

One billion tonnes of CO₂ avoided by the EU power sector and industry since 2005: half due to energy-climate policies and half due to economic context

In October 2013, the European Environmental Agency revealed that the European Union had reduced emissions between 1990 and 2012 by approximately 18 %, close to the 20% emissions reduction target by 2020. On May 15th 2013, the European Commission had already announced that the verified CO₂ emissions generated by installations covered by the EU ETS amounted to 1,867 MtCO₂ in 2012, a 2% decline compared with 2011 and a 12% decrease since 2008. This means that CO₂ emissions have fallen at a rate of 2.6% per year during Phase 2 of the EU ETS (2008-2012), while the emission cap (excluding aviation) increased by 1% per year. Based on a “business-as-usual” scenario, we estimate that around 1.2 GtCO₂ were avoided between 2005 and 2011: around 30% of the reduction was the result of a fall in manufacturing output, while around 60% of the reduction was caused by the development of renewable energy and the improvement of the energy intensity. The carbon price revealed by the EU ETS, which was also weakened by the downturn and the roll-out of the renewable energy directive, does not seem to have been the main driver for domestic CO₂ emission reductions. Nevertheless, the price of CO₂ has also encouraged a reduction of 1,048 MtCO₂ in others sectors or beyond the EU, via the use of carbon credits arising from the CDM and JI mechanisms by EU ETS installations between 2008 and 2012.

Background: Phase 2 of the EU ETS, a target of - 10% of CO₂ emissions reduction compared with 2005

The 2nd Phase of the EU ETS is linked to the 1st Kyoto Commitment Period

The European Union, which has committed to reduce its CO₂ emissions by 8% in 2012 compared with 1990, has applied this target to each of its Member States, and has drawn up a joint policy, the European Union Emission Trading Scheme (EU ETS), in order to reduce the CO₂ emissions generated by the most emission-intensive power generation and industrial plants. Following an initial learning phase, the aim of Phase 2 of the EU ETS was to help the European Union and its Member States to meet their commitment, as defined by the Kyoto Protocol, for the First Commitment Period between 2008 and 2012.

Within the 27 Member States, the EU ETS is forcing 11,000 industrial and power generation plants to keep their CO₂ emissions below an annual cap of 2 billion CO₂ allowances. In addition of the allocation of 9.9 billion free allowances and of 0.4 billion auctioned allowances, operators who are subject to the cap could also use up to 1.4 billion credits generated by the Kyoto Protocol Project Mechanisms (CDM and JI) between 2008 and 2012.

The scope of the EU ETS was broadened during Phase 2, in order to include three States & the aviation sector

45% of the EU-27's overall CO₂ emissions were covered by the EU ETS in 2012. However, the share of the CO₂ emissions regulated by the EU ETS varied significantly with Member States, ranging from 80% in the Czech Republic to 17% in Luxembourg. The scope of the EU ETS changed over its Second Period, due to the inclusion of three new States, namely Iceland, Norway and Liechtenstein, which between them accounted for less than 1% of overall emissions in Phase 2. Lastly, the intra-European civil air transportation sector was also added as of 2012. This sector is not included in the following analysis.

Phase 1 outcome: 2.1% increase in CO₂ emissions on a comparable basis

Expectations for CO₂ emission reductions in Phase 1 were modest, as the European Commission's aim was actually to ensure that the system was properly implemented. Around 2.3 billion allowances were allocated every year, virtually all of which were free. The CO₂ emissions generated by installations covered by the EU ETS ultimately increased by 7.5% over the period between 2005 and 2007, primarily due to the inclusion of Romania and Bulgaria in 2007. The CO₂ emissions increased by 2.1% on a comparable basis in the phase 1 of the EU ETS.

Several studies have estimated the environmental outcome of Phase 1 of the EU ETS compared with business-as-usual scenarios: Ellerman and Buchner (2008) concluded that emissions had been reduced by between 50 and 100 million tonnes; while Delarue *et al.* (2008a and 2008b) estimated that the reduction was between 34 and 88 million tonnes in 2005, and between 19 and 59 million tonnes in 2006; lastly, Ellerman and Feilhauer (2008) estimated that the reductions ranged between 50 and 122 million tonnes. That role is actually disputed by Anderson and di Maria (2009), who found that CO₂ emissions were slightly higher than they would have been in the absence of the EU ETS.

News: CO₂ emissions fell by 12% during Phase 2 of the EU ETS

On 15th May 2013, the European Commission published the verified CO₂ emissions covered by the EU ETS, and showed that these emissions had decreased by 2% in 2012 compared with 2011. A review of the data disclosed by the European EUTL Registry enables the level of CO₂ emissions and the compliance levels of Member States and the sectors covered to be assessed.

If we exclude the aviation sector and Member States -Bulgaria, Romania, Iceland and Norway - which joined the ETS after 2005, CO₂ emissions decreased by 11.9% during Phase 2 (2008-2012), and by 12.3% over Phases 1 and 2 (i.e. between 2005 and 2012), i.e. an average annual decrease of 2.6% since 2005 (still on a comparable basis).

Table 1 – Verified EU ETS CO₂ emissions in millions of tonnes – excluding the aviation sector

Year	Phase 1			Phase 2				
	2005	2006	2007	2008	2009	2010	2011	2012
CO ₂ emissions	2,013.7	2,035.7	2,164.7	2,119.9	1,879.7	1,938.7	1,904.1	1,866.0

Source: CDC Climat Research, based on data from the EUTL

Two trends characterise Phases 1 and 2 of the EU ETS:

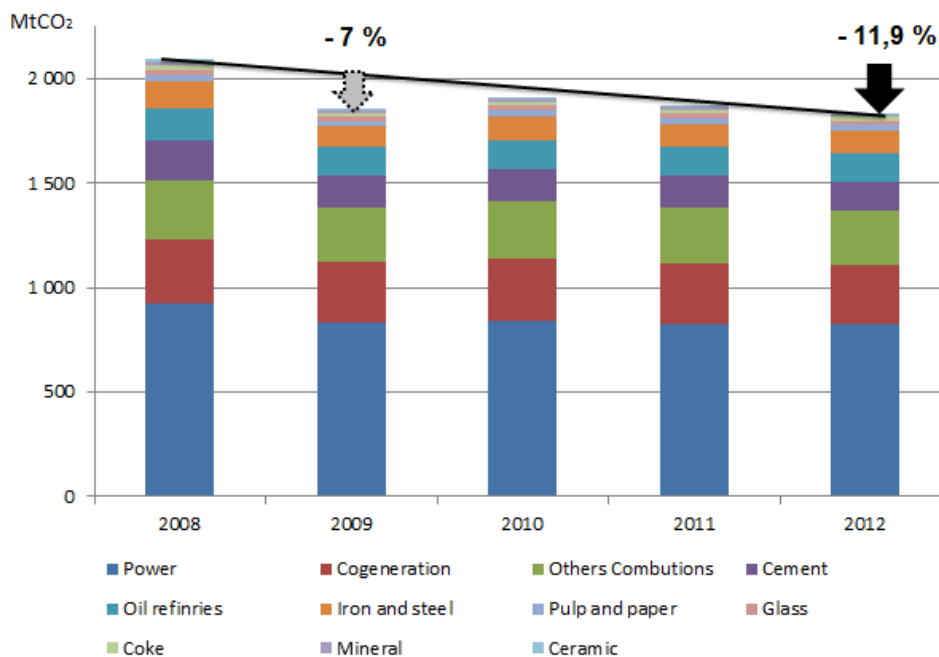
- A 2.1% increase in CO₂ emissions during the Phase 1 (+7.5% including Bulgaria and Romania in 2007),

- A hiatus in 2008, which marked the beginning of the 11.9% decrease in emissions during Phase 2. 2009 recorded the steepest annual fall, with an 11.3% fall in emissions, i.e. 150 million tonnes more than the average downturn during the Phase 2. In 2012, the CO₂ emissions generated by the aviation sector added 84 million tonnes.

CO₂ emissions fell in 22 Member States and across all sectors

All European countries saw a reduction in their emissions between 2008 and 2012, except for Malta and Estonia (see appendix 1). The sharpest fall (-31.5%) was recorded by Denmark (-31.3%), Romania (-31.2%) and Portugal (-30.8%), while CO₂ emissions fell by 4.7% in Germany, by 4.4% in the United Kingdom, and by 21.8% in France.

Figure 1 – Verified EU ETS CO₂ emissions, by sector and per year, excluding aviation

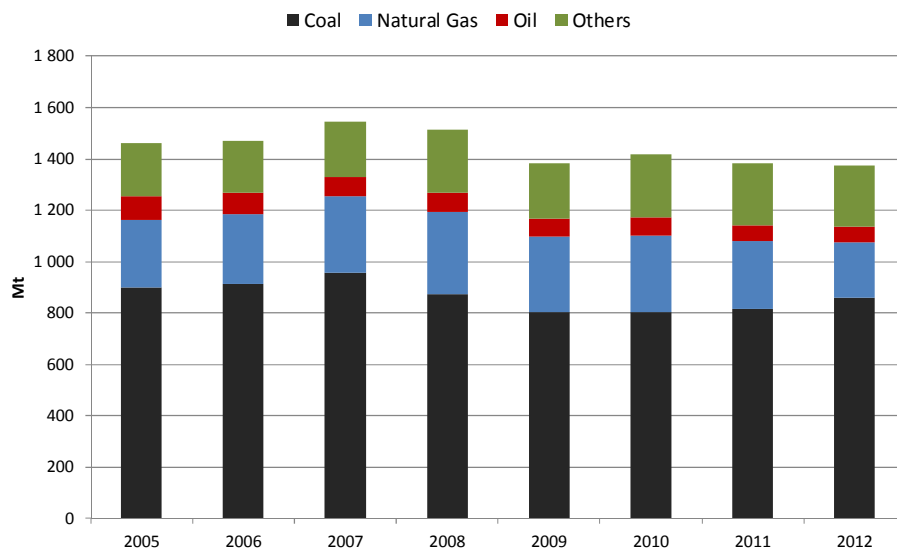


Source: CDC Climat Research, based on data from the EUTL

All sectors without exception saw their CO₂ emissions decrease sharply between 2008 and 2012, with reductions ranging from 9.3% for power generation and co-generation to 41% for ceramic products (see appendix 2). 50% of the steep fall observed in 2009 was due to the combustion sector alone, while the steel, cement and other combustion sectors were responsible for the remaining 50% overall. It is interesting to note that the electricity sector began to have a noticeable impact on the fall in CO₂ emissions from 2008 onwards.

Among power generation and co-generation units, gas and oil-fired power plants experienced the steepest fall in their emissions, which decreased by 34% and 30% respectively between 2008 and 2012. CO₂ emissions from gas-fired power stations fell from 273 to 175 million tonnes over the period. After falling sharply in 2008 and 2009, primarily due to the downturn, CO₂ emissions from coal-fired power stations actually tended to increase between 2009 and 2012, when they reached 846 million tonnes. This increase is explained by coal regaining its competitiveness as a fuel for thermal power plants in Europe, by the export of excess coal produced in the United States to Europe, and by the collapse of the carbon price in Europe, which no longer penalised coal-fired power stations in 2011 and 2012. This increase is also explained by the roll-out of renewable energy, which competes with gas-fired power plants, but not with so competitive coal-fired ones.

Figure 2 – Trend in CO₂ emissions for installations in the combustion sector



Source: CDC Climat Research, based on data from the EUTL and WEPP (Platts)

Compliance: a surplus of 1,742 MtCO₂ carried forward to the phase 3 of the EU ETS (excluding aviation)

The EU ETS ended Phase 2 with 1,742 million excess allowances, resulting from the difference between the allowance supply, which consisted of 9,996 million free allowances and 400 million allowances sold at auction, and 8,662 million returned allowances. Excluding the aviation sector, CO₂ emissions fell by around 2.6% per year between 2008 and 2012, at a time when allowance allocations were rising by 1% per year on average, the number of installations being increased by 7% over the period. All the years show excess allowances (Figure 3) except in 2008.

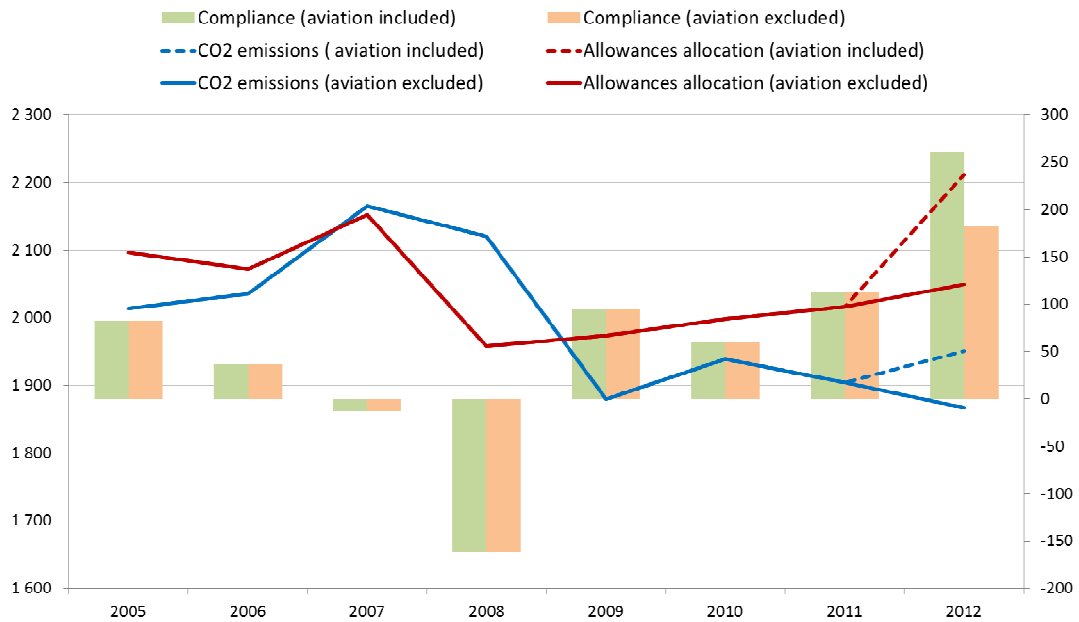
All sectors posted an overall net surplus, except for the power generation and co-generation sectors (Figure 4). Power generation recorded a 648 million tonne shortfall, while the co-generation sector recorded a 168 million tonne shortfall. In contrast, steel plants reached a large surplus of 356 million tonnes, while the surplus for cement plants was 281 million tonnes¹.

Most Member States recorded a similar annual compliance surplus or shortfall positions throughout Phase 2. However, large changes can be observed between Phase 1 and Phase 2. Spain and Italy reached a surplus allowance position during Phase 2 (Figure 5). The change in these countries' positions is largely explained by the steep fall in CO₂ emissions in the cement sector, on the one hand, and by the development of renewable energy, on the other. Likewise, the slowdown in business activity in the United Kingdom (especially in the steel and refining sectors), together with the 17% decrease in emissions from the energy sector, explains the change in that country's position.

Germany is in the exactly opposite situation, as it has moved from a slight net surplus of 1% in Phase 1 to a large shortfall of 10% in Phase 2. This swing could be explained by two factors. First, the fall in the cost of coal, combined with the shutdown of Germany's nuclear power plants, led the country to expand the coal-fired combustion power plant sector. Second, economic activity was relatively more resilient in Germany than in the rest of the EU, which caused more CO₂ emissions.

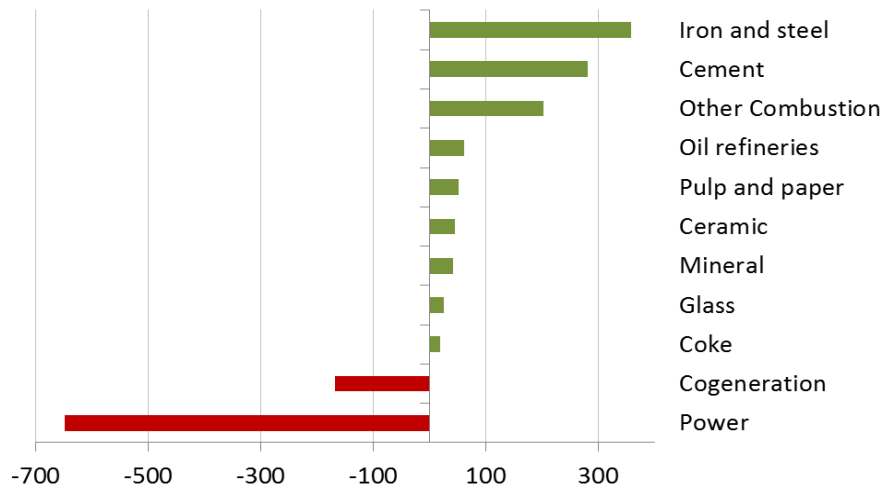
¹ Not all the compliance data are available for 2012.

Figure 3 – Change in CO₂ emissions and in the allowances allocated, in millions of tonnes (left-hand scale, and in compliance positions (right-hand scale)



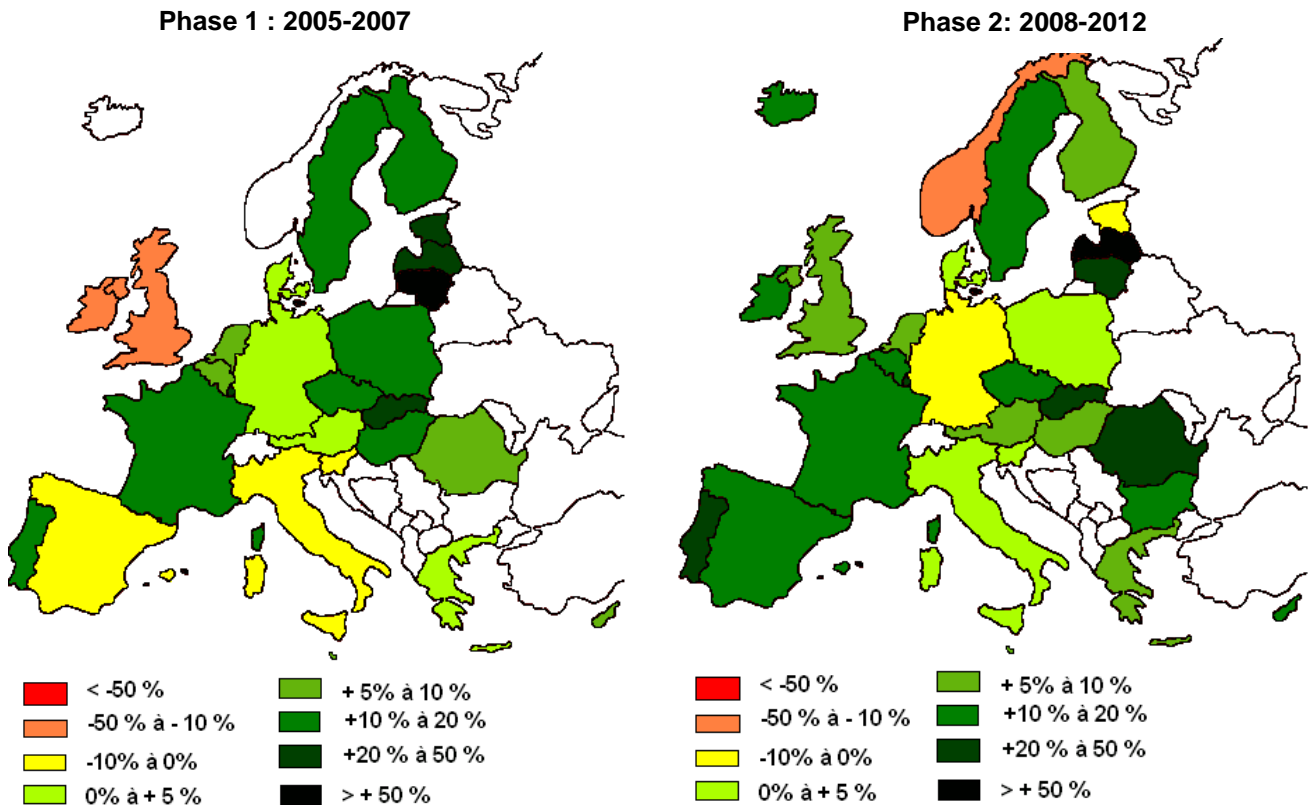
Source: CDC Climat Research, based on data from the EUTL

Figure 4 – The sectors' net compliance position in Phase 2 of the EU ETS



Source: CDC Climat Research, based on data from the EUTL

Figure 5 – Member States' net compliance positions: ratio of net positions based on verified emissions. The data include the allowances auctioned by some countries during Phase 2



Source: CDC Climat Research, based on data from the EUTL

Analysis: 30% of the CO₂ emission reductions were due to the economic downturn, while between 40 and 50% were due to the roll-out of renewable energy (RE)

A number of factors may explain the trend in CO₂ emissions generated by the installations covered by the EU ETS between 2005 and 2012:

- economic activity (output volumes and GDP for each country);
- short-term factors (weather, changes in the price of energy and carbon);
- long-term factors (investment in green technologies, improvement in energy efficiency, change in the power generation pool, including an increase in renewable energy's share of power generation);
- the off-shoring of CO₂ emissions to outside the European Union.

An econometric analysis² enables us to provide an initial estimate of the role played by the economic downturn and other factors in reducing CO₂ emissions. Compared with a business-as-usual scenario for the period between 2005 and 2011 – in which the economic downturn had not occurred, the roll-out of RE and the improvement in energy efficiency were in line with the trend for previous decades, the price of carbon was almost nil, and the price

² The analysis was performed on a sample of 21 countries and on variables monitored between 2005 and 2011. For further information on the econometric analysis, please see "Explanatory factors for the change in CO₂ emissions over both phases of the EU-ETS: an econometric analysis" by O. Gloaguen and E. Alberola, Working Paper No. 15, CDC Climat Research (2013).

of coal and gas were identical to their 2005 levels, the econometric model enables us to estimate that around 1.200 MtCO₂ of CO₂ emissions were avoided.

Based on this alternative scenario, the analysis of CO₂ emissions enables us to conclude that:

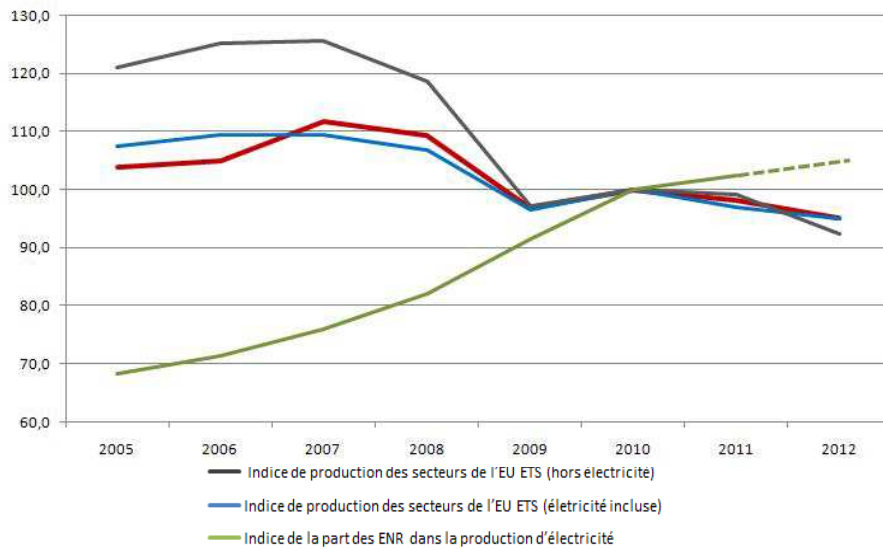
- manufacturing output, and therefore, the **economic downturn**, does indeed explain part of the recorded fall in CO₂ emissions, primarily the sharp decrease recorded in 2009, which accounted for around **30% of the emissions reduction recorded**;
- **Climate & energy policies explain between 50 and 60% of the fall in emissions**, with the abatement relating to and renewable energy and energy efficiency efforts³ accounting for between 40 and 50%, and 10 to 20% respectively. The price of carbon seems to have played a marginal role in terms of explaining changes in CO₂ emissions beyond its potentially endogenous impact on the aforementioned drivers; this role is estimated to account for between 0 and 10% of emissions reduction;
- The **energy price** and the substitution effect between coal and gas apparently explain between **10 and 20% of the fall** in CO₂ emissions.

Although the study tends to conclude that the price of carbon played a small role in the recorded fall in emissions, it is important to underline that the economic downturn, which relates to the development of renewables energies is responsible for the fall in said carbon price, and specifically marginalises its influence in terms of the CO₂ emission reductions at the installations covered by the EU ETS.

Do these results mean that the carbon price has been for nothing? No, for two reasons. First, the price of carbon released by the EUE TS has allowed reductions emissions at a lower cost than those obtained by the deployment of renewable energies – around 5-60 times less expensive than CO₂ emissions reductions from wind or solar (Marcantonini et al, 2013). Second, the presence of the CO₂ price played a positive effect on CO₂ emissions abatements in other sectors or countries beyond the EU. Indeed, it seems the interaction effect between the carbon price and renewables energies injections is consistently positive for the German electricity system, between 2006 and 2010, on the order of 0.5% to 1.5% of emissions (Weigh and al, 2012). However, this carbon price has to be at a high enough level to drive renewable energy deployment (Gavard, 2012). Lastly, the carbon price generated by the EU ETS also contributed to a 1,048 MtCO₂ reduction in emissions beyond the EU, via the use of international carbon credits arising from the CDM and JI mechanisms by the EU ETS installations between 2008 and 2012.

³ We should note that the two energy efficiency variables that were tested and taken into account in the model were total energy consumption per unit of GDP, and electricity consumption per GDP point. Both these variables also capture a series of impacts, including changes in the structure of the economy, changes in the energy mix (a typical example would be the shutdown of nuclear power stations in Germany, which increased the primary energy/GDP ratio due to the lower thermal efficiency of nuclear power) and the potential impact of the CO₂ price (via the investment of funds in the decarbonisation of the economy).

Figure 6 – Change in the CO₂ emissions covered by the EU ETS, in the output indices for the EU ETS sectors, and in the contribution of renewable energy to power generation, Index reference year (100) = 2010



Source: EUTL, Eurostat & CDC Climat Research

Conclusion

The CO₂ emissions generated by the installations regulated by the EU ETS have fallen by 12;3% since 2005 and by 11,9% during Phase 2 (2008-2012), reaching 1,866 MtCO₂ in 2012. Since the launch of the EU ETS, overall CO₂ emissions decreased by 2.6% per year between 2005 and 2012, at a time when the emission cap increased at a rate of 1% per year.

Two main factors explain the 1.2 GtCO₂ reductions between 2005 and 2011: around 300 MtCO₂ were due to the fall in manufacturing output, which resulted in a decrease in CO₂ emissions that was estimated at around 150 million tonnes for 2009 alone, while around 500 MtCO₂ were due to the increasing roll-out of renewable energy.

The carbon price generated by the EU ETS, which has fallen sharply since 2010, does not seem to have played a dominant role. However, we would stress that although the study concludes that the carbon price has played a minor role in the recorded fall in emissions, the backdrop of the economic downturn, which is related to the development of renewable energies, is very likely the cause of the fall in the CO₂ price, and specifically marginalises its influence.

Nevertheless, the CO₂ price plays a positive role on the decarbonisation of power and industrial sectors. First, the price of carbon released by the EUE TS has allowed reductions emissions at a lower cost than those obtained by the deployment of renewable energies (Marcantonini et al, 2013). Second, the presence of the CO₂ price played a positive effect on CO₂ emissions abatements in other sectors or countries beyond the EU. Indeed, it seems the interaction effect between the price of carbon and renewables energies injections (Weigh and al, 2012). Lastly, the carbon price induced by the EU ETS also contributed to a 1,048 MtCO₂ reduction in emissions beyond the EU, via the use of international carbon credits arising from the CDM and JI mechanisms by the EU ETS installations between 2008 and 2012.

To find out more...

News and database

- European Commission, press release: Emission trading scheme: 2012 saw a continuing decline in emissions, but a growing surplus of allowances, 16 May 2013
http://europa.eu/rapid/press-release_IP-13-437_fr.htm
- EUTL database, available on the European Environment Agency website
<http://www.eea.europa.eu/data-and-maps/data/european-union-emissions-trading-scheme-eu-ets-data-from-citl-5>

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Appendix 1 – CO₂ emissions in millions of tonnes for the EU ETS installations in each country; each country's share of overall CO₂ emissions expressed as a percentage, together with the change between 2008 and 2012 (excluding the aviation sector).

	2008	2009	2010	2011	2012	Total	% share	2008-2012 Change
Germany	472.9	428.4	454.9	450.2	452.3	2258.7	23.3	-4.3
Austria	32.1	27.4	30.9	30.6	28.4	149.3	1.5	-11.5
Belgium	55.5	46.2	50.1	46.2	43.0	240.9	2.5	-22.5
Bulgaria	38.3	32.0	33.5	40.0	35.1	178.9	1.8	-8.4
Cyprus	5.6	5.4	5.1	4.6	4.4	25.0	0.3	-21.4
Denmark	26.5	25.5	25.3	21.5	18.2	116.9	1.2	-31.5
Spain	163.5	136.9	121.5	132.7	135.6	690.2	7.1	-17.0
Estonia	13.5	10.4	14.5	14.8	13.5	66.8	0.7	0.0
Finland	36.2	34.4	41.3	35.1	29.5	176.4	1.8	-18.4
France	124.1	111.1	115.4	105.4	103.7	559.6	5.8	-16.4
Greece	69.9	63.7	59.9	58.8	61.4	313.7	3.2	-12.0
Hungary	27.2	22.4	23.0	22.5	21.3	116.4	1.2	-21.9
Ireland	20.4	17.2	17.4	15.8	16.9	87.6	0.9	-17.1
Iceland	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-
Italy	220.7	184.9	191.5	189.9	179.1	966.0	9.9	-18.9
Latvia	6.1	5.8	6.4	5.6	5.7	29.6	0.3	-6.3
Liechtenstein	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-94.5
Lithuania	2.7	2.5	3.2	2.9	2.7	14.1	0.1	-0.1
Luxembourg	2.1	2.2	2.3	2.1	2.0	10.6	0.1	-5.2
Malta	2.0	1.9	1.9	1.9	2.1	9.8	0.1	1.7
Norway	19.3	19.2	19.3	19.2	18.6	95.7	1.0	-3.9
Netherlands	83.5	81.0	84.7	80.0	76.4	405.7	4.2	-8.5
Poland	204.1	191.2	199.7	203.0	196.6	994.7	10.2	-3.7
Portugal	29.9	28.3	24.2	25.0	25.2	132.6	1.4	-15.7
Czech Rep.	80.4	73.8	75.6	74.2	69.3	373.3	3.8	-13.8
Romania	64.1	49.1	47.3	51.2	47.9	259.6	2.7	-25.3
United Kingdom	265.1	231.9	237.3	220.9	231.2	1186.4	12.2	-12.8
Slovakia	25.3	21.6	21.7	22.2	20.9	111.8	1.2	-17.4
Slovenia	8.9	8.1	8.1	8.0	7.6	40.7	0.4	-14.1
Sweden	20.1	17.5	22.7	19.9	18.2	98.3	1.0	-9.5
Total	2,119.9	1,879.7	1,938.7	1,904.1	1,866.9	9,709.3	100.0	-11.9

Source: CDC Climat Research, based on data from the EUTL

Appendix 2 – EU ETS CO₂ emissions by sector in millions of tonnes on a non-comparable basis (including Bulgaria and Romania in 2007)

	Phase 1			Phase 2					TOTAL
	2005	2006	2007	2008	2009	2010	2011	2012	
Combustion	1 460,1	1472	1545	1513	1383	1416	1381	1372	11 540,8
Cement	177,5	182,1	201	190,5	152,9	153,6	152	141,5	1 351,1
Refining	150,0	148,5	153,3	154,1	145,3	142,4	140,7	134,7	1 169,1
Steel	129,3	132,9	132,2	133,3	95,5	113,7	113,4	112,1	962,6
Paper	29,9	30	29,4	31,59	27,91	30,04	28,8	27,69	235,3
Glass	20,1	20,03	21,35	22,73	19,43	20,24	20,86	19,89	164,6
Coke	19,2	21,3	22,08	20,99	15,76	19,94	19,47	16,75	155,5
Other activities	0,2	0,157	20,8	22,72	19,89	21	25,93	20,87	131,5
Metal ores	12,6	14,05	24,94	17,66	11,04	13,24	13,15	12,28	119,0
Ceramic products	14,7	14,89	14,85	13,48	9,111	9,026	8,993	7,951	93,0
Aviation	0	0	0	0	0	0	0	83,78	83,8
Total	2 013,7	2 035,7	2 164,7	2 119,9	1 879,7	1 938,7	1 904,1	1 949,8	16 006,3

Source: CDC Climat Research, based on data from the EUTL

Appendix 3 – The EU ETS compliance: use of allowances and credits during Phase 2

	2008	2009	-{}-2010	2011	2012	TOTAL
Free allocation (A)	1 958	1 974	1 998	2 016	2 049	9 996
Auctions (AU)	44	78	92	93	99	407
Verified emissions (VE)	2 120	1 880	1 939	1 904	1 867	9 709
Gross market position (A+AU-VE)	-117	172	152	205	282	694
Allowances & credits surrendered						
EUAs (R)	2 010	1 839	1793	1 637	1 383	8 662
CERs	84	77	117	178	214	670
ERUs	0	3	20	76	279	378
Total Kyoto credits	84	81	137	254	493	1048
Net EUA surplus on the market (A+AU-R)	-7	213	297	472	766	1 742

Source: CDC Climat Research, based on data from the EUTL

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