Over-Allocation or Abatement?
A Preliminary Analysis of the EU ETS Based on the 2005-2006 Emissions Data

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Over-Allocation Or Abatement? A Preliminary Analysis of the EU ETS Based on the 2005-06 Emissions Data

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Abstract

This paper provides an initial analysis of the EU ETS based on the installation-level data for verified emissions and allowance allocations in the first two years of the first trading period. These data reveal that CO_2 emissions were about 3% lower than the allocated allowances. The main objective of the paper is to shed light on the extent to which over-allocation and abatement have taken place in 2005 and 2006, when a significant CO_2 price was observed. We propose a measure by which over-allocation can be judged and provide estimates of abatement based on emissions data and indicators of economic activity as well as trends in energy and carbon intensity. Finally, we discuss the insights and implications that emerge from this tentative assessment.

Keywords: Climate policy; European Union Emissions Trading Scheme; Data analysis

JEL Classification: C81, H41, O13, Q54, Q58

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1 Introduction

The release of installation-level data for verified emissions and allowance allocations for the first two years of the trial period for the European Union's CO_2 Emissions Trading Scheme (EU ETS) revealed that CO_2 emissions were on average about 60 million tonnes or 3% lower than the number of allowances distributed to installations for these years. This long position has been interpreted as evidence of over-allocation, something that had been suspected but which seemed belied by the higher than expected prices that had prevailed before the first releases of these data in April 2006. While over-allocation cannot be dismissed as a possibility, a long position is not *per se* evidence of over-allocation. Installations that had abated in order to sell allowances or to bank them for use in later years would appear in these data as long. In fact, it would be impossible based on a simple comparison of allocations and emissions at the installation level to determine whether a long position indicated over-allocation or abatement. Hence, the question posed by the title of this paper.

The rest of the paper is organized in four sections. The first presents and comments on the 2005 and 2006 data as well as the price movements associated with the release of these data. Although a full discussion of European Union Allowance (EUA) pricing is beyond the scope of this paper, an understanding of the evolution of EUA prices bears on any discussion of over-allocation and abatement. The next section addresses over-allocation and proposes a measure by which over-allocation can be judged. Then, we turn to abatement and provide some estimates of abatement based on the 2005-06 emissions data and economy-level indicators of economic activity and trends in energy and carbon intensity. The last section concludes.

2 The 2005-06 data and EUA prices

Table 1 provides the average annual installation-level data for 2005 and 2006 aggregated by member states ordered by the size of the annual allocation. The last two columns indicate the extent to which the installations in each member state are as a whole either long or short both in absolute and percentage terms.

<INSERT TABLE 1>

A number of comments need to be made concerning these data. First, these first two years provide a good indication of what will be the final position of the EU ETS at the end of the three-year "trial period." At levels of aggregation significantly above the installation level, such as member states or sectors, 2006 looked a lot like 2005. For the EU ETS as a whole, emissions were a little higher in 2006 than in 2005 and the annual allocation a little lower (since some countries front-ended their three-year allocations). Given continuing economic growth and a near-zero price for carbon during most of 2007, it is reasonable to assume that the three-year average will reveal a net position that is not as long as what is shown by the 2005-06 data; however, the main features of the country and sector positions are not likely to be much different.

Second, the allowance totals for member states reflect the allowances distributed to installations in 2005 and 2006 as recorded in the Community Independent Transaction Log (CITL).[1] This is not the annual average of all allowances that will be distributed during 2005-07 according to the National Allocation Plans. European Union Allowances (EUAs)

[1] Corrections and additions are often made but their effect on the aggregates reported here is small. The data in our analysis are the CITL data updated through September, 2007.

reserved for new entrants, auctions, or early action awards are not included and in many cases these reserves have not yet been released.

Third, and finally, these data do not indicate the amount of purchases and sales made by specific facilities, although they do have implications for trading patterns. Installations that are shown to be short, that is, with emissions greater than the EUA allocation, can be presumed to have purchased or otherwise acquired EUAs from other installations (or from their own forward endowments)[2] to be in compliance. Conversely, installations that are revealed to be long would have EUAs that could be sold, but that doesn't mean that they were made available to the market or transferred to another facility having common ownership.

The first release of verified emissions data had a marked effect on EUA prices, as shown by the sharp break in the price of all maturities of EUAs that can be observed in late April 2006 depicted on Figure 1. Following announcements by the Netherlands and the Czech Republic on Tuesday, April 25 that their emissions were 7% and 15% below the respective allocations to installations, EUA prices fell by about 10%. Subsequent announcements from the Walloon region of Belgium, France, and Spain revealing similarly long positions for the first two and a smaller than expected shortage in Spain led to a closing spot price on Friday April 28 of € 13.35, 54% below the closing spot price on Monday, April 24, of € 29.20. There were further, less severe fluctuations of price until the complete data were released on May 15; however, the essential adjustment was made in these four days and after May

[2] The next year's allocation is distributed to installations two months prior to the date when allowances must be surrendered for the past calendar year. Since EUAs distributed within the trial period are completely interchangeable, installations have the option of borrowing from the next year's allocation to cover a shortage in the just completed year. This option does not apply at the end of 2007 since first period allowances are not interchangeable with second period (2008-12) allowances.

15 the spot price remained close to € 15 until late September when first period allowances began what would be a steady fall to a near zero price in early 2007.

<INSERT FIGURE 1>

The April 2006 price "collapse" demonstrated a readily observable characteristic of markets: They adjust quickly when information that changes expectations is made available. And there should be no doubt that the first release of reliable information concerning emissions covered by a cap-and-trade program affects expectations. The cap is always known, but until aggregate emission data is released no one has a really good idea of what aggregate emissions are and of the resulting demand for allowances. The same phenomenon was observed in the US SO_2 emissions trading program when the first auction revealed emissions and the implied demand for allowances to be much less than expected (Ellerman et al. 2000). In the case of the EU ETS, a similar adjustment of expectations concerning CO_2 emissions and the implied demand for EUAs occurred in response to the release of these data. Anyone doubting the adjustment in expectations need only refer to the headline of the guest editorial in Point Carbon's April 21 edition of *Carbon Market Europe*— "CO_2 price still too low"—and note the absence of such articles since April 2006 (at least as concerns first period prices). While the obvious explanation of the price break in late April 2006 is an adjustment of expectations, EUA prices did not go to zero immediately. Moreover, first period prices did reach zero until a year later as it became iincreasingly clear that weather and other factors would not create additional demand before the end of the period. Finally, it bears noting that the second release of verified emissions in April 2007 had no effect on either first or second period EUA prices. Expectations were calibrated and nothing new was revealed.

3 Do the 2005-06 data reveal over-allocation?

3.1 A working definition of over-allocation

Over-allocation is not a well defined concept. The choice of words implies that too many allowances were created, but the standard by which “too many” is to be determined is rarely stated. Moreover, over-allocation tends to be conflated with being long, that is, having more allowances than emissions. Since any market presumes buyers and sellers and the former will be short and the latter long in an allowance trading system, it cannot be the case that everyone is short. Making sense of over-allocation requires both a standard of reference and some understanding of the reasons that some installations are short and others long.

Two standards of reference can be imagined. The first is what emissions would have been without the trading system, what can be called the counterfactual, and is termed BAU (for Business as Usual) emissions in modeling exercises. Probably all would agree that handing out more allowances than BAU emissions would constitute over-allocation. A second standard could be a cap that is constraining, that is, less than the counterfactual, but still judged not sufficiently ambitious. For instance, if the desired degree of ambition were a 5% reduction of emissions from the counterfactual, and allowances were distributed such as to require only a 2% reduction, the 3% difference might be considered over-allocation. While this second definition is plausible and seemingly the one intended in much of the current debate, we argue that it would be better to reserve the term “over-allocation” for the first definition to which all can agree.

Installations, or any aggregation of installations, such as a sector, member state, or even the system as a whole, can be long or short for a number of reasons other than "over-allocation." One of the most obvious is the very incentive that motivates trading, differences in the marginal cost of abatement. For any given allocation, those installations with lower cost of abatement would be expected to reduce emissions in order to free up allowances to sell to installations that face higher costs of abatement. Such desired behavior would show up in reported installation data as data points that are both long and short according to the marginal cost of abatement at the covered installations.

A second reason for the appearance of a long position is uncertainty, the fact that the future rarely conforms exactly to what is expected, much less to any given allocation of tradable permits, even when expected abatement is taken into account. Over any given period of time, it is inevitable that some installations will produce more than expected and others less. The consequences in an emissions trading system are that the former will be short and the latter long. It ought not to be argued that the installations that are long because they produced less than expected, and therefore had lower emissions, were over-allocated, unless one is prepared to argue that short installations were "under-allocated." Given uncertainty, the only way to overcome such over- and under-allocation would be to adjust allowances ex post. But this would remove some of the incentive to abate.

The effects of uncertainty are not limited to installations; they can extend to aggregates. To the extent that economic activity, weather or any other factor affecting emissions deviates from what is expected, aggregate counterfactual emissions will be higher or lower than expected and any given cap will be more or less constraining with consequent effects on the positions of the components. .

3.2 Presentation of the 2005-06 data

With these considerations in mind, it is useful to look at the short and long positions at the installation level for various aggregates. Figures 2 and 3 do this for the EU as a whole and for the constituent member states both in absolute terms as the annual average for 2005-06 and relative to the average allocation for the indicated aggregate. In both of these figures, the data labeled "gross long" and "gross short" present the sum of the differences for all the installations having long and short positions. Each aggregate then has either a "net long" or a "net short" position indicated by the darker shade and equal to the difference between the "gross long" and "gross short" data points for that aggregate.

<INSERT FIGURE 2>

<INSERT FIGURE 3>

Figure 2, where the differences are expressed as percentages of the total allocation to installations constituting the aggregate, is the more instructive display of the information for the purposes of developing some measure of over-allocation. Lithuania can serve as an example of evident over-allocation. Only eleven installations were short and the difference between total emissions and total allowances allocated to installations was about 45% of the average annual allocation. While over-allocation seems evident, figuring out how much is not obvious since it is possible that the levels of economic activity in Lithuania were not what were expected, that Lithuanian installations may have abated, or that some other factor may explain some or all of the long position.

At the other extreme is the UK where installations were both long and short, but the magnitude of the deficit for short installations (28% of the UK allocation) was much greater than the corresponding figure for installations that were long (7%). Clearly, the UK as a whole cannot be considered to have been over-allocated even if some firms and sectors may be long. Also, the short position may be created, not so much by intention, but by higher levels of economic activity than expected or other unexpected events, such as high natural gas prices, which caused coal-fired power plants to be more heavily utilized than expected and thereby created a larger number of short positions.

Having set up two polar cases, Figure 2 illustrates the great diversity among the EU member states. As indicated by the top bar, the situation of the EU as a whole is balanced with the sum of shorts being about 10% and the sum of longs about 13% for an over-all net long position of about 3%. The same cannot be said for all the member states, which fall roughly into four categories. The first includes those like Lithuania where all or nearly all the installations are long and by an amount that is greater than 15% of the average annual allocation. This group comprises the first seven member states from the top in Figure 2. The next four member states,, Hungary, Sweden, Poland and Finland, constitute a second group that are similar in having significant net long positions, between 10% and 15% of the allowance allocation, but with more short installations, especially in Sweden. The third group consists of the next eight member states—the Netherlands, Belgium, Denmark, Cyprus, Portugal, Germany, Slovenia, and Greece—that are long on balance but by relatively modest amounts that would fall well within what might be expected as a result of a relative advantage in abatement or less favorable economic, meteorological, or other circumstances in 2005-06. The final group includes the five member states who were on balance short: Austria, Spain, Italy, Ireland, and the UK.

While Figure 2 is the more helpful of these two diagrams for evaluating the presence of over-allocation, Figure 3 is necessary to put the phenomenon in perspective and it provides a good picture of the main sources of demand and potential supply of EUAs. The gross shorts, totaling 204 million EUAs as an annual average are located mostly (76%) in four countries: the UK, Spain, Italy, and Germany. The same four countries, plus France and Poland, constitute the largest part of the potential sellers' side of the market with 162 million of the 263 million EUAs were surplus to requirements to cover emissions at many installations in 2005 and 2005, or about 62% of the total. Many of the trades implied by these long and short positions were undoubtedly within the same countries, but there were also net transfers of EUAs among member states.

The net positions displayed in Figures 2 and 3 imply transfers of allowances among member states although borrowing from the next year's allocation would also be a possibility for these two years.[3] The net balances imply that 56% of the demand for international trading came from the UK with another 22% from Italy, 17% from Spain and the remaining 5% from Ireland and Austria. The potential suppliers were more evenly distributed with Poland, France, Germany, and the Czech Republic accounting for 64% of the total.

Member states are not the only aggregates into which the installation data can be aggregated. Another break-out is by economic sector, as is done in Figures 4 and 5 for the 2005 data only.[4] By this grouping, the power sector is in the aggregate modestly short (by about 3%), while all the other sectors are long by more significant percentages. Among these industrial sectors, three—ceramics, bricks and tile; iron, steel and coke; and pulp and paper—are long by more than 15% of the allocation to these sectors. When placed in the

[3] For instance, an analysis done for the Italian registry found that 18% of the short positions in Italy in 2005 were covered by borrowing from the 2006 allocation (Point Carbon, 2006b).

[4] The CITL data does not distinguish between power generation and combustion facilities that are in sectors outside of the power sector. Distinguishing these two requires a separation of installations into these two sub-categories. We are in the process of making this further sub-sector categorization for the combined 2005-06 data that is presented elsewhere in this paper. In its absence, we use the sector data for 2005 based on the sub-categorization performed by Kettner et al. (2007) for Figures 4, 5, and 6. We believe that the patterns revealed by the 2005 data were largely unchanged in 2006.

perspective of the volume of emissions, as in Figure 5, the power sector dominates the potential market. Virtually all of the compliance demand for EUAs in 2005 came from the power sector, as well as about half of the total potential supply.

<INSERT FIGURE 4>

<INSERT FIGURE 5>

When sector and regional classifications are combined, an even clearer picture of the implied redistribution of allowances is obtained. In Figure 6, the sectors are grouped into power and heat and all others (generically industry) and aggregated into regions defined as the EU 15 and the 8 East European accession states. The power and heat sector in the EU15 is the only player in the EU ETS that has been characterized by an overall net short position. More than half of the net length is located in Eastern Europe, although given the delay in establishing the registries in Eastern Europe, most of the net short position of the EU15 power and heat sector in 2005 was probably covered by purchases from the EU15 industrial sectors.

<INSERT FIGURE 6>

3.3 A measure of over-allocation

A measure of the likelihood of over-allocation can be calculated from this data based on the earlier discussion of what might cause long positions. Any aggregate of installation data will typically show the group to be either long or short on balance and to have some installations long and others short. For each, a ratio can be calculated from the net position in relation to the corresponding long or short position, such as indicated below.

$$Net\ Ratio = \frac{Net\ Long\ or\ Short}{Gross\ Long\ or\ Short}$$

The ratio is assigned a negative sign if the net ratio is short and a positive sign if the net ratio is long. To take our earlier examples, Lithuania would have a ratio of +0.98 since it was long and its net long position is almost the same as its gross long position. Conversely, the UK has a ratio of -0.73 since its net short position is 73% of the sum of all short installations in the UK. By definition, the net ratio is limited to values between -1.0 and +1.0 .

A negative net ratio indicates that no obvious over-allocation has taken place. Sectors within a member state may be over-allocated, but if the member state as a whole is not, the over-allocation to one sector is compensated by an implied under-allocation to other sectors. While such differentiation may create problems for sectors that compete across national boundaries, this differentiation can be regarded as an internal matter not significantly different from other forms of assistance or regulatory treatment that may advantage or disadvantage a sector relative to competitors in other countries.

Member states that have positive ratios would need to be divided into two groups depending on where the line is drawn for indicating over-allocation. The first sub-group would be those with a high positive ratio indicating that few installations were short. The second group includes those with a net ratio that is positive but not excessive. There is no a priori answer concerning where to draw the line between these two groups, but the data clusters in a manner that allows some to be clearly assigned to one group or the other.

Figure 7 represents the distribution of allowances by member states expressed as a percentage of the EU25 allocation according to their net ratios. The part of the columns labeled "base" represents emissions that were covered by allocated allowances. The dark parts at the top of the columns labeled “purchase” indicate emissions that were greater that the allocation for those member states with a net ratio from -1.0 to zero. The darker parts of the columns labeled “for sale” indicate allocated allowances in excess of emissions for those countries with a net ratio between 0 and +1.

<INSERT FIGURE 7>

The UK and Ireland, representing about 11 % of the overall EU25 allocation, are the two countries characterized by the shortest positions with a net short that is approximately 2% of all the EUAs issued by the EU25. The next three countries – Spain, Italy, and Austria – account for about 20% of total EUAs and they are all short but less so than the UK and Ireland. On the side of the longs, Greece has a relatively balanced position not unlike that of Austria on the short side of the ledger. Germany’s size will cause the category in which it falls to dominate all the others and so it is for the group with net ratios between +0.2 and +0.4, which constitutes 29% of the total allocation. The last two groups, with net ratios higher than +0.6 include the member states for which the evidence of over-allocation is much stronger. They constitute about 30% of the EU25 total and their combined surplus is about 6% of the total allocation.

Where to place the threshold that would create a presumption of over-allocation is obviously a difficult decision. It should be drawn at a relatively high net positive ratio for the reasons explained earlier and even then other factors should be considered before coming to a definitive conclusion. The important point arising from the 2005-06 data is not that there were some member states for which over-allocation is indicated, but that there were so many for which that was not the case. Even with a relatively low presumptive threshold for over-allocation of +0.60, fourteen member states that distributed 72% of all EUAs cannot be viewed as involving over-allocation. And for the 28% remaining, about

24% of the allowances were required to cover emissions in 2005 so that the maximum over-allocation is on the order of 6% or 125 million EUAs, assuming that none of the length observed in these countries can be attributed to abatement or unexpected transient conditions that created length in these years.

Whatever the correct magnitude of this estimate, it needs to be placed in context. First and as noted earlier, the CITL data do not present a complete indicator of the over-all length of the EU ETS for these years. It does not include many of the allowances in reserves for new entrants, auctions, or other purposes that may have been distributed by the end of 2006 but do not yet show up in the CITL allocation data. While these reserves are not specifically reserved for any single year, most of them will become available before the end of 2007. About 255 million EUAs have been reserved for new entrants, auctions, and other purposes and most of these reserves will be distributed by the end of 2007. If distributed evenly over the three years of the trial period, they add another 85 million EUAs annually . A second observation concerns the over-allocation that was avoided by the cuts that the Commission required from a number of first period NAPs. These totaled 290 million EUAs, approximately equal on an annual average to the potential over-allocation indicated by an analysis of these data. Finally, over-allocation indicates very little about abatement or the reduction of emissions that is the fundamental object of the EU ETS. We now turn to this second part of the question that we pose in the title to this paper.

4 Has the EU ETS reduced CO_2 emissions?

4.1 Some initial considerations

Just as being long or short is a difference between emissions and allocation, so abatement is a difference between emissions and the counterfactual, or what CO_2 emissions would have been in the absence of the EU ETS.[5] And, while the first difference can be readily deduced from two observable data points, the second difference can never be determined with certainty because the counterfactual is not observed and never will be. It can only be estimated, but there are better and worse estimates and much can be done to narrow the range of uncertainty, particularly when the evaluation is done *ex post* when the levels of economic activity, weather, energy prices and other factors affecting the demand for allowances are known.

In the case of the EU ETS, forming a good estimate of the counterfactual is complicated by the lack of historical data corresponding to the installations included in the scheme. Reasonably good data exist for the CO_2 emissions of the EU member states, however the EU ETS includes only a part—ranging from 30% to 70%—of each member state's emissions. And, prior to the start of the EU ETS, there was no reason to collect or to publish data on sectors or installations that were to constitute the EU ETS.

One not entirely satisfactory source for of the data for these installations is that collected to establish an historical "baseline." All the member states collected recent emissions data in the process of developing the first set of National Allocation Plans during 2004 in order

[5] By the absence of the EU ETS, we intend both the trial and 2008-12 periods. What alternative policy might be assumed to be part of the counterfactual is always a difficult conceptual problem. In this case, we assume that the Kyoto Protocol is part of the counterfactual and that other measures that would affect emissions in 2005-06, such as the Renewable Directive, remain in effect. This counterfactual exercise attempts to isolate the effect of the EU ETS as a policy instrument and to determine whether it has had any effect on emissions in 2005-06. Also, we do not assume that aspirational goals trigger responses absent more substantive and specific mandates or incentives.

to establish an initial point for projecting what emissions were expected to be in 2005-07 for the trading sector as a whole, for specific industrial sectors, and for individual installations. While this data source provides a much needed reference point, it suffers from two problems: potential bias and imperfect comparability.

The potential bias in the data arises from the process by which the data were collected. As described in Ellerman, Buchner and Carraro (2007), the data collection effort was largely a voluntary submission by the industries involved and it was conducted under severe time pressures that did not allow for as much verification as could be desired. Cooperation in submitting the data is reported as good, perhaps not surprisingly since allowance allocations would depend on the data submitted; but for that reason there was also an incentive to resolve uncertainties in favor of higher emissions.

While an incentive to inflate emissions clearly existed, its role should not be exaggerated. The government officials cross-checked the data submitted with other information that was often available, as well as checking it for internal consistency. Also, a certain degree of internal discipline could be expected within the process from firms who would not be indifferent to inflated claims by competitors. The important point is not that these data should be accepted as is, or rejected out-of-hand, but that the extent of bias be measured or at least taken into account. It would be wonderful if there were other more reliable data that could be used, but in its absence, the baseline data are all that exist to enable an estimate of the extent to which the EU ETS reduced CO_2 emissions.

The second problem with the baseline data is that the components to be summed across the EU are not fully comparable. Although all member states sought a measure of recent emissions in developing their baselines, the definitions varied. For all, it was an average of recent years ending with 2003, the last year for which data were available, but the years included in the average varied from two to six. Moreover, special provisions were sometimes adopted that let minimum observations be dropped, as in the UK, or for more recent 2004 data to be used instead of the historical average, as in the Czech Republic. Nevertheless, there are presently no other data and the historical baseline data have the merit of reflecting relatively recent years (e.g. around 2001-2003) for the installations in the EU ETS. As with the problem of bias, the solution is not to throw out the baseline data but to understand and to measure the errors that may be created by incomplete comparability.

4.2 Verified emissions compared to baseline emissions

With these significant qualifications in mind, we now present the historical baseline data in comparison with corresponding data on allowances and verified emissions. Historical emissions must not be thought of as the counterfactual for 2005-06; it is the starting point before taking account of changes that would have occurred between the historical reference point and the year of the counterfactual, as we will do in the next section. Figure 8 presents the historical baseline and the average annual allocations and verified emissions for the EU member states summed into a whole for the EU23 and for the regional distinction between the EU15 and the 8 East European accession states (subsequently EE8).

<INSERT FIGURE 8>

For the EU23, verified emissions are 3.1% less than baseline emissions and the corresponding percentages for the EU15 and the EE8 are -2.0% and -7.7%. In these three aggregated comparisons, the solid part of the middle column represents allowances distributed directly to installations. The hatched area at the top of each column indicates the difference between the number of allowances distributed annually to installations in 2005 and one-third of the cumulative three-year total for each member state as indicated in the NAPs. These are allowances that have been reserved for auctions, new entrant or early action reserves, or other special provisions.

4.3 Changes in real output and carbon intensity since 2002

The comparison of verified emissions with the baseline in the preceding section does not take account of factors that would influence the level of CO_2 emissions between 2002 and 2005-06. [6] Continuing GDP growth, or more specifically growth in the output of the sectors included in the EU ETS, would be expected to causes emissions to increase and for the counterfactual to be higher than the historical baseline. Also, CO_2 emissions typically do not grow at the same rate as real output because of the observed tendency towards improved carbon intensity for most economies. In addition to these trend factors, there are a number of unpredictable conditions, such as the weather and energy prices, that will increase or decrease counterfactual emissions and the demand for allowances depending on their realization relative to the expectation.

Economic growth since 2002 has been relatively robust in the EU and particularly in the East European accession states as shown in Figure 9 by the indices describing the cumulative growth in GDP measured in constant prices in relation to the year 2002. For the EU as a whole, GDP has grown by almost 6 percent by 2005 compared to 2002 and by 9 percent by 2006. The figure is slightly lower for the EU15 where most of the economic activity occurs and significantly higher for the Eastern European countries +15% and +22% for 2005 and 2006, respectively).

[6] We use 2002 as an approximate center point for the baseline emissions.

<INSERT FIGURE 9>

GDP reflects a broader definition of economic activity than what is included in the EU ETS, but the same pattern obtains when more sector–specific indices of economic activity are used, as shown by Figure 10.

<INSERT FIGURE 10>

These indices shown monthly activity since the beginning of 2002 through 2007 and each series is normalized to its average value in 2002. All of these indices indicate higher levels of real output in 2005-06 than in 2002. The two most important series, electricity and industrial output excluding construction are both about 6% above the average 2002 level of output when measured as the average 2005-06 level of activity. More specific industrial sector indices show increases of about 8% for cement, 6% for pulp and paper, 5% for iron and steel, and 4% for glass, bricks, tiles, and ceramics. Temporary declines in output of iron and steel and of pulp and paper can be observed in 2005, but these were temporary and the average output levels observed in 2006 are higher for all sectors than in 2005, although electricity production declined as the year progressed.

Since CO_2 emissions typically do not increase at the same rate as broad indicators of economic activity, some estimate of the improvement in CO_2 intensity must be taken into account in estimating a counterfactual for 2005-06. Because of the paucity of industry-specific data on carbon intensity, we examine first the trends in carbon intensity for the economy as a whole for the EU and its constituent parts and then consider whether the economy-wide data can be considered representative of the EU ETS sectors based on the sector specific data that is available.

Table 2 provides a comparison of the annual rates of growth for real GDP, CO_2 emissions, and the implied change in CO_2 intensity between 1995-2000 and 2000-2004 for the EU23, the EU15 and the EE8. Real GDP growth has been less in recent years than in the last half of the 1990s but the recent rate of increase in CO_2 emissions has been greater than in the earlier period. The inescapable implication is that the rate in improvement in CO_2 intensity slowed noticeably around 2000. These trends are especially pronounced in the EU15, but they are also true for the new East European member states. CO_2 intensity is still improving, but the rate of improvement has diminished sufficiently that CO_2 emissions are increasing at a faster rate than they were in the late 1990s despite slower growth in real GDP.

<INSERT TABLE 2>

This slowing in the rate of decline in CO_2 intensity since 2000 raises an obvious problem with extrapolating the declines in carbon and energy intensity experienced during the 1990s beyond 2000. For the purpose of establishing a counterfactual for 2005-06, we assume that the trend prevailing since 2000 is the appropriate one. GDP and economy-wide CO_2 emissions data are now available through 2005. Real GDP grew at 1.95% between 2004 and 2005 for the EU as a whole, but EU economy-wide CO_2 emissions decreased from 4117 to 4093 Mt CO_2, or by 0.6%. If we assume that the 2000-04 trend of annual improvement in CO_2 intensity of 0.8% would have continued from 2004 through 2005 in a counterfactual case without a CO_2 price, emissions would have increased by 1.14% to 4164 Mt CO_2, 71 Mt above observed EU economy- wide CO_2 emissions.

This very rough counterfactual calculation implicitly assumes that energy prices remained unchanged between 2004 and 2005. In fact, energy prices increased in 2005 and the prices of oil and natural gas by considerably more than the price of coal. The effect of a general increase of energy prices relative to other goods would be to increase the rate of improvement in CO_2 intensity and to diminish emissions. However, when the relative prices of oil and natural gas rise relative to the price of coal, and where coal- and gas-fired electricity generation accounts for a significant share of emissions, the effect would be the opposite. How the two contending effects worked out after 2004 is a good question, but with nearly 50% of the emissions in the EU ETS from fossil-fuel-fired electricity generation and given the ease of switching from coal to natural gas and oil, or back, the short-term effect is likely to have dominated in 2005-06 and caused counterfactual emissions to be higher in 2005 than the figure given above. Thus, the highly tentative estimate of 73 Mt CO_2 provided above can be considered conservative.

The critical issue with the use of economy-wide data is whether it is representative of the sub-set of the economy that the EU ETS comprises. Eurostat publishes data on the energy intensity of both the EU economy as a whole and the industrial sector. Examination of these data indicates that the trends observed for energy intensity in the economy-wide aggregates hold true for the industrial sector. The same break in trend around 2000 that is observed for CO_2 intensity per unit of GDP is seen in energy intensity for the industrial sectors and for the economy as a whole for the EU25 and the EU15, as well as for fifteen of the twenty-five member states. Ten member states exhibit a trend to increasing energy efficiency in either the economy-wide or industry figures rates of change; however, when aggregated to the EU25 or EU15 level, the data are consistent with a trend to less improvement in carbon intensity since 2000. Moreover, the rates of improvement in energy intensity for the industrial sectors are generally not as great for the economy as a whole and the slowdown in improvement is more pronounced for the industrial sectors than for the economy as a whole.

Energy intensity is not identical to emissions intensity, although it is an important determinant; however, a second source of data on emissions at a lower level of aggregation than the economy as a whole helps to overcome this problem. The European Environmental Agency has recently released its annual assessment of progress towards the Kyoto goals (EEA, 2007), which provides indices of GHG emissions for industry excluding construction through 2005. Again, GHG emissions are not the same as CO_2 emissions, but the latter constitute most of the former. These data series show the same break in emissions trends around 2000 and rising GHG emissions between 2002 and 2004.

Based on these two sources of aggregate data that are more directly comparable to the EU ETS sectors, we believe that it is unlikely that the trends in CO_2 intensity that are evident through 2004 for the EU economies as a whole were not also broadly true for the EU ETS sectors. Given the observed increase in real output for the EU ETS sectors, it is unlikely that CO_2 emissions from the installations included in the scheme would have declined in the absence of the EU ETS and the significant price that was paid for CO_2 emissions in 2005.

4.4 Estimating the counterfactual and abatement

Figure 11 summarizes the problem of estimating the counterfactual and thereby determining the amount of CO_2 emission reduction that was effected by the EU ETS in the first two years of the program. There are two data points: the imperfect baseline emissions, which we take to reflect approximately 2002 emissions of the EU ETS installations, and verified emissions in 2005 and 2006. The critical issue is: What would have been the rate of change in BAU emissions in the absence of the EU ETS?

Real GDP and the relevant sector-specific indicators of economic activity indicate annual growth of about 2% for the EU as a whole. While the decline in carbon intensity since 2000 has been significantly less than what was experienced in the 1990s, it has not stopped so that 2% annual growth in counterfactual CO_2 emissions would be too high, except that higher natural gas prices in 2005 would have increased emissions and the demand for EUAs. Given the changes in relative energy prices, we take 2% as an upper limit for the growth in counterfactual emissions. Similiarly, the growth in real GDP and the post-2000 trend in CO_2 intensity make it unlikely that the lower limit on the feasible growth of BAU emissions would be less than one percent. Accordingly, it appears likely that counterfactual emissions increased to a level that in 2005-06 would have been from 3% to 6% higher in 2005 and 4% to 8% higher in 2006 than the level of emissions for the EU ETS installations in 2002. The two arrows in Figure 12 represent these two limiting assumptions about the growth of CO_2 emissions absent the EU ETS, given what we can now observe concerning the growth in real output in the EU ETS sectors, the post-2000 trend in CO_2 intensity, and the evolution of CO_2 emissions through 2004.

<INSERT FIGURE 11>

Assuming for the moment that the baseline emissions accurately reflect 2002 emissions for the EU ETS installations, these limiting assumptions imply that the counterfactual lies between 2.14 and 2.21 billion tonnes of CO_2 in 2005 and 2.17 and 2.25 billion tons in 2006. Since verified emissions are 2.01 and 2.03 billion tonnes in these two years, these figures suggest a reduction of CO_2 emissions between approximately 130 and 200 million tonnes in 2005 and between approximately 140 and 220 million tonnes in 2006, or 7% to 8% of what emissions would otherwise have been.

However, the assumption of an accurate baseline is open to serious challenge because of the less than ideal conditions under which the baseline data on installation level emissions were collected. These conditions undoubtedly produced errors, but errors operate in both directions. The more serious concern in estimating a counterfactual is the likelihood of bias, which would imply that the errors are disproportionately and systematically in one direction. To the best of our knowledge, no one has done the empirical work to prove the bias or to develop a better estimate of the level of historical emissions for the EU ETS installations prior to 2005 or of counterfactual emissions in 2005 and 2006. In any case, the critical issue is: What is the magnitude of bias? Or to turn the question around: How much bias would required to support a conclusion of no abatement of CO_2 emissions by EU ETS installations in 2005 and 2006?

The best way of addressing this question would be to take a country-specific approach to estimating counterfactual emissions, but a clear distinction can be made between the new accession countries of Eastern Europe and the EU 15. For the former, historical data were of poor quality and of questionable relevance given the ongoing rapid structural change in those economies. Generally, these conditions do not exist among the EU15 or nearly to the same degree. Accordingly, it is plausible that more bias exists in the baselines of the East European states than in those of the EU15.

To develop an initial counterfactual point estimate that does not take the potential bias in baseline emissions into account, we assume that CO_2 emissions in the EU ETS sectors increased at an annual rate that is the product of the annual increase in observed real GDP between 2002 and 2005 and the rate of decline in CO_2 intensity that was experienced between 2000 and 2004 for each country. That calculation and the resulting data are summarized in the first panel of Table 3.

<INSERT TABLE 3>

The indicated growth in counterfactual emissions for the EU15 and EE8 between 2002 and 2005 is 3.1% and 4.8%, respectively, or 3.5% for the EU as a whole. The indicated abatement is about 174 million tonnes or 8% with percentage reductions of 7% for the EU15 and 12.8% for the eight East European member states.

Not only is this amount considerably larger than what is indicated based on reported economy-wide GDP and emissions data, but the greater proportionate reduction in the East than in the West seems unlikely. There probably was some abatement in the East, and no doubt cheaper abatement opportunities exist there than in the EU15; but firms in Eastern Europe are less attuned to market opportunities than those in the EU15; and, if they are, they would have been impeded from trading by the delays in final approvals of several NAPs and in setting up the East European registries.

A more likely explanation for the result shown in the first panel of Table 3 is that the baseline emissions for the East European countries contain more bias than those of the EU15. Accordingly, the second panel repeats the same calculation concerning growth of emissions that was made in the first panel but from baselines that have been lowered by percentages that would be required to sustain a conclusion of effectively no abatement in the EU15 and EE8. The implied adjustments are 7% for EU15 countries and 11 % for the eight new accession members. Both of these seem unlikely as estimates of cumulative, systemic bias, although undoubtedly errors of this magnitude will exist in the data for individual installations or small sub-sets.

Until better estimates based on more detailed country- and sector-specific research have been done, it is not possible to make a reliable estimate of abatement. Nevertheless, it is unlikely that there was no abatement in 2005. Such a conclusion is also sustained by research now appearing (Delarue, Voorspools and D'haeseleer, 2007), which finds abatement of 88 Mt and 59Mt in 2005 and 2006 respectively in the power sector alone from fuel switching based on a counterfactual simulation of the EU electricity systems using actual fuel prices and observed demand in these years.

The calculations presented in Table 3 indicate an amount that is certainly lower than 170 Mt CO_2 by however much is the bias in the baseline emissions data. An amount half this much—abatement of 85 million tons or about 4%—seems not unreasonable given the independent economy-wide data, but it is arbitrary and must remain so until better data and more careful assessments can be made.

In the meantime, the refutable presumption must be that the EU ETS succeeded in abating CO_2 emissions in its first two years based on three observations.

1. **A Significantly Positive EUA Price**. A significant price was paid for CO_2 in 2005-06, which would have the effect of reducing emissions as firms adjust to this new economic reality.
2. **Rising Real Output**. Real output in the EU has been rising at the same time that the rate of improvement in CO_2 intensity has been declining, which has led to rising CO_2 emissions before 2005.
3. **Historical Emissions Data** that indicate a reduction of emissions even after allowing for plausible bias.

The amount of emission reduction in 2005 and 2006 may be modest, but so is the ambition of the 1st period cap. Given the problems of getting the system started and the changes in management and regulatory practice implied, even a modest amount of abatement may seem surprising, but the available evidence makes it hard to argue that there was none.

5 Concluding comments

The question posed in the title to this paper is whether the 2005-06 emissions data reveal over-allocation or abatement. Any reasonable answer to this question will acknowledge that both have occurred and this paper has attempted to develop estimates of the magnitude of both.[7]

Over-allocation has the unfortunate attribute of depending on the eye of the beholder, especially when viewed *ex post*. Nevertheless, there are plausible, empirical measures that can be developed. The one that we suggest is the ratio of an aggregate's net long (short) position to the sum of the long (short) positions of that aggregate's components. When some sizeable aggregate is long on balance and this ratio is close to unity, the likelihood of over-allocation is high. As we have noted, there are circumstances that would produce a high ratio without over-allocation, so that the presumption of over-allocation can be refuted if such circumstance can be convincingly shown. It is also possible that the over-allocation was intentional, as was arguably the case for the industrial sectors included in the EU ETS, in which case the attribute is the reflection of some equity consideration. Our analysis based on the application of the net ratio indicates that over-allocation occurred and that its magnitude may have been as much as 125 million EUAs, the volume of the surplus allowances for those member states with net ratios in excess of +0.6%.

Whatever the extent of over-allocation, that estimate does not say much about abatement. In a trading system, it is not the allocation to an installation that causes a firm to reduce emissions, but the price that it must pay, even if in opportunity cost, for its emissions.

[7] The observation that unexpectedly the long position of the EU ETS in 2005 was due to some combination of over-allocation and abatement was presciently made as early as May 2006, but little noted in the ensuing focus on over-allocation (Voorspools, 2006).

Whatever one thinks of the allocation in the first period, there can be no doubt that a price was paid and a cost incurred for CO_2 emissions emitted by covered installations in 2005. Therefore, the question can be posed: What was the effect of this price? The data to answer this question are not nearly as good as they should be, but our analysis of what is available indicates that CO_2 emissions were reduced by an amount that was probably between 50 and 100 million tonnes in each of these years.

These very tentative estimates of over-allocation and abatement have important implications. If abatement was at least 50 million tonnes annually, only a relatively small proportion of the observed long position of nearly 60 million tonnes for the EU as a whole in 2005-06 can be attributed to over-allocation. To the extent that there has been over-allocation and that those EUAs have found their way to the market, the clear implication is only that EUA prices (and abatement) are lower than they would otherwise have been.

This reasoning raises the interesting question of what was the source of the surprise that caused EUA prices to drop so sharply when the 2005 emissions data were revealed in April and May of 2006. It cannot have been the total number of allowances; this total had been known since at least mid-2005 when the last first period NAP was approved. Moreover, that total included whatever "over-allocation" had occurred and all observers recognized that the first period EU ETS cap was not very demanding. The surprise in late April 2006 concerned the revealed level of emissions. One plausible explanation is that market observers had over-estimated the level of CO_2 emissions and the consequent demand for allowances because of rising real output, the adverse weather in 2005, and the higher prices for natural gas relative to coal. But, another more intriguing possibility is that market observers under-estimated the amount of abatement that would occur in the first year of the EU ETS as the managers of affected facilities incorporated CO_2 prices into their production decisions. When revealed to be wrong, an under-estimate of abatement would have the same effect on EUA prices as an over-estimate of counterfactual emissions.

Our analysis suggests that such an under-estimate is a distinct possibility. Moreover, experience with emissions trading regimes in the U.S. has shown that unexpected abatement always occurs. And it is unexpected because abatement is so often conceived as resulting only from large machines that engineers can design and regulators mandate and not from the small, incremental changes in production and production processes that managers of existing facilities make in adjusting to new economic realities. These pedestrian changes can cumulatively make a perceptible difference and they are one of the main reasons for choosing market-based instruments, such as the EU ETS.

Acknowledgements

We are greatly endebted to continuing discussions with a number of observers and analysts of the EU ETS, to comments received in response to a presentation of earlier versions of this paper at various fora, and the very helpful comments of the two referees. We also acknowledge our debt to Angela Koeppl from the Austrian Institute of Economic Research (WIFO) in Vienna and to Stefan Schleicher from the Wegener Center for Climate and Global Change at the University of Graz whose initial compilation of the Community Independent Transaction Log (CITL) data showed what could be done with this valuable data base. The usual disclaimer applies to the responsibility of all who have helped us for the interpretations of the data that we present here.

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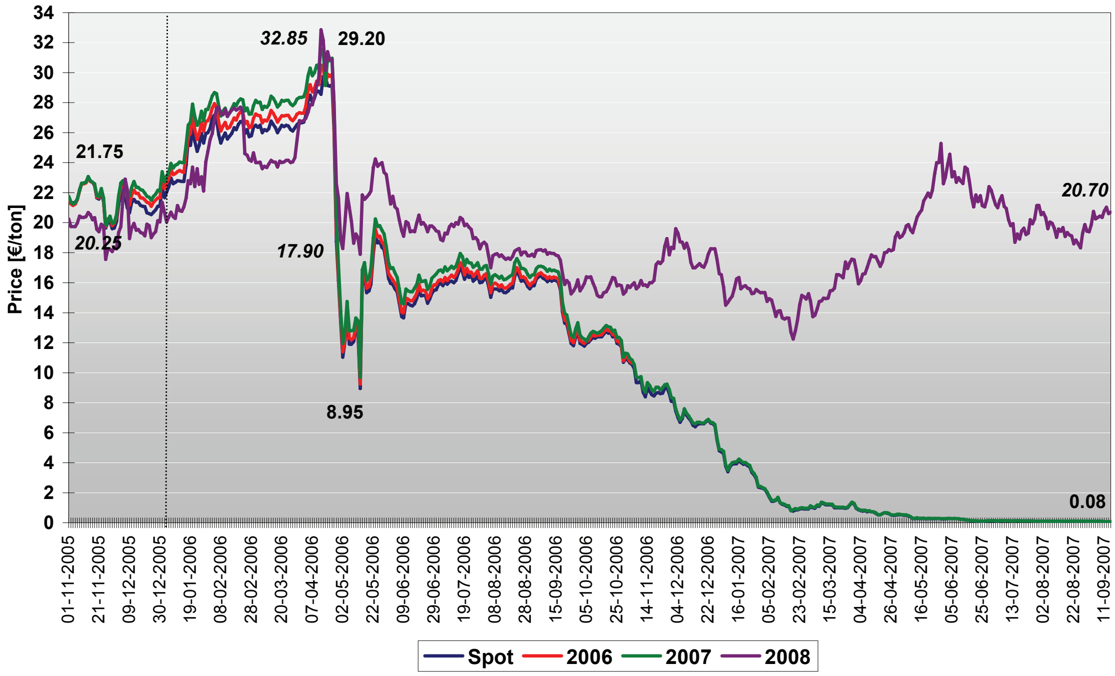
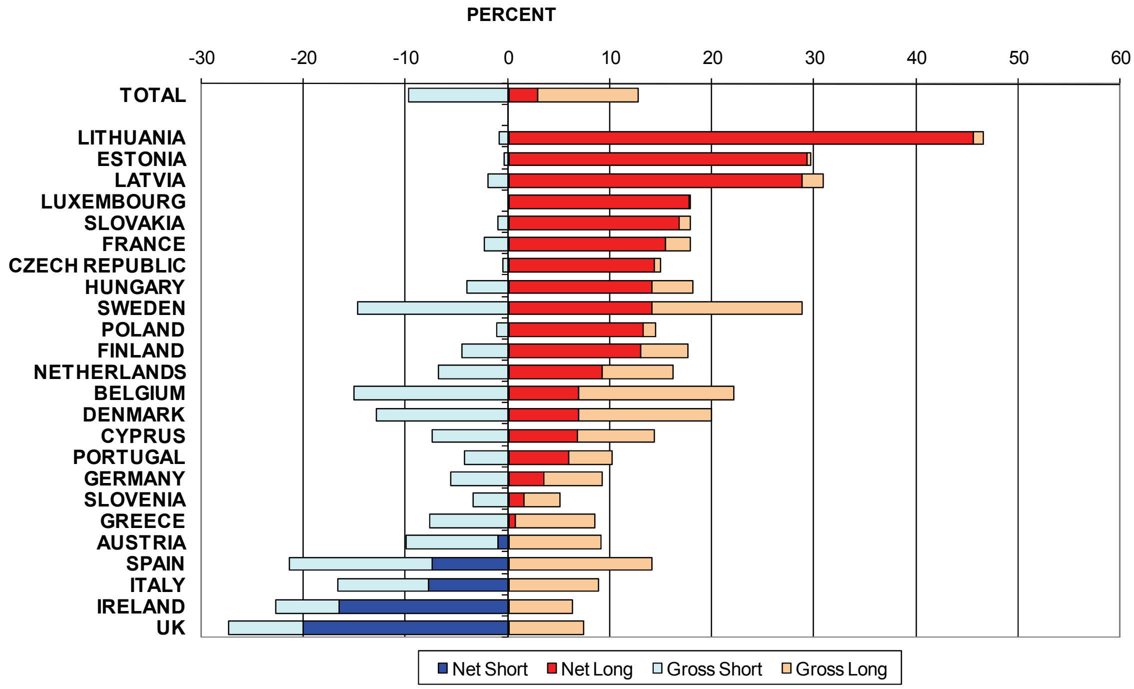
Voorspools, K. (2006) European Emissions 2005: Uncertainties, confusion, blanks and hope. Energy & Environmental Markets: Special Report, Fortis Bank, Energy and Carbon Market Analysis, 15 May 2006.

Figure 1. Price developments on the EU carbon market (OTC Market, November 2005 to September 2007)



Source: Own calculations based on data from Point Carbon.

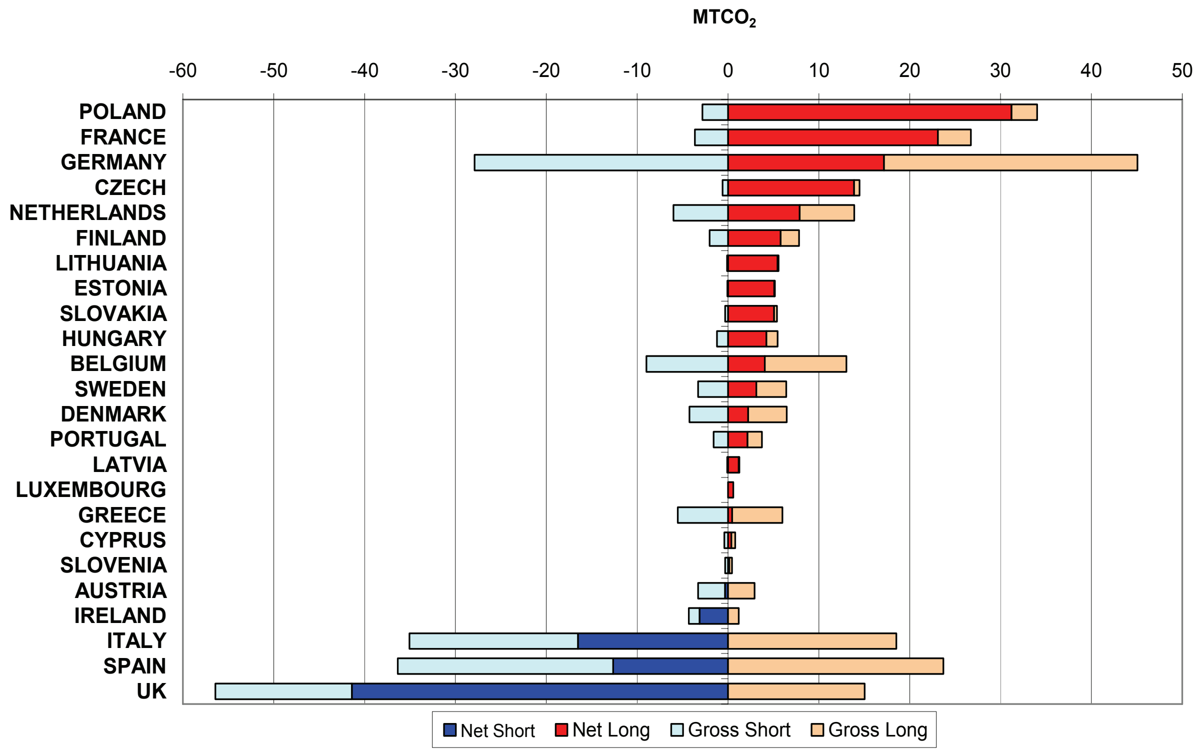
Figure 2. Short and long positions by member state in percent (average 2005/2006)



Source: CITL

Note: average of 2005 and 2006 data

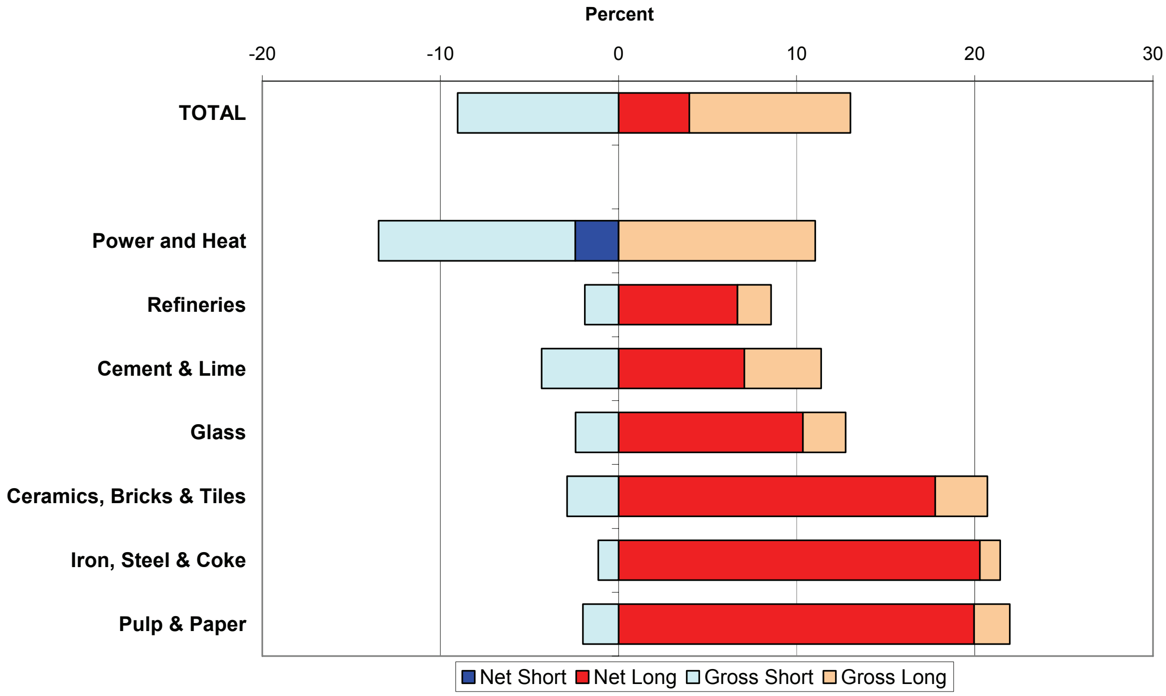
Figure 3. Short and long positions by member state in $MtCO_2$ (average 2005/2006)



Source: CITL

Note: average of 2005 and 2006 data

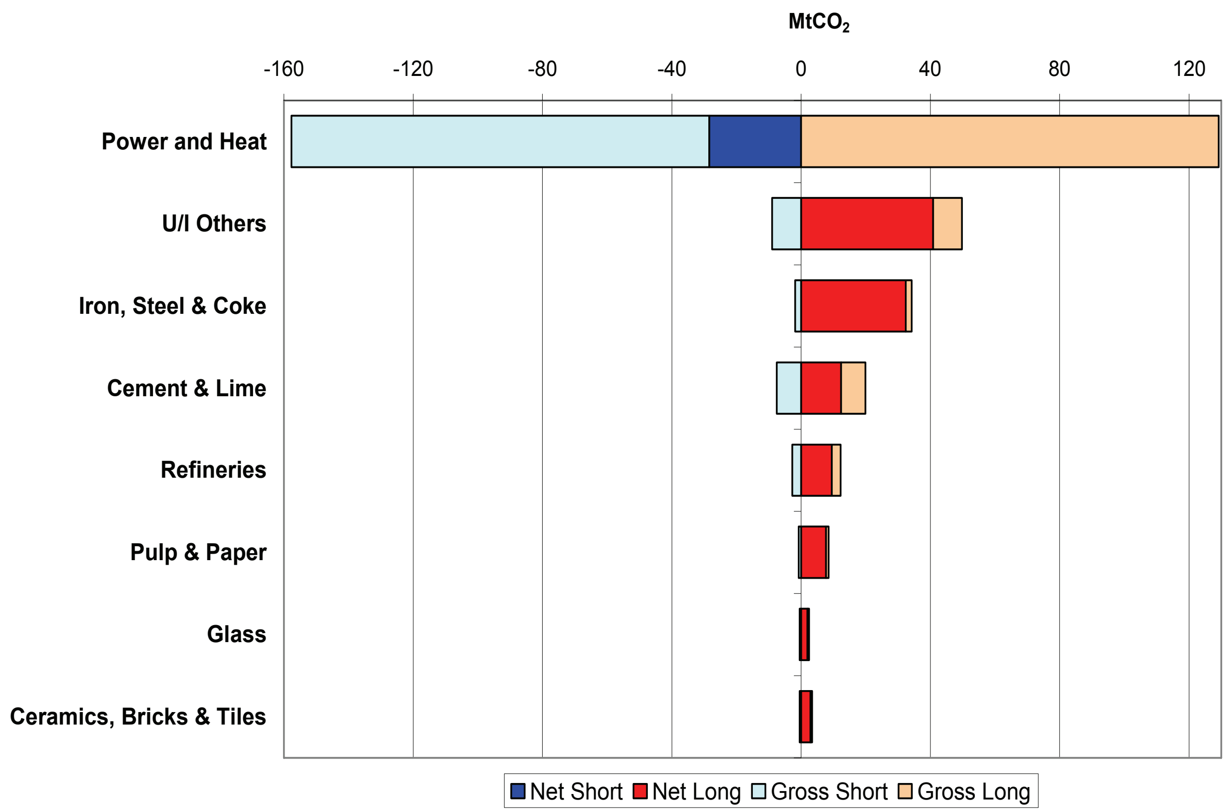
Figure 4. Short and long positions by EU-wide sectors



Source: CITL and Kettner et al. (2007).

Note: 2005 data only

Figure 5. Short and long positions by EU-wide sectors in absolute terms



Source: CITL and Kettner et al. (2007).

Note: 2005 data only

Figure 6. A breakdown of short and long positions by major sectors and regions

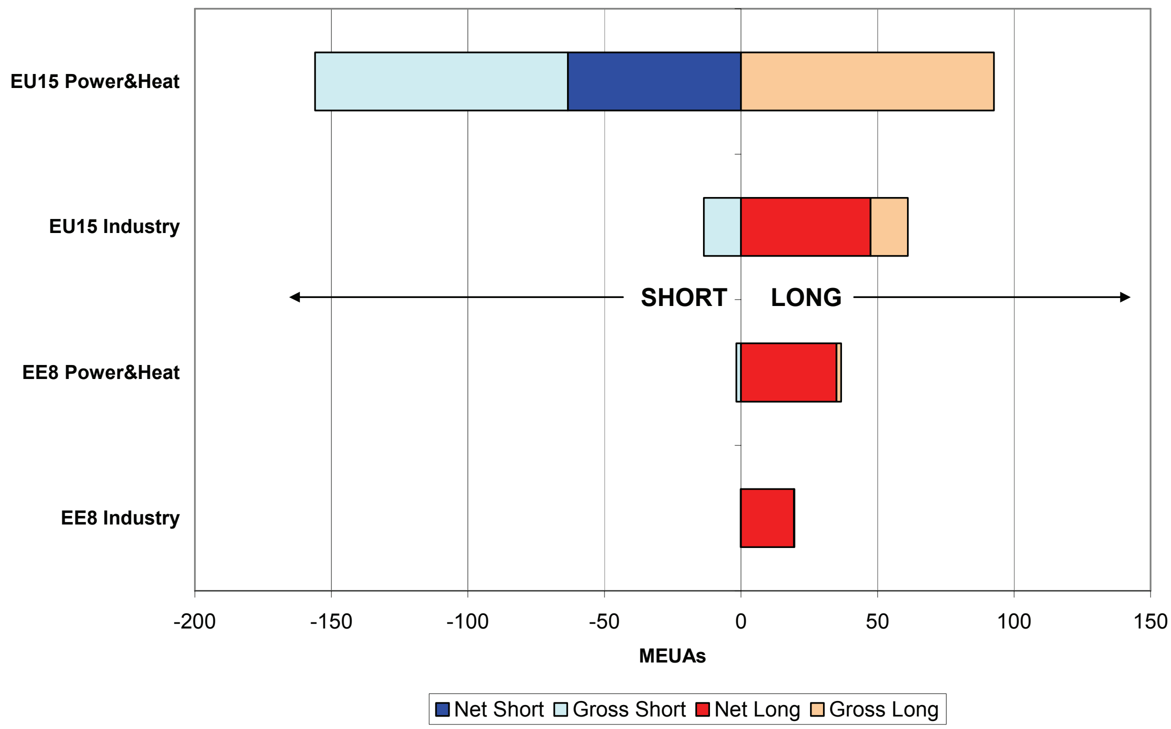
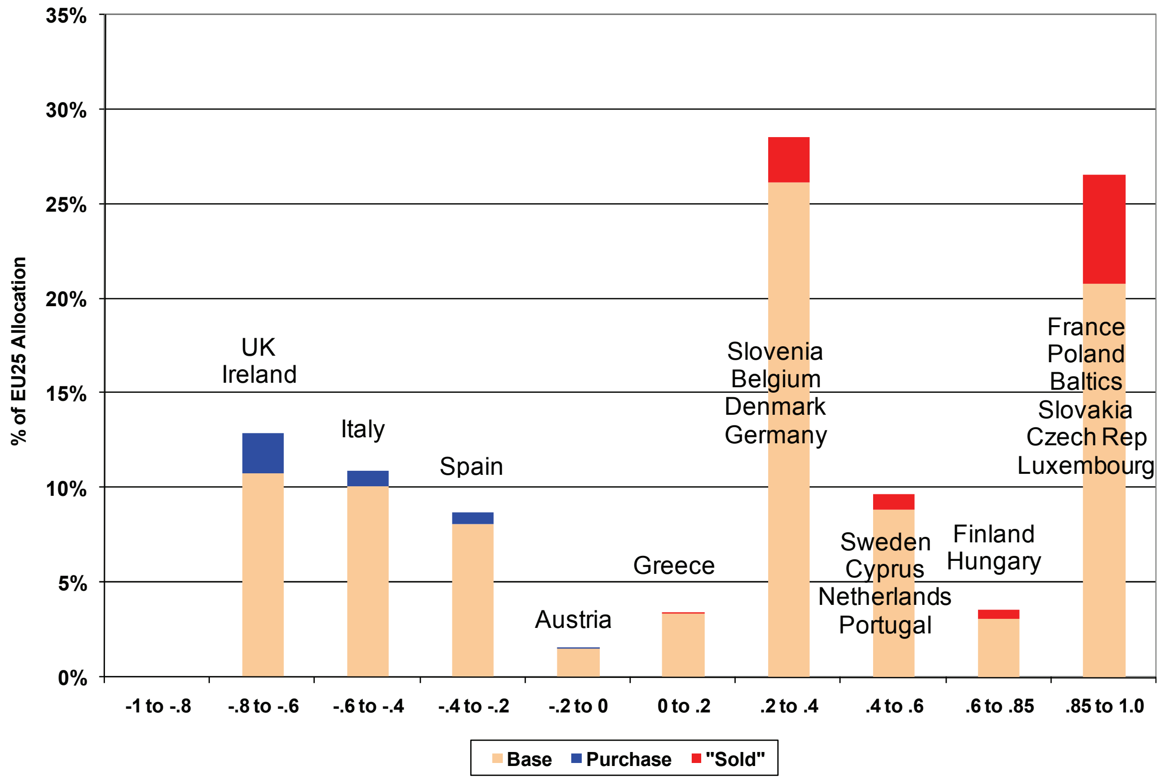


Figure 7. Distribution of EUAs by Net Ratio



Note: average of 2005 and 2006 data

Figure 8. 2005/6 emissions, base period emissions and total allowances: total and by region

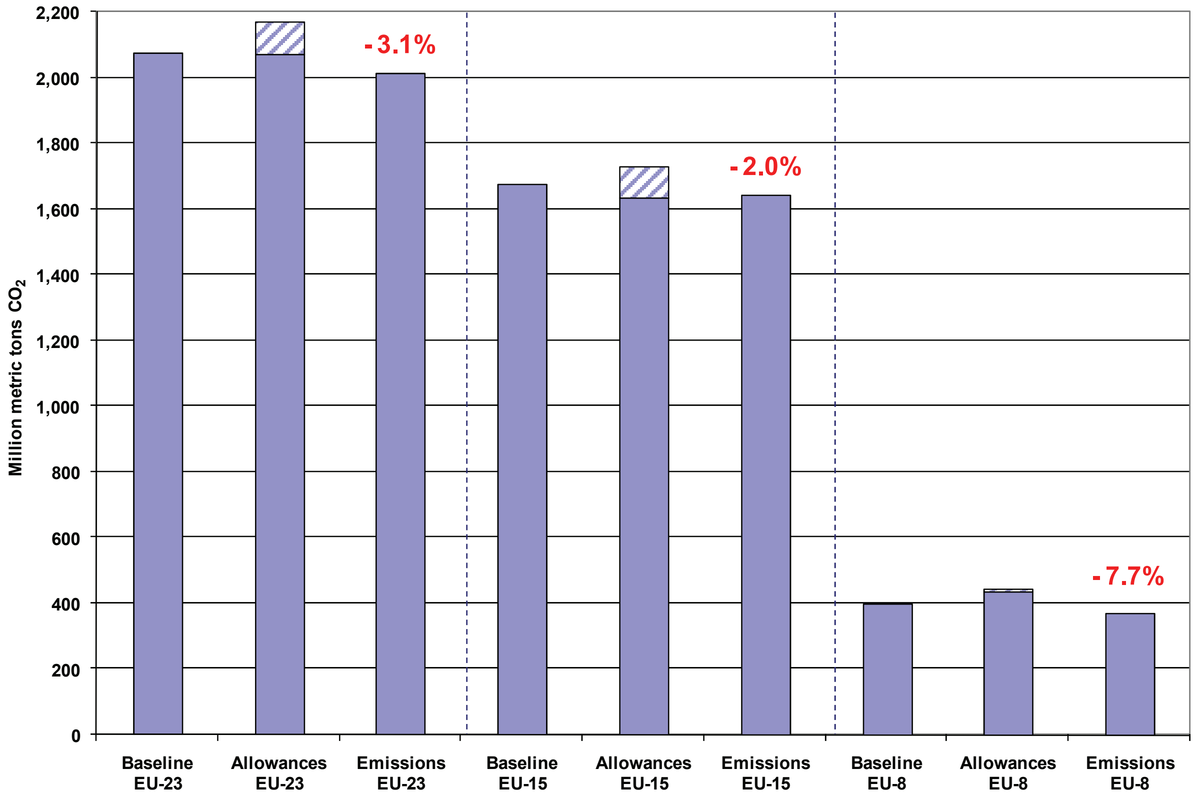
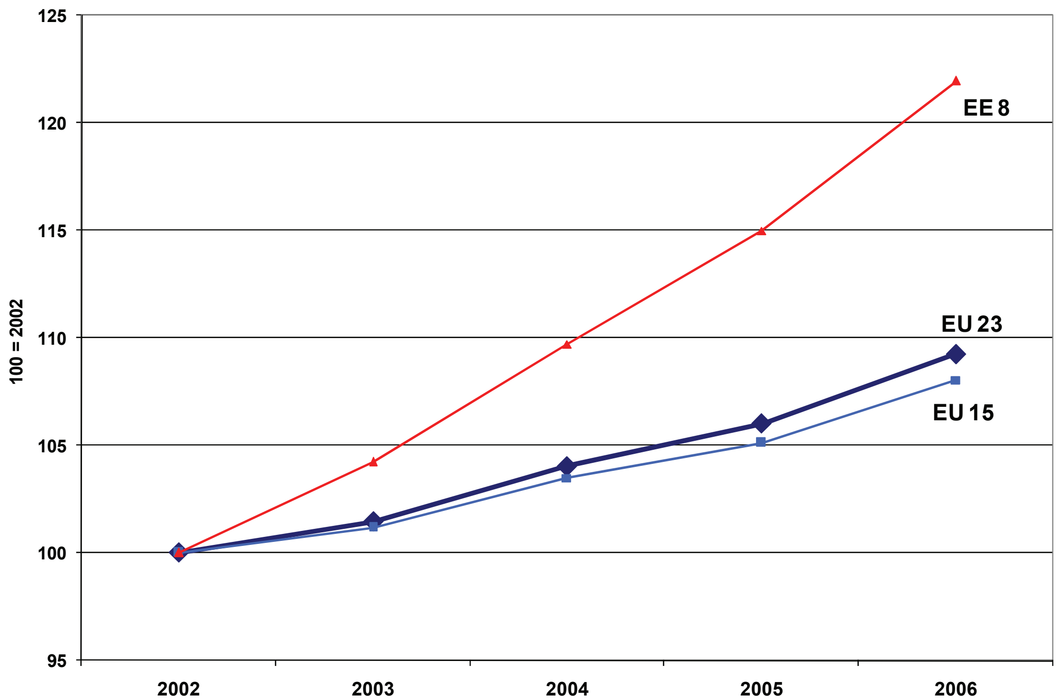


Figure 9. GDP growth in the European Union



Source: Own calculations based on IMF data.

Figure 10. Indicators of economic activity in the EU25 (2002-2006)

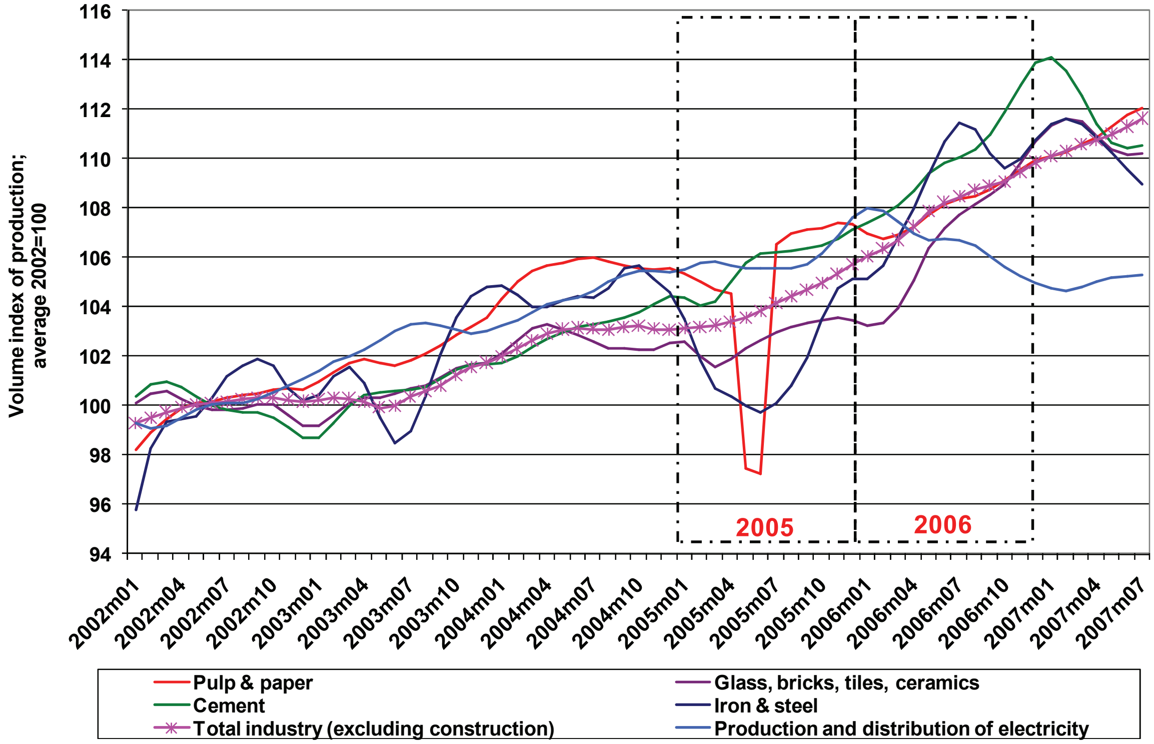


Figure 11. A scenario for BAU emissions in the absence of the EU ETS

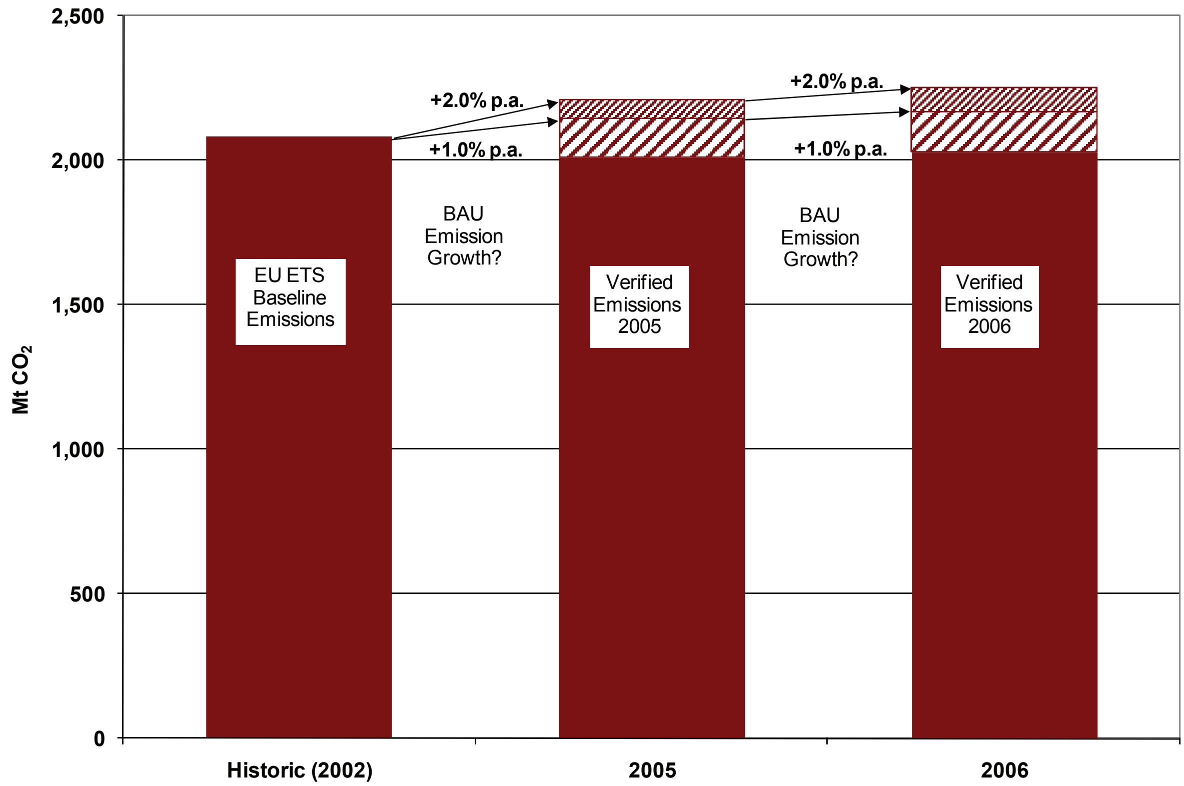


Table 1. A general picture of the EU ETS in its first two years

	Allocation 2005/2006 Mt CO_2	Emissions 2005/2006 Mt CO_2	Difference Mt CO_2	Difference Percentage
TOTAL	**2072.7**	**2014.0**	**58.7**	**2.8%**
Germany	493.4	476.2	17.2	3.5%
Poland	237.0	205.7	31.2	13.2%
Italy	210.1	226.6	-16.5	-7.9%
UK	205.3	246.7	-41.4	-20.2%
Spain	168.9	181.5	-12.7	-7.5%
France	150.4	127.3	23.1	15.4%
Czech Republic	96.9	83.0	13.9	14.3%
Netherlands	86.4	78.5	7.9	9.1%
Greece	71.1	70.6	0.5	0.6%
Belgium	59.1	55.1	4.0	6.9%
Finland	44.6	38.9	5.8	12.9%
Portugal	36.9	34.8	2.2	5.8%
Denmark	32.5	30.3	2.2	6.8%
Austria	32.5	32.9	-0.3	-1.1%
Slovakia	30.5	25.4	5.1	16.7%
Hungary	30.2	25.9	4.2	14.0%
Sweden	22.3	19.2	3.1	14.0%
Ireland	18.9	22.0	-3.1	-16.6%
Estonia	17.5	12.4	5.1	29.2%
Lithuania	12.0	6.5	5.5	45.6%
Slovenia	8.9	8.8	0.1	1.5%
Cyprus	5.5	5.2	0.4	6.7%
Latvia	4.1	2.9	1.2	28.7%
Luxembourg	3.2	2.7	0.6	17.7%

Source: Own calculations based on data provided by the CITL.

Table 2. Trends in Real GDP, CO_2 emissions, and CO_2 intensity

		Annual changes in percent	
		1995-2000	2000-2004
EU23	Real GDP	+2.9%	+1.8%
	CO_2 Emissions	+0.1%	+1.0%
	CO_2 Intensity	-2.7%	-0.8%
EU15	Real GDP	+2.8%	+1.6%
	CO_2 Emissions	+0.4%	+1.1%
	CO_2 Intensity	-2.3%	-0.5%
EE8	Real GDP	+4.3%	+3.6%
	CO_2 Emissions	-1.8%	+0.2%
	CO_2 Intensity	-5.8%	-3.3%

Source: CO_2 emissions from EEA (2006). Own calculations for GDP based on IMF data weighted at 2004 PPP values. Intensity calculated.

Table 3. A country-specific approach to calculating emission reductions

	Baseline Emissions (Mt CO_2)	2005 BAU Emissions (Mt CO_2)	Verified Emissions (Mt CO_2)	Indicated Reduction (Mt CO_2)	Percent Reduction
Without adjustment of baseline emissions					
EU23	2,078	2,150 (+3.5%)	1,976	-174	-8.1%
EU15	1,677	1,729 (+3.1%)	1,609	-120	-7.0%
EE8	401	421 (+4.8%)	367	-54	-12.8%
With adjustment of baseline emissions					
EU23	1,917 (-7.8%)	1,984 (+3.5%)	1,976	-7.6	-0.4%
EU15	1,559 (-7.0%)	1,614 (+3.1%)	1,609	-4.8	-0.3%
EE8	357 (-11.0%)	370 (+4.8%)	367	-2.8	-0.7%

Source: Own calculations based on data from CITL, DEHSt (2005), EEA (2006) and IMF.