bruegelpolicybrief
ISSUE 2013/02
APRIL 2013

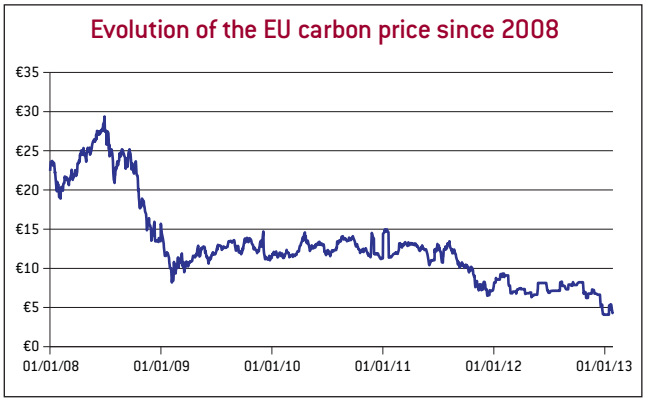
YOU'D BETTER BET ON THE ETS

by Georg Zachmann
Research Fellow at Bruegel
georg.zachmann@bruegel.org

THE ISSUE The European Union's emissions trading system (ETS), introduced in 2005, is the centerpiece of EU decarbonisation efforts and the biggest emissions trading scheme in the world. After a peak in May 2008, the price of ETS carbon allowances started to collapse, and industry, civil society and policymakers began to think about how to 'repair the ETS'. However, the ETS is an effective and efficient tool to mitigate greenhouse gas emissions, and although prices have not been stable, it has evolved to cover more sectors and greenhouse gases, and to become more robust and less distorting. Prices are depressed because of an interplay of fundamental factors and a lack of confidence in the system.

POLICY CHALLENGE

The ETS must be stabilised by reinforcing the credibility of the system so that the use of existing low-carbon alternatives (for example burning gas instead of coal) is incentivised and investment in low-carbon assets is ensured. Furthermore, failure to reinvigorate the ETS might compromise the cost-effective synchronisation of European decarbonisation efforts across sectors and countries. To restore credibility and to ensure long-term commitment to the ETS, the European Investment Bank should auction guarantees on the future emission allowance price. This will reduce the risk for low-carbon investments and enable stabilisation of the ETS until a compromise is found on structural measures to reinforce it in order to achieve the EU's long-term decarbonisation targets.



Source: Datastream. Price per EU emission allowance.

THE EUROPEAN UNION'S EMISSIONS TRADING SYSTEM (ETS) has had a bumpy start. In particular, after a peak in May 2008, the price of tradeable emission allowances has collapsed for various reasons (see section 3). This collapse has resulted in calls from industry, civil society and policymakers to 'fix' the ETS. But is it really broken? Despite its problems, the ETS has significantly evolved to cover more sectors, more countries and more greenhouse gases. The allocation of allowances has become less distorting. The treatment of emission rights from outside the EU has become stricter. Fraud has been made more difficult. The ETS entered its third phase, at the beginning of 2013, as a more mature system.

1 THE ETS WORKS

The ETS is a classical cap-and-trade system specifying a cap for annual greenhouse gas emissions and allocating a corresponding amount of allowances to companies covered by the scheme. By definition, as this cap has decreased, emissions have also been reduced. Excluding the countries that have entered the scheme since 2005 (Bulgaria and Romania joined in 2007 and Norway has participated since 2008) greenhouse gas emissions from ETS participating installations declined by about 14 percent between 2005 and 2012 (Figure 1).

Significant emission reductions were achieved by the tightening up of the system between the first and second trading periods (2005-07 and 2008-12) (Abrell *et al*, 2011). A year-on-year emission reduction of 3.6 percent appears to be due to the tightening of the system. It is not explained by reductions in firm output caused by changing economic conditions and reduced production in Europe (Table 1).

In addition, there is evidence that significant emission reductions already took place before the start of the ETS in order to comply with the system from the beginning (Ellerman and Buchner, 2006; Brewer *et al*, 2009; Ellerman *et al*, 2010). Consequently, the ETS has been able to achieve its purpose – stimulating additional emission reductions.

The instrument of carbon trading was chosen in order to allow differentiation of carbon abatement efforts in different sectors. And indeed, different sectors exhibited different emission-reduction strategies (Figure 2). This is good news. It is in line with the hypothesis that different sectors have different marginal abatement costs, and the ETS is able to induce the cheapest carbon reductions.

Table 2 shows that non-metallic minerals and basic metals were responsible for the main part of the emission reductions observed during the shift from the first to the second trading periods, while there has been no significant additional effect for the energy and paper sectors (Abrell *et al*, 2011).

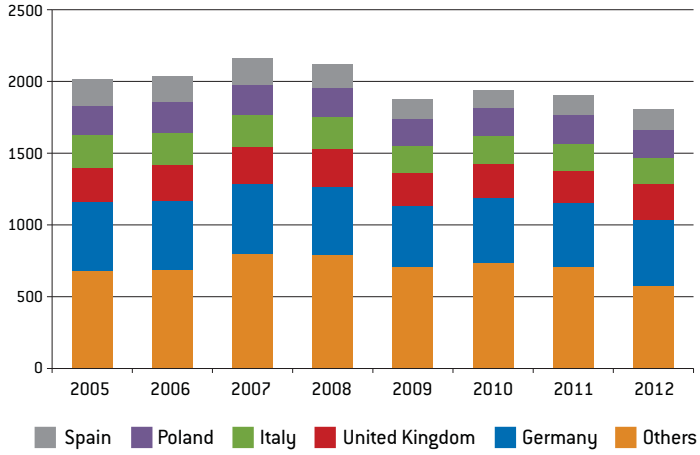
We conclude that the ETS is achieving its aim of keeping emissions in the sectors that it covers under the cap. As the number of allocated allowances is irresistibly declining by 37 million EU allowances (EUAs) each year, emissions will have to continue to decline.

Table 1: Relative change in the growth rate of emissions between (2005-05) and (2007-08)

Reductions caused by the shift to the second period		-3.6%**
Control variables	Changes in turnover	19.1%***
	Changes in employment	0.07%

Source: Abrell *et al* (2011). Note: significance: ** at 5% and *** at 1%.

Figure 1: Country-level verified ETS emissions, million tonnes CO2



Source: Bruegel based on CITL.

Table 2: Relative change in the growth rate of emissions between (2005-06) and (2007-08) by sector

		Pulp & paper	Non-metallic minerals	Basic metals	Electricity & heat
Reductions caused by shift to the 2nd period		-2.9%	-8.7%***	-9.5%*	-0.1%
Control variables	Changes in turnover	15.4%**	29.9%***	8.9%	13.6%**
	Changes in employment	-6.2%	-4.6%	9.9%	1.2%

Source: Abrell *et al* (2011). Note: significance: * at 10%, ** at 5 % and *** at 1%.

2 THE SURPLUS

Since 2008, more EUAs have been issued each year than were used[1], leading to a substantial stock of allowances in circulation. Several fundamental factors are responsible for this surplus. First, industrial production in Europe was strongly affected by the 'Great Recession'. While production grew between 2003 and 2007 by almost three percent per year, it decreased by almost two percent per year between 2008 and 2012. In turn, demand for allowances substantially decreased. Assuming an annual decline of the allowance demand of five percent compared to the baseline, the annual demand reduction from 2008 to 2012 would be more than 100 million tonnes.

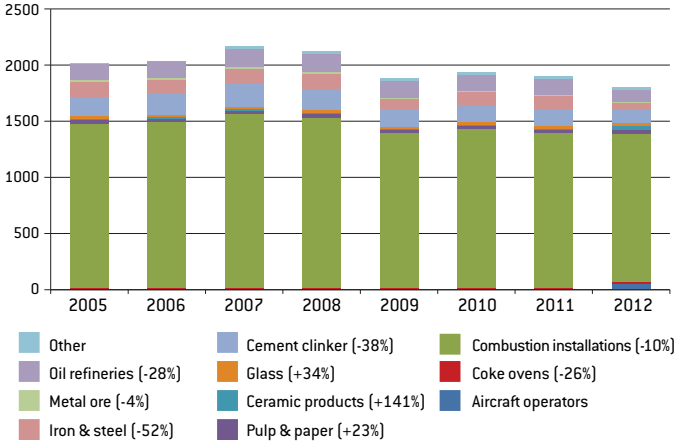
Second, the ETS is only one of several instruments of European climate policy. Energy efficiency policies and renewable energy promotion also lead to carbon reductions. Meeting the EU 20 percent energy efficiency target and the 20 percent renewables target reduces the need for fossil-fueled electricity generation – the largest contributor to emissions covered by the ETS. The production of electricity from solar and wind in the EU doubled from 105 TWh (terawatt hours) in 2008 to 214 TWh in 2012[2].

Third, emission reductions from outside the EU are allowed into the ETS in the form of additional credits. In the ETS second phase, EU legislation allowed 1,420 million tonnes (ie 284 million tonnes per year) of carbon reductions from outside the ETS to be used instead of European emission allowances[3]. This option has been widely used, also because no other country or region has allowed such a generous monetisation of foreign emission reductions.

Fourth, according to the European Commission (2012), some additional 500 million allowances from three exceptional sources have been brought to the market in 2012/2013: 1). Unused allowances from the second phase national new entrants reserves[4] were auctioned at the end of the second phase. 2). The European Investment Bank is selling a fixed amount of third-phase allowances in order to fund a number of carbon capture and storage and innovative renewables projects (NER300 programme)[5]. 3). Some third-phase allowances have been auctioned early in order to avoid the scarcity that was feared at the time the climate package was negotiated in 2008/2009.

As emission allowances not used in the second trading period (2008-12) can also be held over and used in the third trading period, a surplus of *"well over 1.5 billion allowances, and even as large as 2 billion allowances"* might have accumulated at the start of the third phase[6,7].

Figure 2: Sector-level verified emissions (reductions 2005-12 in brackets)



Source: Bruegel based on CITL. Note: million tonnes of CO2.

3 THE EMISSION PRICE SLUMP

A temporary surplus of allowances is not necessarily a problem for the ETS. As the system is to run indefinitely with a constantly decreasing annual

1. See www.eea.europa.eu/data-and-maps/data/data-viewers/emissions-trading-viewer.

2. See www.entsoe.eu/data/data-portal/production/.

3. Trotignon (2011).

4. The national new entrants reserves were set up to distribute free allowances to new carbon-emitting installations in order to not put them at a disadvantage compared to existing installations that obtained allowances for free in the second phase of the ETS. Not all of the reserved allowances were used.

5. Article 10(a) 8 of the revised Emissions Trading Directive 2009/29/EC contains the provision to set aside 300 million allowances for subsidising innovative clean energy installations.

6. European Commission (2012).

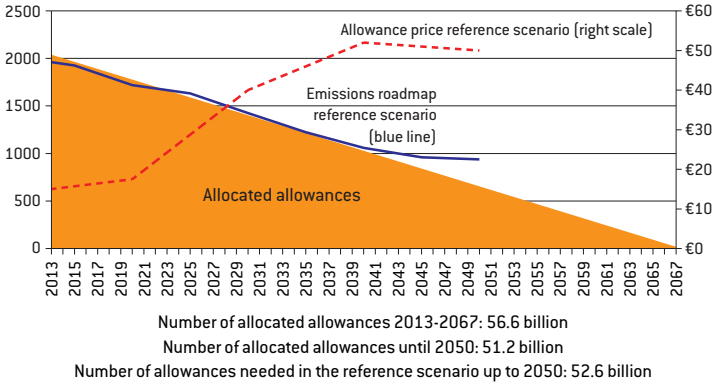
7. The relative importance of the four factors for the surplus is difficult to disentangle. An upper bound for the contributions of the individual factors between 2008 and 2012 is in the range of 500 million tonnes from the recession, 1420m tonnes from international credits, 200m

supply of new allowances it is in fact neither likely nor desirable that the system is tight at every point in time. Using cheap emission-reduction opportunities early to save some allowances for the future is a sensible strategy both from a company and from a social perspective. Such efficient intertemporal arbitrage was explicitly permitted in the legislation by allowing the 'banking' of allowances between trading periods.

However, the decline in allowance prices (see front cover figure) indicates that the possibility of storing the surplus allowances to sell them at a later stage has not stabilised prices today. There are two possible reasons for this: either there are too many allowances in the system even in the long term, or the system as such is not credible.

On the first possibility, according to the European Commission's own analysis the number of available allowances (see orange triangle in Figure 3) will exceed the number of required allowances (see the blue line in Figure 3) until about 2023. After 2025, the banked allowances will start to be used up as emissions exceed annual allocations. Prices will have to reach €40 by 2030 to keep emissions below 1400 million tonnes per year in the European Commission's reference scenario[8]. The current allowance price of €5 could thus indicate that market participants expect – in contrast to the reference scenario – that the present oversupply will continue (for example due to persistently lower growth[9], reinforced complementary energy policies and/or technological breakthroughs that make carbon-abatement significantly cheaper). But to date, a laxer ETS demand-supply balance in 2030 appears no more likely than a tighter than expected balance. Significantly higher prices would for example be possible if some decarbonisation technologies do not prove economically viable (for example carbon capture and storage, or offshore wind) or if Europe decides to step up the ETS in order to meet stringent 2050 decarbonisation targets[10].

Figure 3: Future development of the ETS (million tonnes CO2, left scale)



Number of allocated allowances 2013-2067: 56.6 billion
Number of allocated allowances until 2050: 51.2 billion
Number of allowances needed in the reference scenario up to 2050: 52.6 billion

Source: European Energy Exchange. Notes: reference scenario emissions refer to the sectors currently covered by the ETS: power generation/district heating, energy and industry; emission allowance prices are linearly interpolated between the values disclosed in the Roadmap and, as no initial value is provided, €15 is assumed for 2013.

A second rationale for low emission prices today is that the entire system is not credible. The ETS is a politically created market that fundamentally depends on the long-term commitment of policymakers to maintain the system as the cornerstone of EU decarbonisation efforts. But all long-term policies are confronted with the difficulty that policymakers have to commit to stable regimes beyond their electoral mandates, and sometimes even their generation. Such commitments are only credible when future compliance remains cheaper than non-compliance. With the ETS, policymakers commit to make future consumers pay high prices for carbon, in order to make investment today in low-carbon technologies attractive. This commitment is hardly credible given that (1) EU policymakers might find it difficult to accept the continuation of stringent decarbonisation policies if other countries do not follow suit in due course[11] and (2) maintaining a high carbon price that largely serves to render past low-carbon investments profitable might become politically difficult[12]. Even though the decreasing allocation within the ETS is enshrined into legislation, policymakers can at all points in time shift the demand-supply balance within the system by including new sectors, changing the treatment of international credits or providing additional incentives for carbon reductions within certain countries and/or sectors covered by the ETS. This can have a significant impact on future carbon prices. The non-negligible risk that future policymakers will take measures that obliterate the ETS to avoid carbon price hikes or

tonnes from renewables, 150 m tonnes from energy efficiency, 500 million tonnes from exceptional allowance allocations.

8. This scenario is based on current policies but does not include the effects of the recession, international credits and aviation – but even if those are included the demand and supply balance is likely to cause carbon prices substantially in excess of €50 as soon as carbon capture and storage is required to prevent industrial emissions to exceed the cap.

9. McKinsey (2009) estimates that a reduction of average 2005-30 GDP growth from 2.1 percent to 1.8 percent will cause Europe's emissions to drop by only 6 percent compared to the baseline in 2030. Loosely speaking, the carbon price level predicted in the Commission's reference scenario will be reached 3-4 years later.

10. According to the EU Energy Roadmap 2050 the ETS price might then increase to more than €200 in 2050.

11. A decision on an international agreement to restrict greenhouse gas emissions in the most important economies

to tackle continued carbon leakage is undermining the carbon price today.

Consequently, we consider that the currently observed price slump is more due to a lack of long-term credibility of the ETS, than to a structural reduction of the cost of compliance with the current system. The current low price of emission allowances, which given an expected carbon price of €40 in 2030 would imply a 13 percent annual return, indicates that the ETS is less credible than the sovereign bonds of, say, Pakistan (Caa1 negative Moody's rating), which are due in 2036 and currently yield 12 percent[13].

4 DEALING WITH THE PRICE SLUMP

The current low carbon price could put long-term decarbonisation in Europe at peril by incentivising long-lived high-carbon investments that lock-in future emission patterns, such as lignite-fired power plants. It could also destabilise the ETS by encouraging national measures (see Box 1).

To stabilise the ETS, the European Commission has proposed a measure to reduce the immediate surplus and several policies to strengthen the system in the longer term.

To reduce the immediate surplus, the Commission proposed in November 2012 to temporarily take allowances worth six month of EU emissions (900 million tonnes) out of the trading system, and sell them in 2019 and 2020 rather than 2013-2015. This 'backloading' is supposed to boost carbon prices that dropped below €5 per tonne. The European Parliament is expected to vote on the plan in mid-April 2013.

In its current form, backloading can be seen as a political placebo. In pure economic terms, it is not a cure because shifting the allocation of some excess allowances by some years does not change the underlying value of the allowances[14]. In political terms, the argument is that politically agreeing on an economically ineffective treatment such as backloading is at least an acknowledgment by policymakers that there is a problem with the system that they are willing to rectify, and could pave the way for structural measures. Furthermore, there is an implicit threat by the Commission that eventual structural measures will essentially consist of cancelling the set-aside allowances – hence shaping market participants' expectations that the backloading might not be a temporary but a permanent measure. Even though economically ineffective, we cannot determine to what degree backloading is a valuable political signal and/or will be effective in terms of market psychology.

But there is a cost to using placebos: the credibility of future treatments. Backloading seeks to create credibility in a system by politically infringing on it. The ETS is enshrined in legislation that is very difficult to change, and foresees a linear decline in carbon emissions even beyond 2050. Demonstrating that the system can be politically controlled might backfire in the long term. Why should market participants that have to take investment decisions that will have an impact for forty or more years care about a price signal that can so easily be manipulated by a political decision in 2013? Creating long-term credibility in a market in which supply and demand can be largely determined by policymakers is very difficult. But long-term credibility is essential to drive private investment into low-carbon technologies that will only pay back after decades. Furthermore, backloading is – notwithstanding the long-term risk to reputation – an almost costless exercise and hence only of limited value as a signal.

BOX 1: THE RISK OF A SELF-FULFILLING PROPHECY

The current surplus is regarded by some observers as a sign of political neglect of the ETS. The political acceptance of a prolonged phase of depressed allowance prices might motivate some member states to pursue complementary decarbonisation policies. The United Kingdom, for example, is introducing a national carbon floor price that is supposed to exceed the EUA price. The higher cost of carbon emissions in the UK will incentivise additional emission reductions. Lower emissions in the UK translate into a lower demand for EU emission permits. Any permit made redundant in the UK will ultimately be sold in the rest of Europe – leading to lower ETS prices. This could incentivise other countries to follow the example of the UK and hence there is a danger that national policies essentially substitute the ETS. The ETS could become ineffective because of national policies that assume that it is ineffective – a classic self-fulfilling prophecy.

has been deferred, and ultimate failure is far from impossible.

12. See Brunner *et al* (2011) for an in-depth discussion of the carbon commitment problem.

13. This is in line with Neuhoff *et al* (2012). The authors argue that companies that intend to emit carbon in the near-to-medium-term future already acquired sufficient allowances in order to hedge against rising allowance prices. Consequently only speculators that require substantially higher risk premia will do intertemporal arbitrage.

14. Even if all excess allowances are taken out of the system to make it immediately binding and hence prices pick up in the short term, backloading will certainly not incentivise investments into low-carbon technologies with long economic lifetimes, as the prices will drop as soon as the allowances are reintroduced.

Consequently, the long-term cost of backloading might be greater than its short-term benefits.

The proponents of backloading see it as a means to politically pave the way for structural measures and bridge the current lack of scarcity until such structural measures are implemented. In 2012 the Commission proposed six different structural measures (Table 3).

The measures A to E would tighten the demand-supply balance for emission allowances. This is sensible if there is a desire to step up the decarbonisation effort from that currently foreseen in the ETS Directive to that foreseen in the Commission's Roadmap 2050[15]. The ETS Directive prescribes a linear reduction of 1.74 percent of the average allocation of allowances in 2008-12 – about 37 million EUAs. This would lead to an allocation of about 654 million EUAs in 2050, which is about 68 percent below the 2013 emissions covered by the ETS. In contrast, the European Commission's Roadmap 2050 foresees an economy-wide emissions reduction of 80 to 95 percent of 1990 levels by 2050[16]. The Roadmap 2050 has been welcomed by the EU Council but the 80 to 95 percent decarbonisation target was not formally adopted[17]. Some member states – especially Poland – have strong reservations about tightening the ETS. The same holds true for measure F. Such discretionary price-management mechanisms would imply a paradigm shift from a pure quantity-based to a price-based mechanism. Consequently, the political discussion on the structural proposals of the Commission will take several years and the outcome is uncertain.

Thus, neither backloading nor starting a discussion on structural measures are sufficient to make market participants believe that the ETS will remain as the cornerstone of EU decarbonisation policies. Furthermore, the long-term commitment problem is not dealt with by any of the proposals.

5 REESTABLISHING CONFIDENCE

To establish the necessary confidence in the ETS, policymakers need to credibly commit to the system. Such a commitment is typically achieved by increasing the cost of future non-compliance. Building up a valuable reputation for credibility through a history of compliance in political transactions is currently not an option (but backloading might destroy some 'reputation'). External commitment devices – such as international carbon reduction arrangements – in which an external actor punishes domestic non-compliance, are currently also not conceivable. An internal commitment mechanism that rests on borrowing reputation from established institutions appears to be the only viable option.

One such promising mechanism (initially proposed by Ismer and Neuhoff, 2009; Pizer, 2011; and others) consists of selling guarantees of the future carbon price. This could be organised in the form of a private contract between those making low-carbon investments and the public sector. A public bank would offer contracts that agree to pay in the future any positive difference between the actual carbon price and a target level[18]. Investors would bid to acquire such contracts to hedge their investments. This would produce three benefits: first, the public bank would be able to collect initial payments (a sort of insurance premium) and make a profit if a sufficiently tight climate policy is maintained. Second, the private investor significantly reduces its exposure to the – political – carbon market and hence accepts longer pay-back times for its investments. This would unlock long-term low-carbon investments that are currently too risky. Third and most importantly, public budgets would be significantly exposed to the functioning of the ETS. If future climate policymakers take decisions that lead to increases in the number of available EUAs, they might be called back by the treasuries, be-

Table 3: Structural measures proposed by the European Commission

Option	Content
A)	Increasing EU reduction target to 30 percent in 2020 (achievable via b or c);
B)	Retiring a number of allowances in phase III (2013-20);
C)	Early revision of the annual linear reduction factor from 1.74 percent per year to a faster rate of decline;
D)	Extension of the scope of the ETS to other sectors;
E)	Restrict access to international credits;
F)	Discretionary price management mechanisms.

Source: European Commission (2012).

15. See European Commission (2011).

16. Considering the disproportionate decarbonisation burden allocated to the ETS sectors (-93 to -99 percent for power, -83 to -87 percent for industry versus -54 to -67 percent for transport), and the decarbonisation already done by these sectors between 1990 and 2012, the Roadmap 2050 would require an 80 to 95 percent reduction in the ETS sectors compared to 2013 levels (see European Commission, 2011).

17. Poland also vetoed Council conclusions on the Roadmap in 2012 because they contained emissions reduction targets after 2020. There is some legal question around whether unanimity is required for this. See http://www.europeanvoice.com/article/2012/november/meps-back-qualified-majority-decision-at-climate-talks/75789.aspx.

18. In technical terms this is a 'put option on the carbon price'.

cause this would activate the guarantees pledged to investors. Consequently, all parties – also investors not covered by the scheme – would know that there is money on the table. This would serve as a much stronger and hence more credible commitment device for preserving the integrity of the ETS. The lower risk associated with the future carbon price would immediately imply a higher carbon price.

The scheme would introduce a soft form of a floor price by making it expensive but not illegal for policymakers to accept very low carbon prices in the future. At the same time, the possibility of future carbon policy shifts – which undermine the credibility of discretionary price management approaches such as auction reserve prices, which might be changed from one day to another – do not affect the guarantees given to investors under the guarantee scheme.

There would be significant freedom of scope in structuring such guarantee contracts. Important design elements are the amount of guarantees issued, the level of the target price, the exercise date (or date range), the reference price and the mode of allocating contracts (eg by tender or by auction). Policymakers might also decide to sell products differentiated by exercise date and/or target price.

The implementation of a scheme such as we have proposed could be but does not necessarily have to be done by the EIB. As a European public bank backed by member-state taxpayers' money, the EIB would be a credible counterpart for writing such guarantee contracts. Legally, it is plausible that only the governing council of the EIB, consisting of the finance ministers of the member states, would have to agree to such an operation by simple majority.

The auctioning of a limited number of long-term carbon price guarantees could be used to stabilise the current, functioning system around the already-agreed linear reduction factor. It would provide flexibility for policymakers to change future climate policy and at the same time

BOX 2: THE PROPOSAL IN PRACTICE

To give one example, the European Investment Bank (EIB) might be asked to auction off guarantees for buying back one billion allowances for the year 2030 at a target price of €40.

(1) Fair price of the guarantee:
The guarantee to be allowed to sell an emission allowance in 2030 at €40 is worth slightly more than the discounted guaranteed price (at a two percent interest rate this is €28.57) minus the current cost of an allowance (currently €5), ie €23.57[19]. Consequently, with no change to the carbon price, the EIB would produce significant upfront revenues from selling guarantees.

(2) Confidence in the system increases:
As a consequence of the political commitment to buy back one billion allowances in 2030 at a price of €40, market participants will understand that it is cheaper for future policymakers to stabilise the ETS, than to allow it to fail and thus to have to pay the insured companies. Hence, regulatory uncertainty will diminish and risk premia will decline. This will encourage long-term investment in low-carbon technologies that crucially depend on the future carbon price and that are currently too risky. Furthermore, the ability to bundle allowances and guarantees into a safe asset would allow companies to more easily refinance their low-carbon projects through financial markets (asset-backed securities). Earlier long-term investments in low-carbon technologies should allow Europe to pursue a smoother and hence cheaper decarbonisation pathway.

(3) The current EUA price will rise:
With the reduced risk premia, intertemporal arbitrage will force the current carbon price to rise. One focal point for the current price is the expected 2030 price of €40 discounted at a risk-free interest rate of two percent. This would be €28.57.

With increasing current allowance prices, the incomes for national treasuries will increase as they auction off their annual allocations of allowances. At the same time, the income of the EIB from selling guarantees will shrink. It might make sense to compensate for this implicit transfer.

19. The reason for this is that the portfolio of an allowance and a guarantee would yield more than €28.57 if the allowance price rises above €40 (the present value of a carbon price of €50 is €35.70). If the carbon price is with 14 percent probability €50 and otherwise €0, the value of the portfolio would be €29.57. Minus the cost of the allowance this is €24.57.

would socialise the cost that such shifts have for locked-in low carbon investors. This will unlock low-carbon investment. In addition, the guarantees would restore credibility in the ETS. This will increase current carbon prices and hence result in more immediate abatement.

Notwithstanding this operation, the current ETS linear emission reduction factor is not sufficient to meet the 2050 decarbonisation target set out in the Commission's Roadmaps. Hence, a further tightening of the system – requiring a change to the directives – would be necessary to achieve the 80-95 percent decarbonisation target by 2050. In the light of the current economic situation and the uncertain state of international climate negotiations, an early and credible European commitment to increase the reduction factor appears politically difficult. It is thus crucial to quickly stabilise the ETS in order to allow it to continue to play its important role of cost-effectively synchronising Europe's existing decarbonisation commitments.

Research assistance by Amma Serwaah is gratefully acknowledged.

REFERENCES

Abrell, Jan, Anta Ndoye Faye and Georg Zachmann (2011) 'Assessing the impact of the EU ETS using firm-level data', *Working Paper* 2011/08, Bruegel

Brewer, Thomas, Dora Fazekas, Michael Grubb, Robert Heilmayr and Misato Sato (2009) 'Climate Policy and Industrial Competitiveness: Ten Insights from Europe on the EU Emissions Trading System', *Climate & Energy Paper Series* 09, Climate Strategies

Brunner, Steffen, Christian Flachsland and Robert Marschinski (2011) 'Credible commitment in carbon policy', *Climate Policy* vol. 12, issue 2: 255

Ellerman, Denny and Barbara K. Buchner (2007) 'The European Union Emissions Trading Scheme: Origins, Allocation, and Early Results', *Review of Environmental Economics and Policy* 1(1), 66–87

Ellerman, Denny, Frank J. Convery and Christian de Perthuis (2010) *Pricing Carbon*, Cambridge University Press

European Commission (2011) 'A Roadmap for moving to a competitive low carbon economy in 2050', *Commission Communication* COM(2011) 112, and impact assessment SEC(2011) 1565

European Commission (2012) 'The state of the European carbon market in 2012', *Commission Communication* COM(2012) 652

Ismer, R. and K. Neuhoff (2009) 'Commitments through financial options: an alternative for delivering climate change obligations', *Climate Policy*, 9, 9-21

McKinsey (2009) *Impact of the financial crisis on carbon economics: Version 2.1 of the global greenhouse gas abatement cost curve*, available at http://www.mckinsey.com/client_service/sustainability/latest_thinking/greenhouse_gas_abatement_cost_curves

Neuhoff, Karsten, Anne Schopp, Rodney Boyd, Kateryna Stelmakh and Alexander Vasa (2012) 'Banking of Surplus Emissions Allowances: Does the Volume Matter?' *Discussion Paper* 1196, DIW

Pizer, William (2011) 'Seeding the Market. Auctioned Put Options for Certified Emission Reductions', *Duke University Policy Brief* NI PB 11-06, Nicholas Institute for Environmental Policy Solutions

Trotignon, Raphael (2011) 'Combining cap-and-trade with offsets: lessons from CER use in the ETS in 2008 and 2009', *Working Paper* 2011-03, Chaire Economie du Climat

Bruegel, Rue de la Charité 33, B-1210 Brussels, (+32) 2 227 4210 **info@bruegel.org** **www.bruegel.org**

bruegel