over at least the next 10-15 years, are likely to result in long term emissions reductions additional to those delivered by the EU ETS. This remains true even if the reforms of the EU ETS currently being discussed are adopted.

Furthermore, contrary to the assumption underlying the waterbed effect, the supply of allowances to the market is not fixed in the long term, but is set by future policy decisions which can respond to circumstances. While in theory there is the possibility of a long term waterbed effect, if surplus allowances created by additional actions and held in the Market Stability Reserve (MSR) are returned to the market in the future, in practice this is most unlikely to happen. Decisions on the supply of allowances will reflect the circumstances prevailing, including international commitments to emission reductions and the size of a surplus.

This is especially the case as any additional surplus would only return in the 2060s or later, given the likely scale of the surplus that will anyway accrue, and the limit on the rate of return from the MSR of 100 million tonnes per annum. It seems unlikely that allowances returning after a period of decades would be allowed to result in additional emissions. Allowing additional emissions would, for example run counter to the Paris Agreement, including its provisions to aim for net zero emissions in the second half of the century. The waterbed effect would thus not occur, at least not in full, even over the longer term.

## About Sandbag

Sandbag is a Brussels and London-based not-for-profit think tank conducting research and campaigning for environmentally effective climate policies.

Our research focus includes reforming the EU Emissions Trading System and the Effort Sharing Regulation; accelerating the phase-out of old coal in Europe; deep decarbonisation of industry through technologies including Carbon Capture & Storage.

For more information, visit [sandbag.org.uk](http://sandbag.org.uk) or email us at [info@sandbag.org.uk](mailto:info@sandbag.org.uk)

The supply of allowances could be reduced, and the waterbed effect thus avoided over the long term, by a range of policy measures including the following:

- arrangements for retiring allowances from the MSR, or elsewhere once the MSR reaches a certain size limit;
- decisions taken post-2050 not to return allowances from much earlier surpluses, given prevailing policy circumstances;
- Member States choose to retire allowances, and hence reduce the cap, in order to neutralise surplus allowances resulting from other policy actions;
- the additional surplus gives confidence to policy makers to enable tighter caps to be set for future phases, by reducing the perceived cost;
- the EU ETS is replaced by another mechanism, or fundamentally modified, before the additional surplus is returned to the market and the new arrangements do not recognise EUAs in full; and
- vigorous additional policy actions, and new low-emitting technologies to replace current ones, result in emissions always remaining below the cap.

The future supply of allowances, and so any waterbed effect, is thus under direct policy control.

Even when the market returns to scarcity, these policy responses enable any benefits of additional action to be captured in full. It seems likely that the effect of additional actions will continue to shape policy through such mechanisms. The waterbed is therefore unlikely to apply even for additional actions taken when the market is short of allowances.

## **Conclusion**

In practice a large majority of the emissions reductions from additional actions are likely to be permanent. The often repeated claim that additional policy actions “do nothing to reduce emissions because the EU ETS cap is fixed and emissions will take place elsewhere up to the level of the cap” is seriously misleading, reflecting an outdated view of the EU ETS. It should not be used as an excuse for inaction.

## **Key recommendations**

- EU and national policy makers should be confident that putting in place additional policy actions today and in the coming years will further reduce emissions in sectors covered by the EU ETS.
- Action should be taken to retire any further surplus allowances created by additional actions, or to reduce the cap by a corresponding amount.
- When considering delivering targets, EU and Member State policy makers should take account of the small waterbed effect that can occur, and ensure they have factored this in to their assumptions about overall emission reductions that can be achieved.
- Putting in place additional policy actions should not be used as an alternative to tightening supply through the current EU ETS reform process. Rather the two sets of actions should reinforce each other.

# 1. Additional policy actions in the EU ETS sectors

## 1.1 The argument that additional policy actions do not reduce emissions in the EU ETS sectors

Many additional policy actions are being taken to reduce greenhouse gas emissions in sectors covered by the European Union Emissions Trading System (EU ETS), which limits emissions from power generation and large industry. These actions include implementing energy efficiency programmes, deploying renewables, replacing lignite and coal plants with less carbon intensive generation, and introducing national carbon pricing. Such actions are being taken at both national and EU level. The term “additional actions” is used throughout this report to refer to some combination of such actions.

Additional actions play a valuable role in reducing emissions. They form an essential part of putting the European economy on an efficient low carbon pathway. They have a range of other benefits, related to both carbon emissions reductions and other goals (see section 4), including addressing some of the intrinsic limitations of carbon pricing. And they also act to supplement existing EU action, which is not enough to deliver long term targets.

However, it is sometimes argued that such additional actions do not reduce total emissions, because the level of emissions in the EU ETS sectors is set by the EU ETS cap, which is fixed by legislation, with reductions in emissions in one place automatically matched by increases elsewhere. This is sometimes referred to as the “waterbed effect” by analogy with the fixed volume of water in a waterbed - squeezing a waterbed at one place immediately leads to it bulging out in another<sup>1</sup>.

For example, in 2015 RWE used such arguments in objecting to the closure of lignite plant:

*“The proposals [to reduce lignite generation] would not lead to a CO<sub>2</sub> reduction in absolute terms. [The number of] certificates in the ETS would remain unchanged and as a result emissions would simply be shifted abroad.”<sup>2</sup>*

Similarly, in 2012 the then Chairman of the UK’s Parliament’s Energy and Climate Change Select Committee, opposed the UK’s carbon price support mechanism for the power sector arguing that:

*“Unless the price of carbon is increased at an EU-wide level, taking action on our own will have no overall effect on emissions”<sup>3</sup>*

This argument has also been made by some neutral, well-informed observers of energy markets. For example, Professor Steven Sorrel from Sussex University recently argued that:

*“Any additional abatement in the UK simply ‘frees up’ EU allowances that can be either sold or banked, and hence used for compliance elsewhere within the EU ETS”<sup>4</sup>*

As a corollary of this argument, it is sometimes argued that additional actions will also reduce the efficiency of the EU ETS. For example, additional actions may require more costly emission reductions than those signalled by the carbon price without affecting the total quantity of emissions.

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<sup>1</sup> This proposed effect is closely analogous to the rebound effect widely observed for some types of energy efficiency investments, such as improved home insulation. By lowering the effective price of energy such measures tend to lead to the benefits being taken as a mixture of greater comfort and reduced consumption. The waterbed effect argument essentially argues for a rebound effect of 100% on measures to reduce emissions.

<sup>2</sup> See RWE statement, “Proposals of Federal Ministry for Economic Affairs and Energy endanger the future survival of lignite”, 20 March 2015. <http://www.rwe.com/web/cms/en/113648/rwe/press-news/press-release/?pmid=4012793>

<sup>3</sup> [www.parliament.uk/briefing-papers/sn05927.pdf](http://www.parliament.uk/briefing-papers/sn05927.pdf)

<sup>4</sup> <http://www.energypost.eu/brexit-opportunity-rethink-uk-carbon-pricing/>

However, these arguments reflect outdated assumptions that allowances are in short supply and that there is a large amount of unmet demand for allowances. This is not the case in the EU ETS at present, and is unlikely to be so for additional actions taken over at least the next 10-15 years over which time a cumulative surplus of allowances is likely to remain even if some of the currently proposed reforms to tighten the cap are implemented. The arguments also ignore the potential for policy responses over time that could reduce the supply of allowances to recognise the effect of additional actions. The remainder of this report explores the basis of the “waterbed effect” argument and why it does not hold.

This report takes into account previous discussions and analysis of the waterbed effect, including a study by Ecofys (see Annex 3). It extends the work by modelling the likely extent of any waterbed effect given the circumstance of the EU ETS.

## 1.2 Additional actions being taken to reduce emissions

As noted above, there is a range of additional actions, going beyond the effect of the carbon price itself, that can reduce emissions within the EU ETS sectors as set out above. Examples of additional actions that are already in place or currently proposed are shown in Table 1<sup>5</sup>.

**Table 1: Additional actions in Europe to reduce emissions in the EU ETS sectors**

<i>Measure</i>	<i>Description</i>	<i>Main rationale</i>	<i>Date</i>
<b>1. German lignite reserve<sup>6</sup></b>	2.7GW of lignite power plants will be paid €1.6b to go into a reserve, then closed.	To help meet national 2020 GHG target.	2015 announced 2016 put in law
<b>2. Netherlands coal closures<sup>7</sup></b>	4 coal plant closures of 2.4GW from 2015 to 2017. In exchange, scraps coal tax.	To help meet national 2020 and longer term GHG targets.	2013 announced 2014 put in law
<b>3. UK coal phase-out announcement<sup>8</sup></b>	Announcement that all UK coal plant must close by 2025.	“Coal is the most carbon intensive fossil fuel and damages air quality.”	2015 announced 2016 consultation
<b>4. UK carbon price floor<sup>9</sup></b>	UK ETS installations must pay £18/tonne to supplement the EU ETS price.	“Support and certainty for low carbon investment”	2010 announced 2013 started
<b>5. French carbon</b>	Power plants pay tax of €30/t	“To curb coal-fired power	2016 announced

<sup>5</sup> In some instances, where electricity generation from one source is removed, for example by the closure of coal plant, there is the possibility that it may be replaced by other generation which is equally carbon intensive or more so. This is likely to be at most a small proportion of any widespread and diverse programme of additional action (see Annex 2). It is in any case separate from the “waterbed effect”, which due of the operation of the fixed EU ETS cap.

<sup>6</sup> See Clean Energy Wire write-up of the ministry announcement. <https://www.cleanenergywire.org/news/brown-coal-standby-reserve-cut-co2>

<sup>7</sup> See report in Argus media. <http://www.argusmedia.com/pages/NewsBody.aspx?id=856174&menu=yes>

<sup>8</sup> See Amber Rudd’s announcement of the coal phase-out. <https://www.gov.uk/government/speeches/amber-rudds-speech-on-a-new-direction-for-uk-energy-policy>

<sup>9</sup> See UK HM Treasury Carbon Price Floor [https://www.gov.uk/government/uploads/system/uploads/attachment\\_data/file/42639/consult\\_carbon\\_price\\_support\\_condo\\_c.pdf](https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/42639/consult_carbon_price_support_condo_c.pdf)

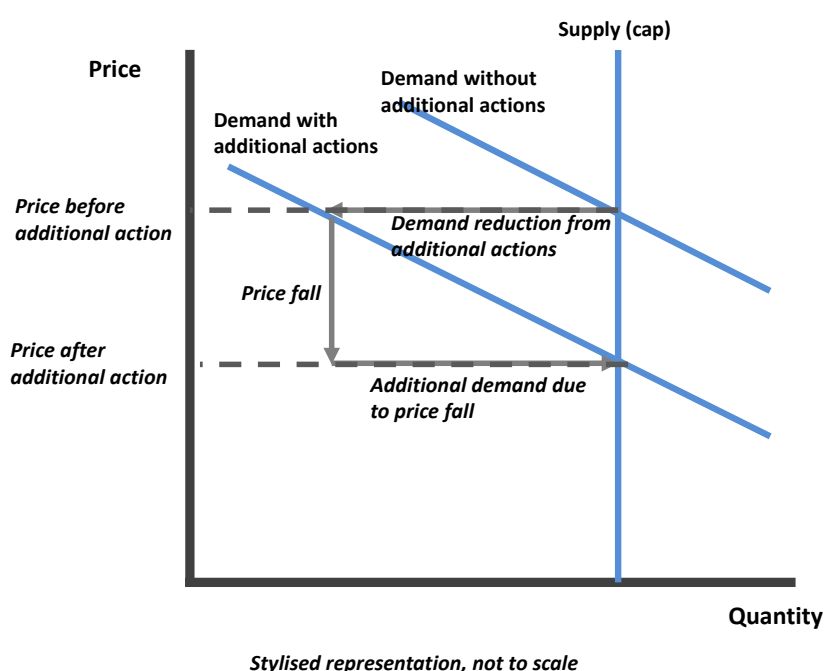
<b>floor price<sup>10</sup></b>		generation and boost renewables”	2017 to start
<b>6. Feed in tariff for solar and wind</b>	A number of countries have offered a fixed price for renewables generation	To incentivise early stage deployment	Continuing
<b>7. Energy Efficiency Directive</b>	20% energy efficiency gains by 2020	To help meet EU energy efficiency target	2012 entry into force

### 1.3 The hypothesis of the waterbed effect in detail

The argument that additional actions to reduce emissions will be ineffective assumes that demand for allowances will adjust so that the quantity of allowances used is always equal to the cap, which is fixed.

This is illustrated in stylised form in the diagram below. There is fixed, perfectly inelastic supply, represented by a vertical supply curve. Demand for allowances without additional actions leads to prices at an initial level. Additional actions reduce demand for allowances at any given price, effectively shifting the demand curve to the left by the amount by which additional actions reduce emissions. This leads price to fall until the lower price creates sufficient additional demand that total demand is again equal to the supply set by the cap. Because the supply curve is vertical the equilibrium quantity of emissions is unchanged, remaining equal to the cap<sup>11</sup>.

Chart 1: A price response to the change in demand for allowances can lead to emissions re-equilibrating at the cap



However, at present large increases in emissions (such that emissions rise to the cap) due to falling prices are not occurring. The market has a surplus of allowances both cumulatively and on an annual basis. The price of

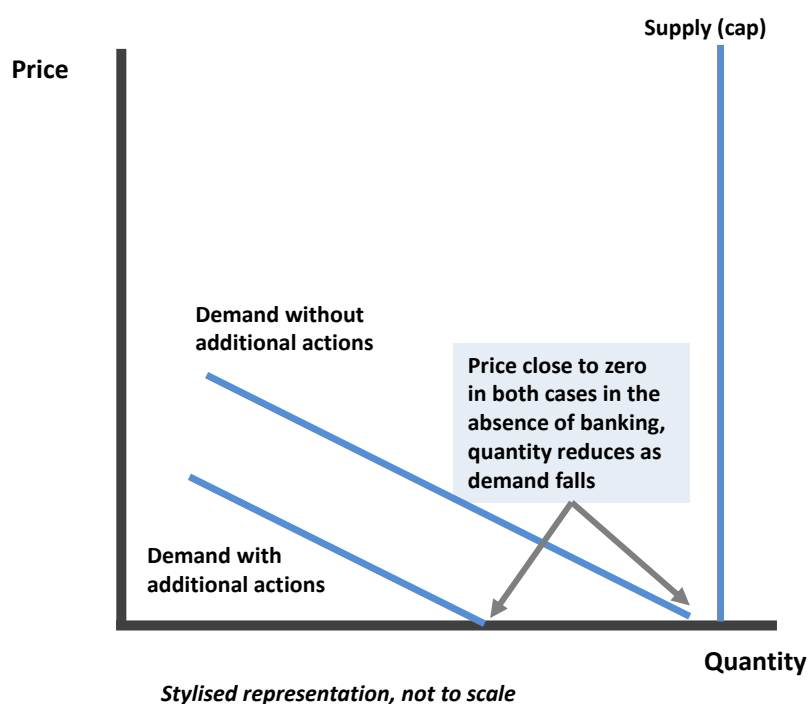
<sup>10</sup> See Reuters report <http://www.reuters.com/article/us-france-carbon-idUSKCN0XN1C6>

<sup>11</sup> This is analogous to the well-established rebound effect for energy efficiency measures. Improved domestic insulation lowers the effective price of energy, so consumers take some of the benefits as increased warmth, and some as reduced consumption. The argument here is that in effect there is a 100% rebound effect for emissions reductions under the EU ETS.

allowances would be close to zero in the absence of banking of allowances into subsequent phases, because there would be a cumulative surplus over Phase 3 of the EU ETS, and so no scarcity of allowances<sup>12</sup>.

If demand were further reduced in the absence of banking there would be no significant price fall, because prices would already be close to zero. Correspondingly, there would be no increase in demand for allowances to offset the reduced emissions from additional actions even with a fixed cap. The emissions reductions from additional actions would be retained in full. This is again illustrated in stylised form in the diagram below.

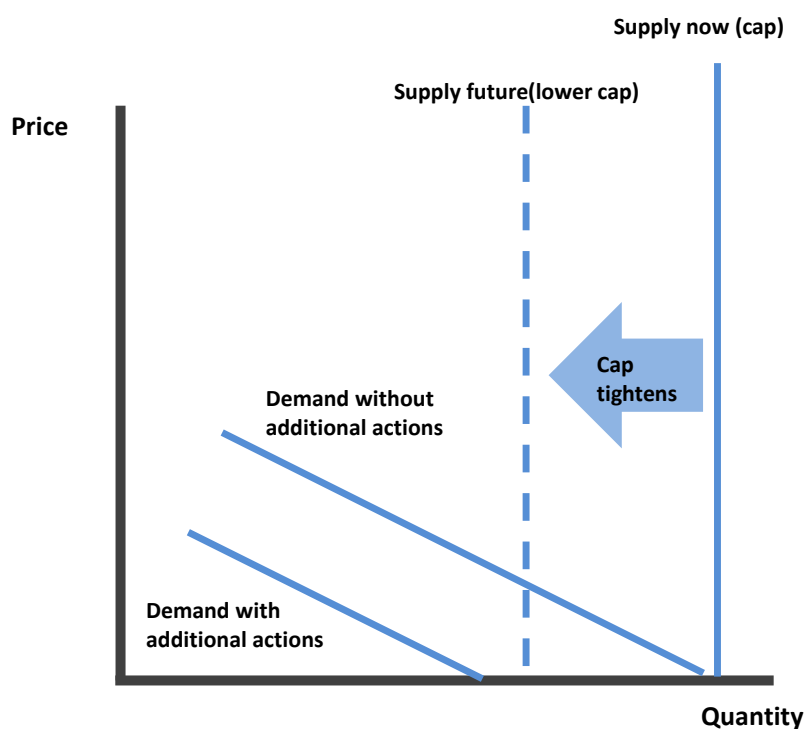
Chart 2: With a surplus of allowances and price close to zero (assuming no banking) any reduction in demand for allowances will be retained in full



In practice the potential to bank allowances and the introduction of the Market Stability Reserve (MSR) in 2019 supports the present price. It is expected that in future as the cap continues to fall be reduced then allowances will become scarce. There is therefore a value to allowances set by the cost of future emission reductions (see chart 3).

<sup>12</sup> Such a situation occurred towards the end of Phase 1 of the EU ETS (2005-7), which did not allow banking into Phase 2. Towards the end of the Phase there was a surplus of allowances and the price fell to close to zero.

Chart 3: Illustration of likely future market tightening



*Stylised representation, not to scale*

Additional actions to reduce emissions in the EU ETS sectors will postpone the expected date at which the market returns to balance by increasing the surplus. This will, in turn, reduce prices. This is because the current price of allowances will be set by their discounted future value. With an increased surplus, any allowances bought now will need to be held for longer before being used, and so their value will be discounted more. This price fall will in turn lead to some increase in emissions. The situation is further complicated by the cap not being fixed in the longer term, but the subject of policy decisions which will inevitably be influenced by prevailing circumstances.

Assessing the “waterbed effect” therefore requires assessments of how the market for allowances will operate in the next few years as well as in the longer term. This includes assessment of how future levels of the cap and the supply of allowances are set, and how this is affected by the reduction in demand for allowances due to additional actions.



## 2. Modelling the extent of the waterbed effect

### 2.1 Modelling approach

The extent of an increase in emissions due to price falls caused by an increase in allowances being available within the EU ETS is modelled by:

- establishing a base case set of emissions and prices based on current and expected emissions, caps and abatement costs;
- developing a scenario for the quantity of emissions savings from additional actions;
- estimating the extent of a price fall due to the availability of allowances freed up by additional action; and
- estimating the increase in demand for allowances corresponding to this price fall using a marginal abatement cost (MAC) curve.

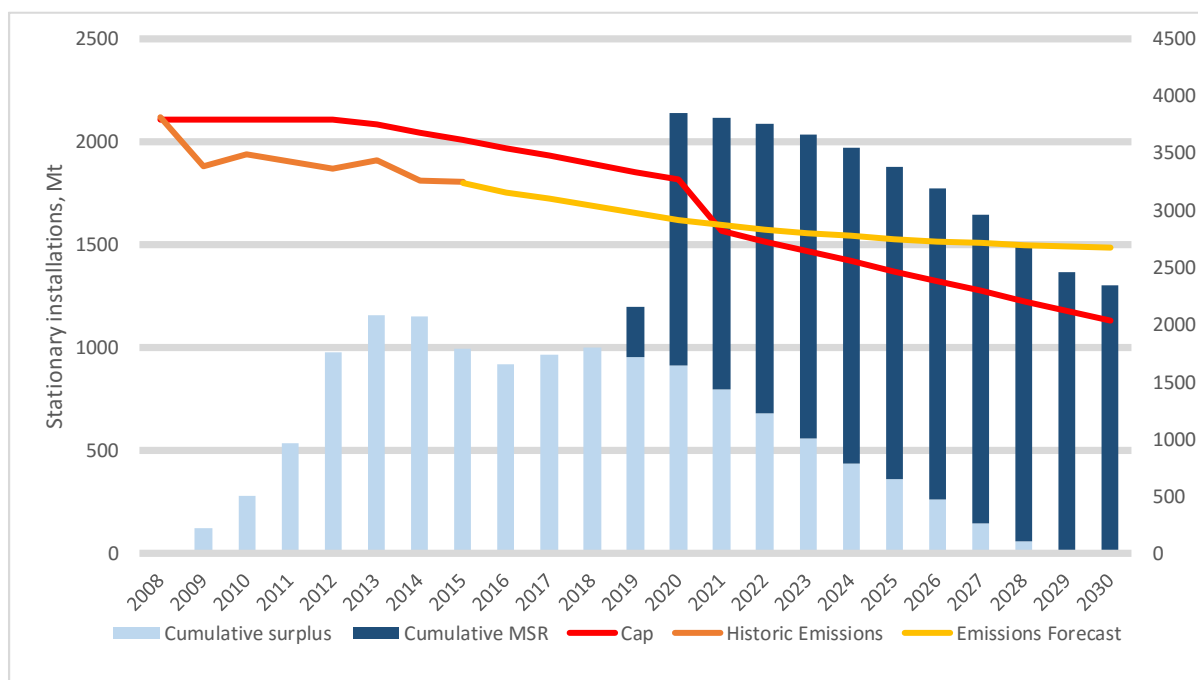
The estimate of the reduction in prices is based on the additional time which the market takes to return to scarcity.

Further details of the modelling approach are described in Annex 1.

### 2.2 A scenario for base emissions and additional actions in future

Our base case emissions scenario without additional actions is shown in the chart below. The scenario includes rebasing the cap to reflect actual emissions at the start of Phase 3. Even with the rebasing, there is a surplus of over three billion allowances by the start of Phase 4, including both those in the MSR and those available to the market,

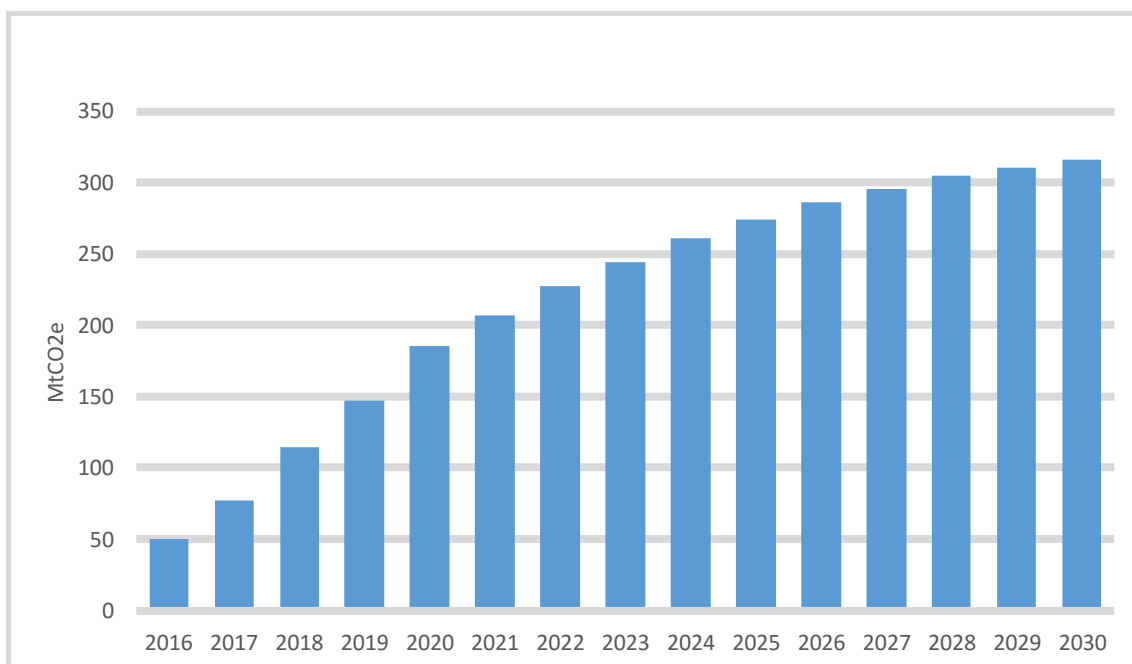
Chart 4: EU ETS Supply and demand to 2030



We have then established a scenario to assess the likely effect of additional actions in EU ETS sectors in future. The scenario is illustrative only, and is intended to establish the extent of any waterbed effect. Additional actions are

assumed to reduce emissions by an average of 220 MtCO<sub>2</sub> per annum, about 13% of the cap, over the period from now to 2030. A sensitivity with emission reductions of half this level is also examined.

Chart 5: Scenarios for emission reductions due to additional action scenario



There are various combinations of additional actions that could produce such reductions in emissions. Some examples of the type of actions that could contribute towards such reductions are shown in the table. Many combinations of such actions are possible. Additional actions are likely to involve a reduction in coal burning, because emissions from coal burning currently account for over 40% of the total covered by the EU ETS.

**Table 2: Illustrative magnitude of potential emissions reductions form additional actions**

Additional action	Annual emission reductions (million tonnes CO <sub>2</sub> )
Retirement of 5 GW of baseload lignite plant	48
Retirement of 5 GW of midload coal plant	20
Deployment of an extra 5GW of wind generation displacing coal	8
Energy efficiency reducing electricity demand by 10% over time	100 (approximately)
French coal phase out	11
UK coal phase out by 2025	75

Source: Sandbag calculations

### 2.3 Impact on emission levels resulting from changes in price

As noted, additional actions increase the surplus and so reduce the price of allowances. This in turn increases demand for allowances, and so will tend to absorb at least some of the increased surplus due to additional actions. We have expressed this increase in demand as a percentage of the reduction in demand from the additional action.

So for example, if additional actions reduce emissions by 200MtCO<sub>2</sub> p.a., and the resulting price fall increases demand for allowances by 20 MtCO<sub>2</sub> p.a., then the increase in demand is 10%. This is a measure of the extent of a waterbed effect.

We have looked at three sources of evidence for the impact on emissions levels as a result of changes in price:

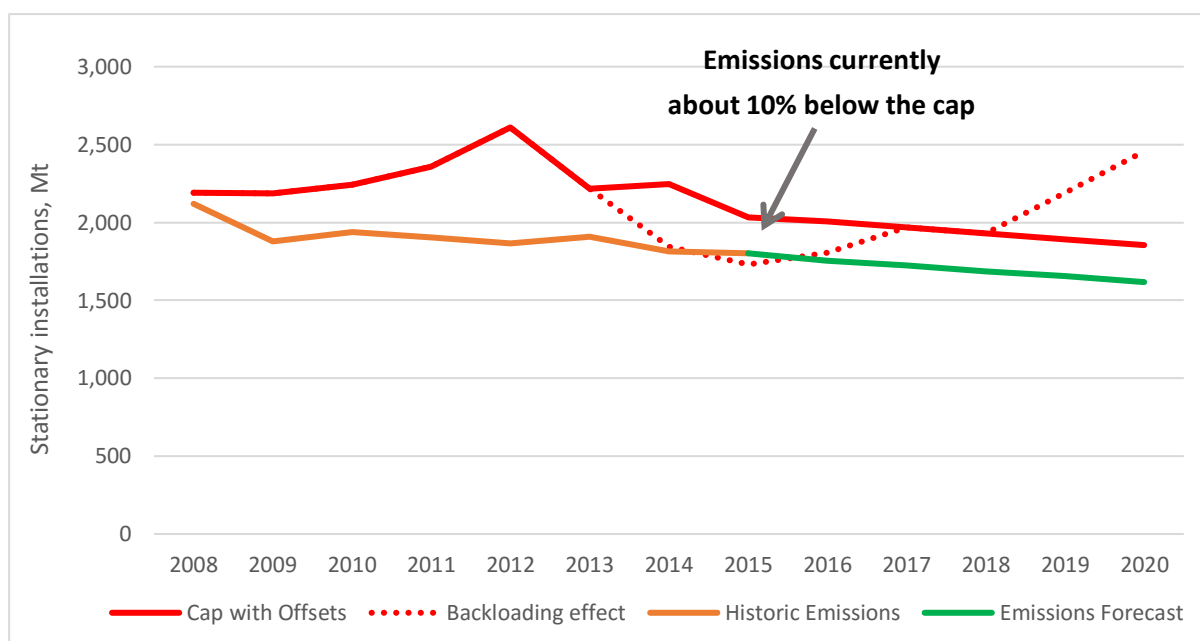
- the current market surplus;
- the likely response of individual sectors; and
- the MAC curve.

### 2.3.1 The current market surplus

Emissions have been below the cap since 2008. Annual EU ETS emissions in 2015 were approximately 200 MtCO<sub>2</sub> p.a. (about 10%)<sup>13</sup> below the cap (see Chart 5). This year emissions will likely be 13% below the cap, with no sign of emission rising to meet the cap.

Policies on renewables and energy efficiency together with the UK's carbon price floor have, over time, contributed to significant emission reductions. This is particularly the case in the power sector where emissions have fallen by 21% between 2008 and 2015. These emission reductions have not been replaced by additional emissions elsewhere. Consequently, there is now an accumulated surplus of approximately 2.7 billion<sup>14</sup> allowances, which is continuing to grow.

Chart 6: Emissions are currently well below the cap



<sup>13</sup> The average annual surplus for the period 2008-2015, has been 223MtCO<sub>2</sub>. We expect emissions to continue declining in 2016 and even with the last year of backloading, the annual average surplus would only come down to between 180 and 190Mt.

<sup>14</sup> The term surplus is here used to include both allowances available to the market and those to be placed in the MSR. This consists of 1.8 billion EUAs held in registry accounts and available to the market and a further 900Mt withheld from auctioning to be added to the MSR.

### 2.3.2 The response of individual sectors

Energy efficiency policies and the economic recession since 2008 have, among other factors, reduced the rate of electricity demand growth. In fact, electricity demand in the EU has decreased by 6% in the period 2008-2014, with a 2% reduction in 2014 alone<sup>15</sup>. Even with stronger future economic growth, low carbon supply seems likely to meet, in full, any electricity demand growth.

Large additional demand for allowances from coal power generation appears unlikely over the long term as, capacity that enables switching availability will significantly decline. The EU Reference Scenario 2016<sup>16</sup> forecasts that solid fossil fuel capacity will only represent 4% of total installed net generation capacity by 2050, down from 18% in 2015. Faster decline than this is likely in many scenarios. Gas capacity on the other hand will remain broadly stable over the same period with renewables covering all of the expected increase in electricity demand as well as any potential deficit due to coal plant closures. However, a slower decline in coal burn with lower carbon prices remains possible, and this is captured in the MAC curve we have used for this analysis.

Industrial emissions have also shown little tendency so far to grow in response to the surplus of allowances to date. There appears to be little reason to assume rapid growth in the future as a response to increases in allowance availability. The primary factor influencing industrial emissions is the level of industrial production, not the availability of emissions allowances. The argument that more emissions intensive production methods could be used when more allowances are available does not seem convincing since such methods would only be available for a limited range of products and, more importantly, would include higher fuel consumption or process changes, which seem unlikely to be approved by investors<sup>17</sup>.

### 2.3.3 The marginal abatement cost curve

The change in demand for allowances in response to price follows a MAC curve. The MAC curve we have used is shown in Chart 7 (below). A decrease in the price of allowances leads to reduced levels of emission abatement and thus additional demand for allowances.

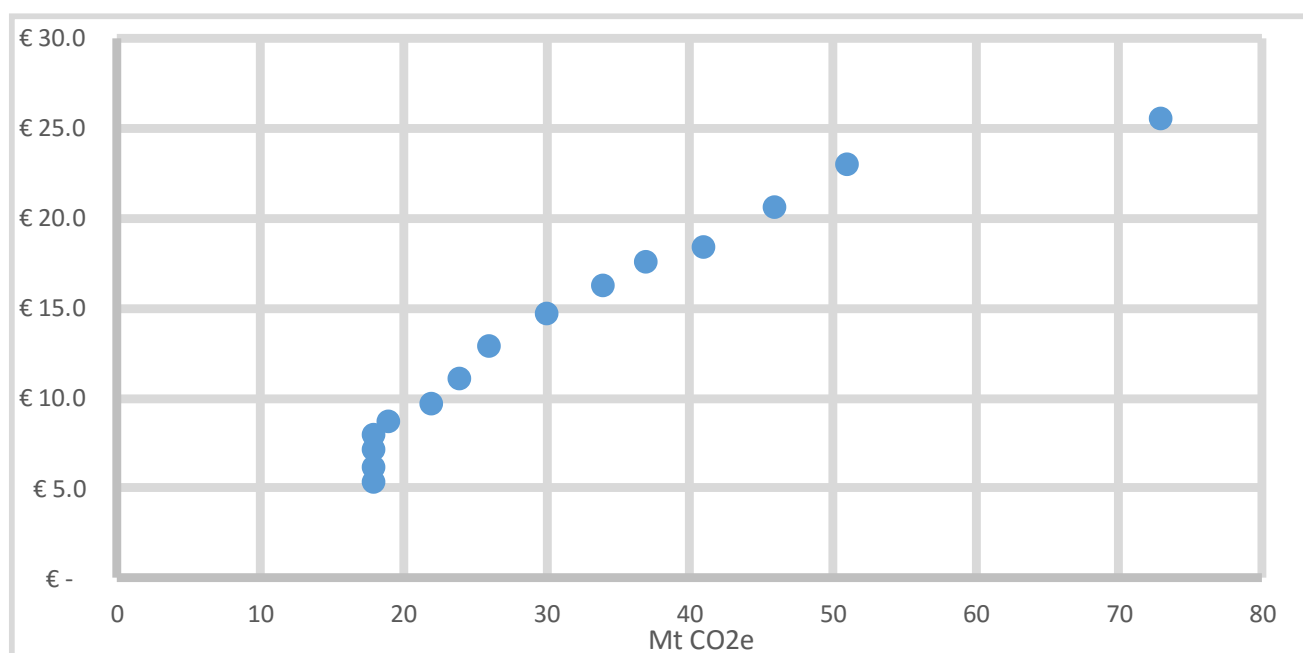
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<sup>15</sup> Latest available Eurostat data. ENTSO-E data for 2015, which is not directly comparable, shows demand growth of 1% for that year.

<sup>16</sup> <http://ec.europa.eu/energy/en/data-analysis/energy-modelling>

<sup>17</sup> The effect is likely to be asymmetric with reduced allowance availability and increased prices increasing abatement, but with a smaller increase emissions in response to lower prices.

Chart 7: Forecast market prices and abatement<sup>18</sup>



It is assumed constant over time in the absence of more reliable information or knowledge of future relative fuel prices.

## 2.4 Results of analysis

### 2.4.1 Change of demand for allowances in response to changes in price

From the analysis described above, we estimate that the increase in demand for allowances due to falling prices (percentage of emission reductions from additional action lost) accounts for only between 2% and 8% of the emissions reductions due to additional actions. The increase in demand for allowances resulting from the price fall is lower in earlier years because prices are low, so even a large percentage change in price leads to only a small absolute change in emission reductions.

Correspondingly, over 90% of the emission reductions due to additional actions are maintained, and the allowances that are freed up by these emissions reductions are added to the surplus.

An immediate waterbed effect thus occurs to only a very limited extent – less than 10%.

<sup>18</sup> Source Thomson Reuters. We have used a stylised curve in our modelling based on this data, and on evidence from the response of the market to date and sectoral analysis described above. The MAC curve is implemented in the modelling in piecewise linear form.

**Table 3: Approximate estimates of the percentage of emission reductions lost as a result of price falls**

Year	Increase in demand for allowances (Percentage of average emissions reductions lost from additional action)
2017	2%
2020	3%
2025	5%
2030	8%

Parameters would need to be in error by about an order of magnitude to substantially affect the conclusion that most allowances freed up by additional actions add to the surplus.

#### 2.4.2 Additional surplus allowances and the interaction with the MSR

Emission reductions due to additional actions will further increase the number of allowances in the MSR.

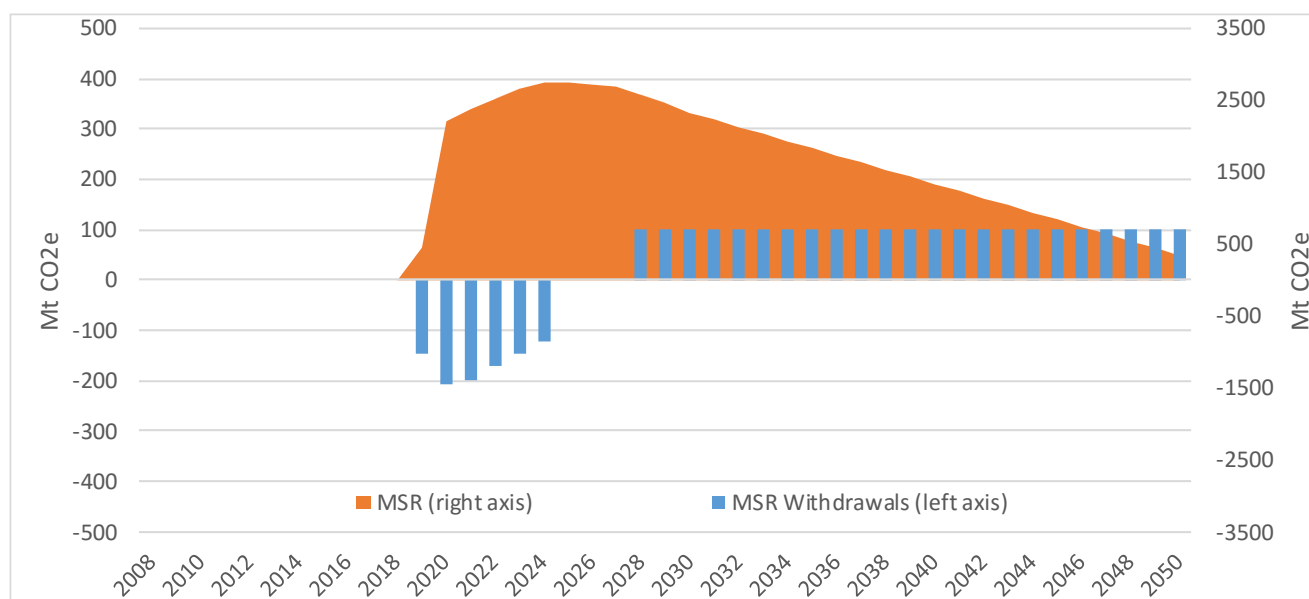
The MSR will already have approximately three billion allowances by 2030, even without additional actions, and these can only be returned to the market at a rate of 100 million per year. This means that the surplus will take 30 years to return, even without additional action.

The further surplus created by additional actions would only potentially start returning to the market in the late 2050s and 2060s, and continue to return for a long period after that time (if the decision was taken to allow this to happen). Allowances released by additional action before the start of the MSR in 2019 add to the existing surplus and are nevertheless absorbed over time into the MSR as it begins operation.

Chart 8, overleaf, shows the MSR dynamics until 2050 in our base case. The cap is rebased to reflect forecasted emissions at the end of Phase 3 in line with our previous [proposals](#). This is a tighter cap than currently envisaged, so the surplus, while still very large, is smaller than it might otherwise be.

Surpluses generated now will be absorbed by the MSR and could start returning to the market only in the 2030s. The full volume is not exhausted until into the 2050s even without additional actions.

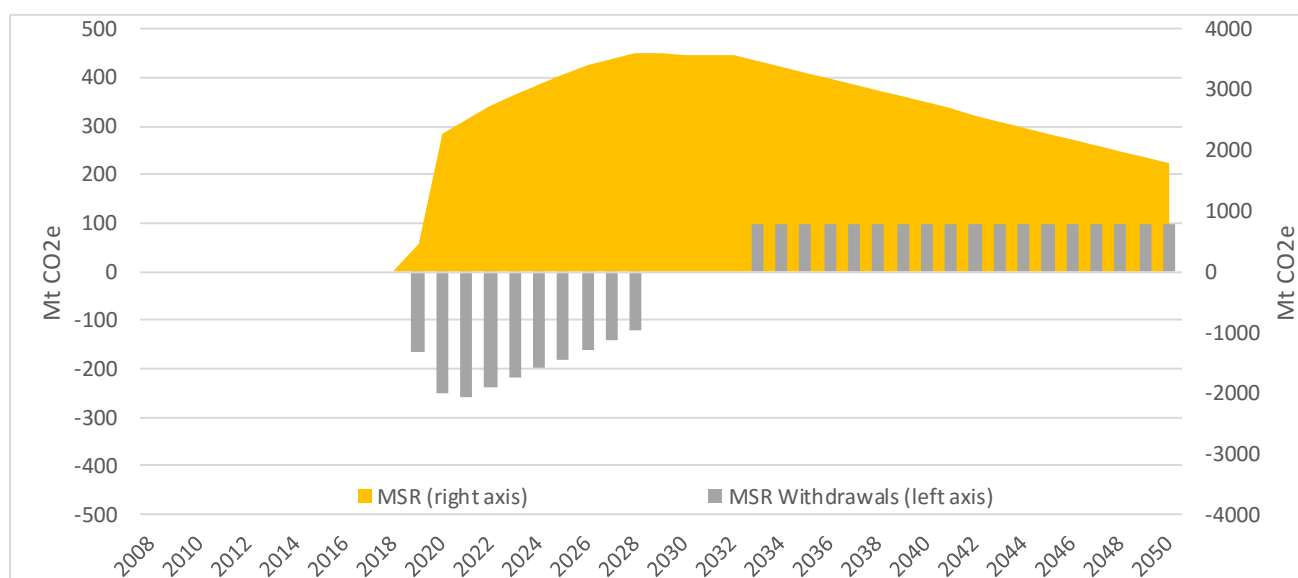
Chart 8: MSR annual withdrawal/return volumes in base case



*Note: Assumes our base case emissions with rebasing of the cap to reflect actual emissions 2017-9 and MSR introduced as planned from 2019. The MSR rapidly grows in size at the beginning of its operation, primarily due to the backloaded allowances that are placed in it. It continues to withdraw allowances from the market until the amount of allowances in circulation falls below 400Mt in 2027. From the following year, the MSR starts releasing 100Mt per annum.*

Chart 9 shows the MSR dynamics in the case with additional actions as described above. It shows that there would be still over two billion allowances in the MSR by 2050. This implies that the MSR will only be emptied in the 2070s. Allowances not used because of additional action in the next ten years return between the late 2050s and the 2070s.

Chart 9: MSR withdrawal/return volumes with additional action



Assumptions are the same as for the previous chart but with approximately 220 MtCO<sub>2</sub> of emissions reduction due to additional actions

### 2.4.3 Sensitivities of results to assumptions

The above conclusions are dependent to some extent on the continuation of the MSR in its current form. Some sensitivities are summarised in Table 4 below. The table shows the date the surplus due to additional action begins to return from the MSR. The process typically takes about 20 years to complete.

**Table 4: Base case and sensitivities for timing of return of surplus allowances due to additional action from the MSR**

Scenario	Start year of return from MSR of surplus due to additional actions	Notes
Case with additional action (including rebasing of the cap to actual emissions at the start of Phase 4.)	2063-2087	Base Case
Increase of linear reduction factor to 2.4% from 2020	2061-2085	Small effect on emissions, so little effect
No rebasing of the cap in 2020	2083-2107	Increased surplus without additional action delays return of further surplus
Increase in the rate of return from the MSR to 200 million allowances per annum from 2020	2048-2060	All allowances return earlier due to increased rate
Level of additional action halved (e.g. due to slower retirement of coal plant) from ?	2061-2073	End date of return is earlier due to smaller savings

The return of additional surplus allowances created through the introduction of additional actions would occur earlier if a decision was taken to release allowances from the MSR more rapidly, for example at a rate of 200 million p.a.. However, even with this increased return rate, under the additional action scenario it would still take two to three decades before the surplus is exhausted and the MSR is emptied.

Similarly, if a somewhat lower surplus built up, then surplus allowances from additional actions would return earlier than set out in the additional actions scenario. However, given the size of surplus already accumulated, it would still take decades for any additional surplus allowances to return to the market.

Conversely, continuing the Phase 4 cap from the level it reaches at the end of Phase 3 without rebasing (as is currently proposed) would increase the surplus, and thus further delay return of any allowances from additional actions.

In theory, once additional allowances begin to be returned to the market, the waterbed effect would start to appear, albeit with a delay of several decades after that the additional actions took place. However, given the level of emission reductions that the EU has committed to, and the requirements of the Paris Agreement, it is difficult to envisage that there would be the scope for these allowances to be returned to the market, and that no actions to reduce supply would have been carried out in the meantime. This is considered further in the next section.



### 3. The likelihood of permanent emissions reductions

The waterbed effect hypothesis assumes that the supply of allowances is fixed. This is only true in the short to medium term over which the cap is defined by legislation, and even then only in part as there is potential for action to alter supply, for example by cancelling allowances in the MSR. Supply in the longer term is not fixed, but set by future policy in the context of prevailing circumstances and international obligations. (In analytical terms, the potential for policy response means that the long term supply of allowances is endogenous with respect to the effect of additional actions, rather than exogenous as implied under the waterbed effect hypothesis.)

In this context, while there is a theoretical possibility that allowances freed up by additional actions might eventually return from the MSR it seems unlikely in practice that they would ever return to enable additional emissions. There would not therefore be a significant waterbed effect even over the longer term.

There are various reasons for this, reflecting the likelihood that future policy decisions will be affected by the size of the market surplus and MSR, by price levels, and by the policy context prevailing in the second half of the century.

Several things can prevent emissions that match the additional surplus of allowances ever occurring, either because aggregate supply of allowances is reduced in response to the additional surplus, or because there is never any demand for the surplus allowances. Emissions can be avoided permanently, and in full, by appropriate choice of policy.

Examples include the following.

**Retiring allowances from the MSR.** Allowances may be retired once the MSR reaches a certain size limit. Our modelling of the MSR shows that with any reasonable limit on the size of the MSR, volumes would become sufficiently large to trigger retirement.<sup>19</sup> Additional actions will increase the number of allowances going into the MSR, which in turn pushes the number in the reserve further above any future size limit, and hence leads to additional cancellation of allowances above the limit.

**Deciding not to return old allowances from the MSR post 2050.** Policy decisions may be taken post-2050 not to return allowances from much earlier surpluses, given prevailing policy circumstances. Emission limits would be much tighter than they are now. The existing 2050 target would lead to the cap already being at around 100-400 million tonnes p.a. by 2050. There is also a commitment under the Paris Agreement to aim for net zero emissions in the second half of this century. Large volumes of emissions from much earlier periods would disrupt this goal.

**Retirement of allowances by Member States.** The additional surplus may give individual Member States the confidence to retire allowances, and hence reduce the cap. The chances of effective Member State cancellation are greater if they have more flexibility to retire allowances in varying circumstances.

**Tighter caps in future.** If emissions are reduced by additional actions, prices are likely to remain lower than they would otherwise be and the surplus will remain larger for longer. This may reduce the perceived costs of tighter caps, and enable tighter caps to be set.

**Successor mechanisms to the EU ETS.** The EU ETS may be replaced by other mechanisms, or fundamentally modified, before the additional surplus is returned to the market. Any new arrangements may not recognise allowances in full. Under many of our scenarios it takes four or five decades from now for allowances to return to the market from the MSR. The likelihood of a successor policy to the EU ETS appears significant over such an extended period.

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<sup>19</sup> See our previous report on the MSR <https://sandbag.org.uk/reports/stabilising-market-stability-reserve/>

**Indefinite surplus.** Vigorous additional policy actions - such as the phase out of coal, the development of industrial CCS and introduction of new low-emitting technologies to replace current ones - may result in cumulative emissions always remaining below the cumulative cap. In such circumstances some EUAs will simply not be needed. Emissions savings due to additional actions will be realised in full, or very nearly so.

Some of these events, such as a tightening of future caps, can occur even when the market is no longer in surplus. For example, lower allowance prices due to additional action may enable tighter caps even in a market not in surplus. The absence of the “waterbed effect” is thus not dependent on the current surplus in the EU ETS. It is only dependent on adequate policy action being taken. Additional actions can thus result in long term emissions reductions even after the market has returned to scarcity.

In the light of these possibilities allowances only return, and the corresponding emissions only occur, if there is a failure over several decades to take policy decisions at the EU level (and national level in the case of Member State cancellation) to respond to larger surpluses. The “waterbed effect” will thus only be present at all if policy makers choose to allow it to be over several decades.

Sandbag’s strong preference is for the EU ETS cap to be progressively tightened, the size of the MSR to be limited and allowances retired above a limit set for the MSR, reducing total supply. This helps deliver cost effective emission reductions in line with the EU’s own targets and the Paris Agreement. However, in the unlikely event that allowances released by additional action are allowed to return to the market, with no counterbalancing reduction in supply and an increase in emissions takes place, the emissions would nevertheless have been delayed by several decades from when they would otherwise have occurred.

## 4. Other benefits of additional actions

It is often argued that undertaking additional measures is not only ineffective because of the “waterbed effect”, but is also inefficient because it makes emission reductions more costly. However, additional policy actions often have a range of benefits beyond reductions in greenhouse gas emissions. Examples include the following:

**Structural transformation.** The energy system needs to be transformed in a variety of ways as part of the transition to a low carbon economy, and carbon pricing will not always be able to incentivise this effectively<sup>20</sup>. For example, grids need to become more flexible. Many additional actions to reduce emissions have co-benefits in this respect. For example, energy efficiency measures can help lock in lower emission systems.

**New technology development.** Renewable power generation is a critical component of any low carbon energy system and policies to promote the deployment of renewables are found in all major economies. The EU’s role in reducing the costs of renewables through policy-driven deployment has been one of its major contributions to the long term effort to limit climate change. Similarly, other new technologies such as carbon capture and storage require additional support in the early stages of commercialisation.

**Other environmental benefits.** Some policies may provide other environmental or social benefits. For example, closing coal plants reduces local or regional pollution that directly affects health<sup>21</sup>.

**Energy security.** Lower carbon energy supply may reduce dependency on imported fossil fuels.

**Industrial policy.** Some means of emission reductions may be promoted as part of a wider industrial policy.

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<sup>20</sup> See Grubb, Planetary Economics (2013) for a full discussion of this issue.

<sup>21</sup> See Sandbag’s [report](#).

The presence of these other potential benefits implies that in assessing additional policies it is usually inappropriate simply to take account only of the benefits of direct greenhouse gas emission reductions or to calculate the cost of measures in €/t of abatement<sup>22</sup>.

Furthermore, carbon pricing is itself an imperfect signal for long term investment. There are several reasons for this, including the political risk associated with long term revisions to the price, and asymmetries of political risks tending to lead towards weaker than optimal targets. Additional policies and actions can help overcome these limitations.

## 5. Conclusions

Additional policy actions in the EU ETS sectors cause at most a limited “waterbed effect”, with less than 10% of emissions reductions from additional actions being absorbed by a price response. The immediate waterbed effect thus only occurs to a small extent. This is consistent with the current state of the market where emissions remain well below the cap despite lower prices.

Correspondingly, in practice over 90% of the emissions reductions from additional actions are likely to be retained into the long term. While there is a theoretical possibility that allowances may return to the market in the very long term it is most unlikely in practice that they will do so and undesirable that they should. Various policy mechanisms, including cancellation of allowances and tighter future caps, have the potential to act to prevent any increase in net supply due to allowances returning from the MSR. These also applies to a large extent to additional actions taken after the market has returned to scarcity, so a waterbed effect would be expected to only a limited extent at most even then.

The often repeated claim that additional policy actions “do nothing to reduce emissions because the EU ETS cap is fixed and emissions will take place elsewhere up to the level of the cap” is seriously misleading, reflecting an outdated view of the EU ETS and an erroneous assumption that the supply of allowances is fixed in the long term. It should not be used as an excuse for inaction.

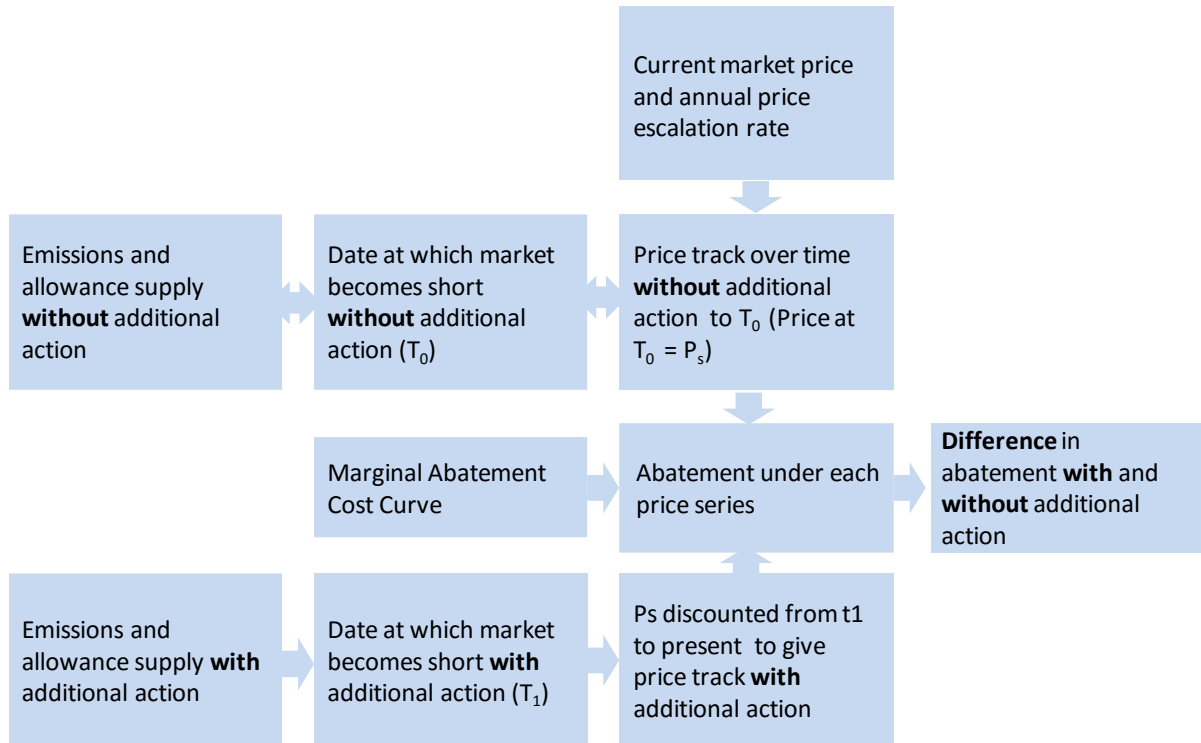
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<sup>22</sup> For an example of this type of comparative approach see the report by the OECD ([http://www.oecd-ilibrary.org/environment/effective-carbon-prices\\_9789264196964-en](http://www.oecd-ilibrary.org/environment/effective-carbon-prices_9789264196964-en)) arguing that explicit carbon prices were below the levels of the implicit carbon price due to other policies such as Feed-In-Tariffs, and thus carbon pricing was more cost-effective as a means of emission reductions. However, the analysis acknowledged that carbon emission reduction was only one motivation for many of the policy instruments included in the study but that it had not accounted for these co-benefits. Consequently the case made is inconclusive. See Executive summary and p.31 for notes on co-benefits.

## Annex 1: Further details of modelling approach and results

The structure of the model used to estimate the decrease in the EUA price and the amount of resulting additional abatement is set out in the diagram and described further below.

### Structure of model



### Step1: Specifying the case without additional actions

An escalating price track is specified as follows.

- The average 2016 market price, assumed to be €4.50/t, is used as a starting point.
- An escalation rate of the price is specified. It is assumed to be equivalent to a risked rate of return on assets that a company would require to hold EUAs rather than sell them now. (Risk free arbitrage is not possible beyond two to three years due to the absence of liquid markets.) Based on this framework an escalation rate of 10% is assumed.
- The years at which the market returns to scarcity,  $T_0$ , is calculated based on allowance supply and emissions
- Based on the starting price, escalation rate, and  $T_0$ , the price at the time of scarcity ( $P_s$ ) is calculated

There is a consistency check that the price  $P_s$  is approximately equal to the level of fuel switching costs, on the assumption that more substantial abatement, including fuel switching, is then necessary. The escalation rate includes the effect of some reform of the EU ETS, which is built into our base case. Without this reform the escalation rate of prices would be slower, and the price  $P_s$  would be reached at a later date, consistent with the greater supply in the absence of reform.

The process is thus iterative to represent price and emissions in practice solving simultaneously (represented by the double headed arrows on the flow chart).

The amount of abatement in this scenario is then calculated based on the marginal abatement cost curve.

## Step 2: Specifying the case with additional actions

The price is then reduced to reflect the increased supply of allowances. This is done as follows.

- The date at which the market returns to scarcity with additional actions ( $T_1$ ) is calculated
- The price reached in that years is set equal to  $P_s$ . This in practice means the same price is reached some years later.
- This price is discounted back to the current date using the same escalation rate of 10%, giving a lower starting price (below the current market level).

This in effect discounts the price by the number of years' difference between the timing of the market returning to balance with and without additional action.

The amount of abatement with this new lower price track is calculated.

In principle this could affect the price calculation (price and volume need to solve simultaneously) but in practice the effect on the date at which the market returns to balance is small – not more than one year – and well within the uncertainties caused by other assumptions.

## Step 3 – calculating the difference between cases

The reduction in abatement (increase in demand for allowances) is then calculated by subtracting the abatement with additional actions from the abatement without additional actions. This is extent of the waterbed effect. It is expressed as a percentage by comparing it with the reduction in demand due to additional action.

This analysis implicitly assumes that additional actions are all announced and committed to at once, and the full effect is immediately realised in the market price as this information is absorbed, with the price escalation rate unchanged. An alternative assumption, perhaps more realistic, is that the market price is affected only gradually over time by a programme of additional actions, with less of an immediate price fall and a slower subsequent escalation rate to reach the eventual price  $P_s$ . This would give a price track between those with and without additional actions estimated here, and would thus show a somewhat reduced waterbed effect. The effect of the assumption of a full and immediate effect on the market price is therefore to tend to overstate the price response, and therefore the extent of the waterbed effect.

The results of the analysis are summarised in Table A1 below. The greater different in emissions in the later years is due to the greater absolute difference in price.

**Table A1: summary of waterbed effect**

Year	Without Additional Action		With Additional Action		Difference (Increase in emissions)	
	Price	Resulting Abatement	Price	Resulting Abatement	Increase in allowance demand	Increase in demand as percentage of average additional action
<b>2016</b>	4	8	2	4	4	2%
<b>2020</b>	7	13	3	6	7	3%

<b>2025</b>	11	21	5	10	11	5%
<b>2030</b>	17	34	8	16	18	8%

### Comparison of price tracks with Point Carbon analysis

The escalation rate on price here is smaller than that assumed by Point Carbon in their price forecasting over the next four years. Point Carbon projects price increases (and therefore rates of return for those holding EUAs as financial assets) of over 30% p.a. in the remainder of this decade. Prices then escalate and a rate close to the assumption we have adopted in our modelling. The very high escalation rates over the next four years assumed by Point Carbon lead to their price projections being consistently above the price levels we have assumed.

	Without rebasing		With rebasing	
	Price (€/t)	Growth Rate from previous (% p.a.)	Price	Growth Rate from previous (% p.a.)
<b>2016</b>	4	n/a	4.5	n/a
<b>2020</b>	12	32	15	35
<b>2030</b>	33	11	42	11

## Annex 2: Robustness of emissions savings from additional actions

In this report additional actions are assumed to result in an initial emissions saving, which may be balanced by increases elsewhere due to the functioning of the EU ETS cap. This Annex considers the circumstances in which the types of action shown in Table 1 result in emissions savings.

**Energy efficiency** directly reduces the demand for electricity or combustion energy, thus reducing emissions. The only exception to this would be if the system were oversupplied with renewables, and their use were curtailed further by energy efficiency programmes. This is likely to be the case only for a small proportion of the year at most.

**Additional deployment of renewables** almost always displaces fossil generation and so reduces emissions.

The **closure of lignite plant**, which is the most emissions intensive form of electricity generation, will be replaced by less emissions intensive sources, so again reduces emissions.

**Replacing coal plant with less carbon intensive generation**, from gas, nuclear or renewables also results in a direct saving.

The **closure of all coal plant in weakly interconnected markets** will also reduce emissions, because the generation will be replaced by less carbon intensive sources.

The **action of a national carbon tax** also reduces emissions to the extent that it increases efficiency or results in more carbon intensive sources of electricity generation being displaced.

**Reduction of output from coal plant in strongly interconnected markets**, either by closure or a carbon tax, opens up the possibility that the plant may be replaced by other coal plant currently running below capacity. Whether this occurs depends on detailed operating regimes. It has been estimated that this may occur to some extent in the Netherlands (see <http://www.nltimes.nl/2016/07/13/report-closing-all-dutch-coal-plants-by-2020-to-cost-e7-billion/>) However this is unlikely to apply in the case of large scale closures of coal plant, as there would not be enough alternative plant to increase generation in the event of closure in any case.

## Annex 3: Comparison with other work

A recent study by the consultancy Ecofys<sup>23</sup> also examined the waterbed effect. It looked specifically at the closure of Dutch coal plants. The study found that in response to the closure of coal plants there would be increased emissions elsewhere comprising:

1. Additional emissions from alternative electricity generation to the extent that the alternative is not carbon-free.
2. A small amount of additional emissions from a decrease in the EUA price
3. A surplus which would either stay in circulation or go into the MSR and return to the market at a later date, thus representing a delay in emissions.

This is broadly in line with our conclusions in this study. However, Ecofys' analysis appears to foresee less of a delay in returning allowances to the market, which appears to reflect estimates by some third party analysts of a smaller surplus than we expect<sup>24</sup>.

The study notes in passing that if more widespread national measures are adopted this will have a correspondingly larger effect on the EU ETS and MSR, as is shown by our analysis. However, the Ecofys study does not explore this further. They also note that modifications to the EU ETS to take account of national measures could affect outcomes, but again their report does not explore this further.

Ecofys' conclusions are thus broadly in line with those of this study, although they do not cover all of the issues raised here.

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<sup>23</sup> <http://www.ecofys.com/en/news/the-waterbed-effect-and-the-eu-ets-study-now-available-in-english/>

<sup>24</sup> They cite studies by European Environment Agency, 2015a, PBL & NEa, 2014, DEHSt, 2014, Thomson Reuters Point Carbon, 2014, and Sandbag, 2015, showing the surplus decreasing to below 833 Mt between 2025 and 2032. Sandbag's work suggests that there will be no volumes released before 2030.



## About this briefing

We are grateful to the European Climate Foundation for helping to fund this work. Full information on Sandbag and our funding is available on our website ([www.sandbag.org.uk](http://www.sandbag.org.uk)).

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