Point Carbon

EU ETS Phase II – The potential and scale of windfall profits in the power sector

A report for WWF

By

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Executive Summary

WWF has asked Point Carbon to undertake a study to assess the potential and scale of windfall profits in the power sector in selected countries (UK, Germany, Spain, Italy and Poland) during the second phase of the EU Emissions Trading Scheme (ETS), which runs from 2008 to 2012. In this report, we define a windfall profit as accruing to thermal (CO_2 emitting) power generation if the additional revenue earned from the pass-through of CO_2 (opportunity) costs to power prices exceeds the level of compliance costs incurred under that scheme by thermal generators.

We have found that:

- The level of windfall profits estimated by Point Carbon is significant across many countries, with the estimated level in the five countries included in this study to be between 23 and 71 billion euros, in total, during the second period of the EU ETS (2008 – 2012) – based on an EUA price of 21 to 32 €/t CO_2 and a range of pass-through assumptions.
- Windfall profits are highest in countries that have a high level of pass-through of CO_2 costs into wholesale power prices, countries with emissions intensive (coal) plant setting the price the majority of the time, and countries that allocate the highest percentage of free allowances to the power sector.
- We estimate highest levels of windfall profits for generation in Germany (between €14-34 billion) and UK (€6-15 billion), due to the high level of pass-through as well as the relatively high level of emission intensity of marginal plant. The generation systems more dominated by low-emitting technologies tend to have lower levels of profits, such as Spain (€1-4 billion);
- Windfall profits accrue due to the allocation of EUAs to generation free of charge. As such, this is due to a political decision, rather than due to any form of improper activity by individual generators. The EC is proposing to remove the free allocation of EUAs to the power sector from 2013 and replace free allocation with auctioning of allowances, so this issue should only persist in phase 2 and there should be no aggregate windfall profits from 2013 onwards;
- Providing a free allocation to individual plant that is carbon intensive does reduce the incentives provided by the scheme to invest in low emissions generation technology - thereby off-setting one of the main aims of the scheme;
- A high level of pass-through is more consistent with each individual generation plant acting efficiently. This is because it is through generators acting on the prevailing CO_2 price in their decisions to run plant that gives the scheme its main short-run benefits – that of promoting the use of existing lower CO_2 intensive plant at the expense of higher CO_2 emitting plant. If a plant is not being dispatched in regards to these signals, then the power system is not fully optimising its use of plant. That is, using the lowest cost (measured as short-run marginal cost) plant to meet demand at any time. Given this, we believe that it is not the level of pass-through that provides windfall profits, it is the level of free allocation that does;
- The profits of the full value chain in the power sector will be dependent on the ability of suppliers to pass-through higher generation costs to end-customers. In this report, we

measure the windfall profits accruing only to the generation sector of the market – as we are assessing the pass-through of costs into wholesale power markets. Where prices are capped or regulated, generators may not be able to pass-through these full costs into retail prices and so the total windfall profits may not be realised.

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Disclaimer

1 Introduction

WWF has asked Point Carbon to undertake a study to assess the potential and scale of windfall profits in the power sector in selected countries during the second phase of the EU Emissions Trading Scheme (EU ETS), which runs from 2008 to 2012.

The countries that are assessed (Germany, United Kingdom, Spain, Italy and Poland) have been chosen to provide coverage across different geographic locations in Europe and to reflect different power market structures. The difference in these power systems will reflect the fuels used for generation, the type of plant that is responsible for setting prices and the level of pass-through into power prices.

1.1 EU ETS background

The EU ETS was established through binding legislation proposed by the European Commission (EC) and approved by the EU Member States and the European Parliament. The scheme is based on six fundamental principles:

- It's a 'cap-and-trade' system;
- The current focus is on CO_2 emission reduction from power sector and industrial emitters;
- Implementation takes place in phases, with periodic reviews and opportunities for expansion to other gases and sectors. In this report, we have been asked to focus specifically on the power sector;
- Allocation plans for emission allowances are decided periodically, in advance, for each phase;
- It includes a strong compliance framework;
- The market is EU-wide but taps emission reduction opportunities in the rest of the world through the link to the Kyoto Protocol's Clean Development Mechanism (CDM) and Joint Implementation (JI), and provides for links with compatible schemes in third countries.

At the heart of the ETS is the common trading 'currency' of emission allowances. One allowance (EU Allowance - EUA) represents the right to emit one tonne of CO_2. In the first (2005 to 2007) and second phases (2008 to 2012) Member States are tasked with drawing up national allocation plans (NAPs), which give each installation in the scheme a certain number of allowances free of charge, thus allowing it to emit the corresponding amount of CO_2 without any cost.

The limit or 'cap' on the number of allowances allocated creates the scarcity needed for a trading market to emerge. Companies that keep their emissions below the level of their allowances are able to sell their excess allowances at a price determined by supply and demand at that time. Those facing difficulty in remaining within their emissions limit have a choice between taking measures to reduce their emissions, such as investing in more efficient technology or using a less carbon-intensive energy source, buying the extra allowances they need at the market rate, or a combination of the two, whichever is the lowest cost. Theoretically, this ensures that emissions are reduced in the most cost-effective way.

1.2 Allocations

1.2.1 Level in NAP

In phase 1 of the EU ETS (2005-07) more allowances were handed out to installations than were required due to the fact that allocation plans were based on estimates of emissions rather than independently-verified, measured emissions. This led to prices collapsing at the end of April 2006 and dropping to less than thirty euro (€) cents per tonne by mid-2007.

The total level of allocation for the second phase has now been set, with the EC having commented on every national allocation plan from EU27 Member States. We calculate that the level of allocation is around 200 Mt/year lower than current emissions forecasts, based on prevailing fuel and CO_2 prices.

1.2.2 Method of Allocation

In order to introduce EU companies to emissions trading with a "soft landing", particularly given the fact the EU was the only region implementing such an emissions trading scheme, the EU ETS Directive ruled that most allowances should be allocated to installations free of charge — at least 95% during the initial phase and at least 90% in the second phase from 2008 to 2012.

In phase 1, industry sectors covered by the scheme were allocated according to their projected requirements, whilst it was the power sector that was faced with the largest reduction burden. This is because the power sector is not exposed to international competition, it has the largest potential for emissions reduction (for example, through switching from coal-fired to gas-fired generation) and most importantly, it has the ability to pass-through the costs of purchasing allowances into the power price.

The options for the allocation of emissions allowances in a trading scheme are:

- **Grandfathering** – in which allowances are provided to the installation on the basis of either historical or expected future requirement for such allowances by the installation;
- **Benchmarking** – in which allowances are provided to the installation on the basis of a specific benchmarks;
- **Auctioning** – in which allowances are provided to the installation on the basis of prices that the installation is willing to pay in an auction.

Both grandfathering and benchmarking allocate allowances for free. Grandfathering was the most commonly used method of allocation in phase 1 and is still widely used in phase 2, albeit with more countries using benchmarking especially for the power sector.

Even though Member States were given the option to auction up to 10% of allowances during phase 2, only 11 Member States have decided to use auctioning. This means that around 75

Mt/year will be auctioned compared to a theoretical total of circa 200 Mt/year – or around 4% of all allowances will be auctioned.

As part of the review of the EU ETS Directive, which sets out changes to the scheme from 2013 onwards, the EC has proposed that from the start of Phase 3 (2013) that 100% of the allocation to the power sector will be auctioned.

1.2.3 PASS-THROUGH OF OPPORTUNITY COSTS

Free allocation of the vast majority of allowances has been politically problematic in phase 1 of the EU ETS. More specifically, it has been the pass-through of the opportunity cost of allowances that were allocated for free into the power price that has been particularly controversial. We now look at why this should happen in theory and how it gives rise to what is termed windfall profits.

In looking at the impact of the CO_2 price on how power is priced in a liberalised power market, it is important to realise that, from an economic optimisation standpoint, it is incorrect to assume that if all of the CO_2 allowances are provided free to the operator, then the spot CO_2 price will not subsequently influence power pricing. This is because the traded CO_2 price becomes an opportunity cost for the generator that it must take into account in deciding to generate.

The CO_2 price is an opportunity cost because in deciding to generate, a power producer will use up both its fuel and the CO_2 allowances required to offset the emissions from that generation. In more liberalised power markets, generators will only generate electricity if the revenue from selling electricity exceeds the revenue that they could earn from selling their fuel and CO_2 permits in the respective spot markets. This will influence power prices as the electricity market needs to provide a higher level of remuneration for generators to secure the same volume of electricity. However, this does not necessarily mean that the CO_2 price will influence the electricity price all the time.

In a more liberalised power system, the combined opportunity costs of fuel and CO_2 for the marginal generator must exceed the power price, if the system is to have a sufficient level of generation to meet demand. If the power price does not exceed these short-run marginal costs, then it would be more profitable for the marginal generator to sell the fuel and the CO_2 allowance than to generate. Thus, the price must change to ensure that there is sufficient generation to meet the level of system demand. If the power price exceeds these short-run opportunity costs, for instance, because it is recovering some fixed costs, then the market price may have no need to adjust. That is, since the costs are not incurred and are simply opportunity, the level of fixed cost recovery is not impacted and therefore it is more economic to generate even without changing the bid price. If prices change even if there is no need for them to do so, then this will be evidence of some degree of market power.

In addition to it being a source of opportunity costs, some cost of the EU ETS will have been incurred for this sector as power generation as a whole was short of allowances in 2005 and 2006 (and will be shorter in phase 2 compared to phase 1). Generators will want to recover any costs associated with the allowances they need to purchase on the market to cover the emissions associated with their generation. As this increasingly becomes the case (less free allocation and more incurred cost), then we expect that the impact on the power price will increase to all periods as this then does start to impact on the level of fixed costs that are recovered.

In short, we argue that:

- The passing through the value of CO_2 as an opportunity cost is necessary if the market cost of CO_2 is to influence the use of power plant, and by extension, the level of emissions from the sector. If generators are not factoring this into their despatch and pricing decisions, then the application of the scheme will have largely failed in that sector;
- The more liberalised a power market, the more generators will act on spot prices in their dispatch decisions and the greater the level of pass-through of the opportunity costs of CO_2 into the wholesale power price. In more regulated power sectors, the regulation of end user tariffs and often the lack of meaningful spot markets for power might mean that the pass-through of opportunity costs is not done by generators, leading to sub-optimal power dispatch and higher levels of emissions than is economically rational;
- This means that power prices should see an uplift from the imposition of the EU ETS. This is important for the scheme to affect behaviour as it provides additional revenue to low CO_2 forms of generation while at the same time it should encourage a reduction in demand and an increase in efficiency measures;
- The EC is pushing for Member States to move towards fully liberalised power markets, which would both serve to remove some anti-competitiveness issues and make the emissions trading scheme function in the most efficient manner;
- Providing a free allocation to the thermal (CO_2 producing) generators of the power sector can:
    - offset some of the incentive to invest in the future in low CO_2 plant (by providing a capital grant to more carbon intensive forms of generation) but should not affect the optimal dispatch of existing plant;
    - provide significant additional profits through opportunity costs, that are not matched by an incurred cost, being passed through to power prices. It is these profits that have been labelled windfall profits and which have been identified as a current problem of the EU ETS.

Further details of the theory of pass-through of opportunity costs into power prices are included in Appendix 2.

1.3 Windfall profits defined

In this report we define a windfall profit as accruing to thermal power generation if the additional revenue earned from the pass-through of CO_2 (opportunity) costs to power prices exceeds the level of compliance costs incurred under that scheme by thermal generators.

This means that windfall profits depend on:

- the increase in revenue that comes from the pass-through of both opportunity and incurred costs into the power price. This is in turn dependent on:

- the marginal price setting plant in the power system. In general, European power systems tend to see either coal or gas as the marginal price setting generator. Whether gas or coal is at the margin is largely dependent on the installed capacity mix of each individual power system and the relative level of fuel prices. Given the seasonal changes in some fuel prices (particularly natural gas prices), gas and coal can be marginal plant at different times of the year in some systems that have installed capacity that is reasonably balanced between the two fuels. Other fuels may also be a marginal plant in some systems (such as oil) but this is becoming more uncommon;
- the level of pass-through into the power price which is a function of the state of liberalisation and the degree to which dispatch is governed by spot prices; and
- the level of CO_2 prices.

- the incurred costs of complying with the scheme, which is a function of the level of emissions of the thermal sector, the level of free allocation to the sector and the level of CO_2 prices.

Under this definition, if the level of free allocation is zero, then the level of windfall profit to thermal power generation will also tend to be zero (indeed, we would expect to see a net cost). As such, we would expect that the level of windfall profit to the power sector in phase 3 (when it is proposed that all allowances allocated to the power sector will be auctioned) would tend towards zero. Also, this definition is an earnings-based definition of profit, which means that it is calculating net earnings before interest, tax and depreciation is taken into account.

We now turn to assessing what the level of windfall profit is expected to be during phase 2 when there remains a high level of free allocation.

2 Methodology and assumptions

2.1 Calculation of windfall profit

As outlined in the previous chapter, we have defined the accruing of windfall profit to thermal generation as being the net additional profit earned by this sector due to an increase in revenue to plant from the introduction of the EU ETS less the incurred compliance costs of the sector.

Figure 2-1 Formula for estimation of windfall profits

Windfall profit = $TR_t - TC_t$

$TR_t = TGEN * P_{CO2} * CPT * EF_{psp}$

$TC_t = (E_t – FAL_t) * P_{CO2}$

Where:

TR = Total Revenue

TC = Total Cost

TGEN = Thermal Generation

P_{CO2} = CO_2 price

CPT = cost pass through

EF = Emissions factor

E = Emissions

FAL = Free Allocation

Subscript:

$_t$ = thermal plant

$_{psp}$ = price setting plant

We note that when calculating windfall profits, we:

- Include thermal (CO_2-emitting) plants only. Non-emitting plant-types, such as renewables and nuclear, do not receive an allocation but do benefit from the uplift in power prices due to pass-through of CO_2 prices. This is an important element of how the EU ETS will impact on this sector. We do calculate the total revenue that will accrue to the power sector as a whole, in each country, from the introduction of the pricing of carbon in this report;
- Include the generation and emissions from plants producing electricity and we exclude the generation from combined heat and power (CHP) plants. This is because CHP plants are mostly despatching electricity according to heat requirements and rarely have output that is priced into wholesale markets;

- Estimate the windfall profits accruing only to the generation sector of the market – as we are assessing the pass-through of costs into wholesale markets. The profits of the full value chain in power will be more dependent on the ability of suppliers to pass-through higher generation costs to end-customers. This ability will be different in different systems and is outside the scope of this report;
- Estimate the windfall profits accruing to the thermal power generation sector for each country rather than for individual generators. The change in revenue for an individual generator will depend on their specific plants and how these are affected by the addition of a CO_2 price and changes in the merit order of the power stack.

2.2 CO_2 price assumptions

In our assessment of the level of windfall profits, we use two CO_2 prices:

- Forward curve over the counter (OTC) closing prices: we use an average of 08-12 vintages. The forward curve used is from the same day as the fuel prices we have used in our model to calculate emissions levels from the thermal generation; and
- An assessment of the implied average fuel switching cost for 2009 using the fuel prices from 24 January 2008. This is the average price that the CO_2 price would need to be to make gas competitive against coal in the merit order using average annual fuel prices. We note that this is not our fundamental forecast of the average price over the five year period as it does not reflect the impact of the import of CER/ERU credits to meet the demand, nor the post-2012 price in the case of a yearly long position.

Table 2-1 EUA prices used to assess windfall profit levels

€/tCO_2	Average EUA price 08-12
Implied fuel switching price[1]	32
Forward market (24 January 2008)[2]	21

[1] Based on implied average fuel switching cost for 2009 using fuel prices from 24 January 2008
[2] Based on Point Carbon's OTC closing prices, average of Dec 2008-12 vintages. (http://www.pointcarbon.com/Home/Market%20prices/Methodology/category745.html)

2.3 Thermal generation emissions

The forecast level of power sector CO_2 emissions is based on Point Carbon's proprietary CO_2 market forecasting model, Carbon Market Trader (CMT). The CMT model estimates power sector emissions using a detailed data base on individual generation installations of each plant covered by the EU ETS. We include assumptions on the evolution of the sector that includes the closure of existing plant and new build of different technologies (including non-thermal plant). These assumptions are based on: published information on power projects that are either under construction or have been announced; and our views on the implication of policy measures aimed at the sector including those aimed at encouraging energy efficiency and renewable forms of generation.

The model also includes assumptions on:

- Current market fuel price forward curves plus our plant by plant level power stack model. Fuel prices are based on market forward prices (taken on 24 January 2008), which we combine with plant-specific transportation cost estimates to derive delivered fuel prices;
- Power demand forecasts. These are based on data from UCTE, Eurelectric, and Eurostat.

The model then estimates the level of future emissions by dispatching the lowest cost plant (based on carbon included short run marginal costs) available to meet given demand at any time. The results of the optimisation, in terms of thermal emissions from the power sector, are reported in Table 2-2.

Table 2-2 Average level of annual power sector generation and emissions (2008-12)

Country	Power sector total generation (08-12) TWh/year	Power sector thermal generation (08-12) [1] TWh/year	Power sector emissions (08-12)[1] $MtCO_2$/year
United Kingdom	360	280	178
Germany	570	424	338
Spain	320	175	93
Italy	340	268[2]	152
Poland	174	166	156

[1] Based on Point Carbon analysis using fuel and CO_2 prices from 24/01/2008. Only electricity generation plants included.
[2] We note that around 40TWh of thermal plant in Italy comes from Power Purchase Agreements (PPAs) known as CIP6. This volume receives a tariff that allows for full-recovery of any ETS costs.

2.4 Level of free allocation

Even though the European Commission (EC) has now ruled on the total level of allocations that each EU27 Member State is allowed to allocate in the second phase, not all countries have produced installation-level allocation lists or published final NAPs that reflect the cuts to the total cap that the EC has enforced. In order to calculate the level of free allocation to each country's power sector, we have used in order or preference either:

- Sectoral allocations as published in the phase 2 NAP and final installation lists; or
- Derived sectoral allocations based on information published in the phase 2 NAP; or
- A pro rata reduction for the power sector based on Phase 1 sectoral allocation * overall NAP reduction.

We summarise the status of NAPs of our selected countries in Table 2-3

Table 2-3 Status of National Allocation Plans and power sector allocation

Country	National Allocation Plan status[1]	Total approved cap (Mt/year)	Power sector cap (Mt/year)	Cap as % of forecast emissions[5]
United Kingdom	NAP finalised and approved by EC. Installation-level data published.	246.2	107[2]	60%
Germany	NAP approved by EC. No final installation list published. Power sector cap based on information in NAP, verified emissions and Point Carbon calculation.	453.1	230	68%
Spain	NAP finalised and approved by EC. Installation-level data published. Power sector cap taken from Spanish legislation documents.	152.3	54	58%
Italy	NAP approved by EC. No final installation list published. Power sector cap taken from revised NAP submitted for consultation in Dec 07.	201.6	100[3]	66%
Poland	NAP approved by EC. Poland has published a NAP taking into account the cuts required by the EC, although it is taking legal action against the EC to increase its cap	208.5	106[4]	68%

[1] Status as of 20/02/08
[2] Large Electricity Producers (LEP) only
[3] Based on cap to existing power plants of 87 Mt/year and the new entrant reserve allocation that will be allocated to known planned generation plants
[4] Based on total cap of 208.5 Mt/year, allocation to electricity generation only ,
[5] Emissions forecast based on Point Carbon's Carbon Market Trader model (see Table 2-2)

The **UK** submitted a plan which was accepted by the EC and allocated 246.2 Mt/annum in total. The large electricity producers (LEP sector) will receive an allocation of 107.4 Mt/annum. There is a separate allocation for good-quality combined heat and power plants, although we do not include this in our calculation of the power sector cap or our emissions forecasts. The UK has set aside a new entrants reserve of 17.3 Mt/annum and plans to auction 17 Mt/annum.

The **German** NAP has gone through many changes on route to the final version. Germany's initial proposal was to allocate 482 million allowances per year, but it later reduced that figure to 465 million after revised emissions figures were made available. However, the EC on 29 November 2006 reduced Germany's allocation to 453.1 million. There is no final installation level allocation list or sector split of allowances at the time of writing.

Our forecast of the power sector cap in Germany (230 Mt/annum) is based on the total cap less the auctioning volume and the new entrant reserves. The compliance factor is fixed for industrial installations at a 2.5% reduction per year from relevant emissions and it is the power sector that has to bear the remaining reduction in order to respect the total cap.

The EC assessed the **Spanish** NAP in February 06 and authorised the total cap to be reduced from 152.7 to 152.3 Mt/year. Following two revisions to the NAP, which included changes to existing installations and new entrants reserve, the power sector cap has been set at just over 54 Mt/year. This represents a significant cut from the phase 1 allocation and leaves the Spanish power sector with around 50% of its requirement, based on recent estimates of emissions. No auctioning is planned in Spain during phase 2.

Italy had their submitted NAP cut by the EC from 215 Mt/year to 201.6 Mt/year. Italy produced a revised NAP for consultation in December 2007, based on the new total cap. This plan sets the cap for the power sector at 87 Mt/year, which is around a 30% decrease from phase 1. The new entrants reserve is set at 15.6 Mt/year and additional free allowances will be provided to new entrants should this reserve run out. Allocation to known new-build from the new entrants reserve is included in our analysis, along with the corresponding emissions from new plants. Italy does not plan to auction any allowances.

The EC ruled in March that **Poland** had to reduce its cap to 208.5 Mt/year, significantly lower than the 284.6 Mt/year that Poland proposed. Poland subsequently published a new national allocation plan in December 07, which respected the new cap and distributed the cut amongst different sectors. Following a round of public consultations, Poland released a final NAP (including installation-level allocations) on 12th February 2008, which allocates the power sector 132.3 Mt/year (105.8 Mt/year for electricity generation and 26.5 Mt/year for power and heat).

Poland, along with six other Member States, has filed a lawsuit against the EC for its March decision on Poland's allocation plan, but must allocate according to the approved cap as it undertakes legal action. A decision on the lawsuits is not expected until 2009 at the earliest.

2.5 Price setting plant by system

As discussed above, it is the level of pass-through of CO_2 prices (opportunity costs) into the power price that increases generators revenue and allows for windfall profits to be realised. The level of pass-through differs in each of the markets as different plant types set the marginal price: the higher the emissions intensity of the price setting plant, the higher the absolute level of pass-through. In terms of broad characteristics of the different markets, we note that:

- The German market, which is characterised by having considerable coal capacity (around 70% of installed thermal capacity in Germany is coal fired) sitting alongside non-CO_2 emitting forms of generation such as nuclear, hydro and wind;
- The UK market, which is characterised by an almost even mix of coal and gas-fired installed capacity, with gas plant now being the marginal thermal plant in many periods;
- The Spanish market has considerable low carbon generation (wind, hydro and nuclear) and a thermal stack with considerable levels of new gas plant and some underlying coal – a 60% to 40% difference in installed capacity;
- The Italian market has, like Spain, a tranche of new gas plant (CCGT) which competes against older, fully depreciated coal and oil plant; and
- The Polish market is almost entirely (95%) dominated by coal-fired generation.

In assessing the plant that will be the price setting plant, we used our power stack models (described above) and identified the marginal price setting plant, given our assumptions, in each modelled hour. We then aggregated these to derive the proportion of time that different thermal generation plant will spend at the margin in phase 2 for each system (see Table 2-4).

Table 2-4 Estimated proportion of time plant is price setting

	% of time – coal	% of time – gas
UK	35%	65%
Germany	75%	25%
Spain[1]	25%	40%
Italy[2]	20%	70%
Poland	95%	5%

[1] We note that for Spain, low-emitting generation sources (hydro and co-gen) were setting the price for around 35% of the time
[2] We note for Italy that oil-fired plant is estimated to remain at the margin 10% of the time

2.6 Level of cost pass-through assumptions

In influencing our assumption on the likely future level of CO_2 cost pass-through in each country, we look at evidence of how the following power markets have responded to date to the introduction of CO_2 pricing. In assessing the evidence on the pass-through level, we focus on looking at out-turn power spreads, which take out the impact of changes in variable (fuel) costs from the power price. The spreads we look at include:

- **Spark-spread** – the power price less the price of gas adjusted for the efficiency of gas-fired generation plant;
- **Dark spread** - the power price less the price of coal adjusted for the efficiency of the coal-fired generation plant;
- **Green spread** – the spark spread less the price of CO_2 adjusted for the carbon intensity of gas-fired generation; and
- **Dark green spread** – the dark spread less the price of CO_2 adjusted for the carbon intensity of coal-fired generation.

In assessing the spreads, we look at:

- **Forward spreads**. In those markets with traded forward contracts that have reported prices (Germany, UK), we use the year-ahead prices (prices for delivery in the following calendar year) as these tend to have less noise than spot prices. That is, spot-price spreads will be affected by both the CO_2 price and a myriad of other system factors including temperature, precipitation, wind speed, power demand, availability of plant, and availability of imports / exports. With forward spreads, these factors are less dominant as assumptions on future weather, demand and supply change much more gradually, providing a more stable and transparent indicator of the underlying impact of changes in the variable cost component of power.
- **Spot spreads**. In those markets either without reported forward contracts or where forward contracts are seen to be less liquid (Spain, Italy and Poland), we look at the behaviour of spot spreads to assess if there is any evidence of CO_2 pass-through into prices. This analysis is less robust given the noise that is inherent in those prices and the results need to be treated with greater caution. To control for the greater noise in the contracts, we have looked at the behaviour of both the spot spreads and the average level of spot spreads across each month. In general, a lack of a traded forward curve is symptomatic of less liberalised market and would lead us to expect a smaller degree of pass-through.

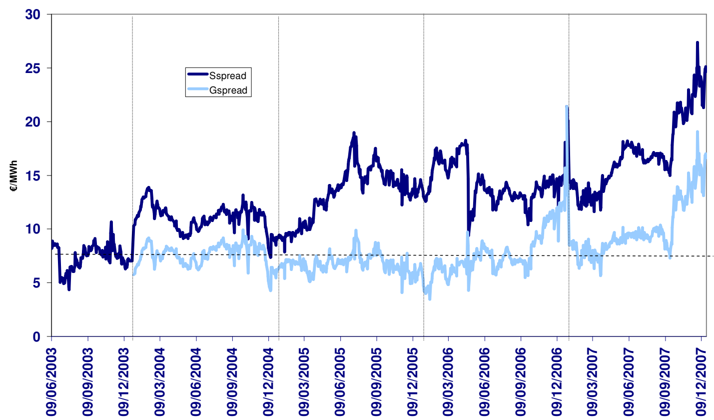
We note that we have looked at data for how the different power systems appeared to pass-through CO_2 spot and forward prices into power contracts through-out phase 1 of the EU ETS. Phase 2 will have a higher level of incurred costs (less free allocation) so phase 1 behaviour may not be a perfect indicator of behaviour in phase 2. For instance, in those systems where the level of pass-through was low in phase 1, then a higher level of pass-through may occur.

Reflecting the generation mix in each of these countries, we look at coal spreads for German and Polish power and gas spreads for UK, Spanish and Italian power. We present the analysis for each country in the coming sub-sections.

2.6.1 United Kingdom: Pass-through analysis

UK pass-through: Y+1 spread analysis

Gas plant efficiency used = 50%; Uses prices for the year-ahead contract for power, fuel and CO_2.



Source data: Comstock

- The level of pass-through of the CO_2 price into forward spreads appeared immediately in forward contracts in the UK. Forward spreads had been trading for the 2004 contract at around an average of 8 €/MWh. These spreads showed an immediate increase in value for 2005. If you take out the value of CO_2, then the spreads go back towards similar levels seen for the previous year. This pattern is repeated throughout the period with spreads increasing for 2006 in line with the evolution of the CO_2 price. A big correction in spreads also followed the CO_2 price realignment in 2006 – but green spreads remained largely constant.

Conclusion:

- Evidence of a high level of CO_2 opportunity costs being passed through into forward power prices.
- Level of pass-through: HIGH

2.6.2 Germany: Pass-through analysis

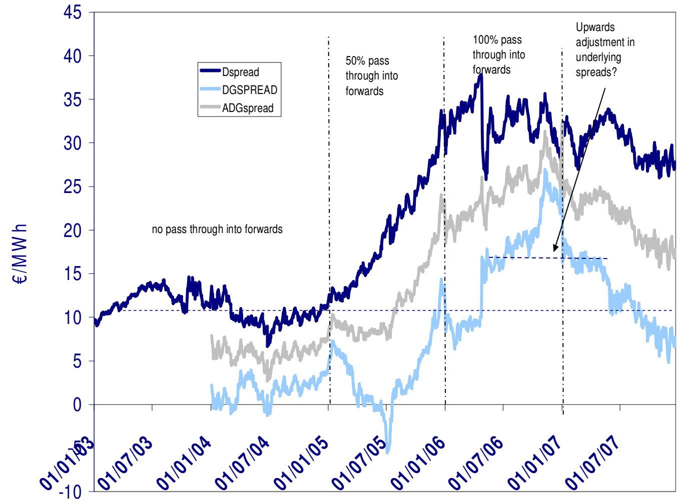
Germany pass-through: Y+1 spread analysis

Coal plant efficiency used = 34%; Uses prices for the year-ahead contract for power, fuel and CO_2.

- The level of pass-through of the CO_2 price into spreads shows an evolutionary approach. There seemed to be little evidence of prices being passed through into prices prior to the start of the scheme. However, once the scheme started functioning, there appeared to be a gradual increase of the level of pass-through into prices. For the last few years, a high level of pass-through appears in evidence.

Conclusion:

- Evidence of a high level of CO_2 opportunity costs being passed through into forward power prices. The level of pass-through not as immediate as in the case of the UK.
- Level of pass-through: HIGH

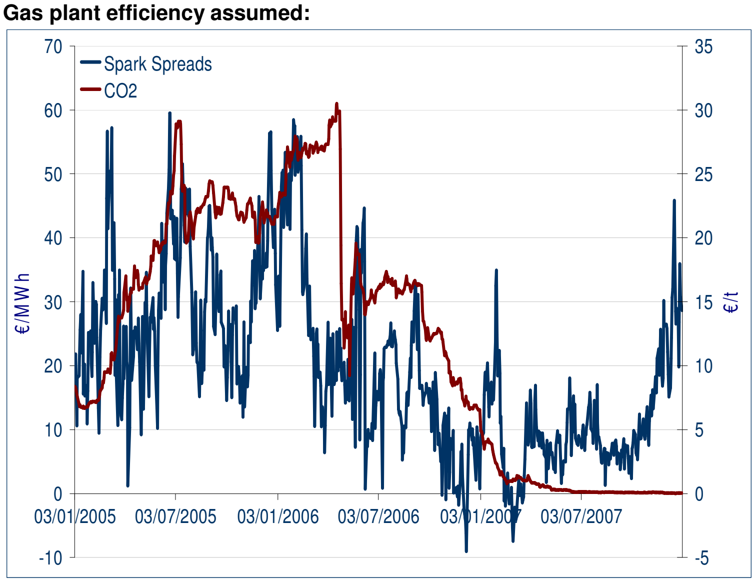


Source data: EEX

2.6.3 Spain: Pass-through analysis

Spain pass-through: Spot spread analysis

Gas plant efficiency assumed:



Source data: OMEL

- The level of spot spreads shows a good level of correlation to the CO_2 price.

Correlation:

- CO_2 – spreads (daily) = 0.62
- $C0_2$ – spreads (monthly average) = 0.72
- For spot spreads, the high level of correlation does suggest a high degree of opportunity cost pass-through into the Spanish market. We do note that although hydro levels were very low for Spain in 2005, and this would have contributed to higher spreads, correlation levels were higher for all three years than just looking at the first two.

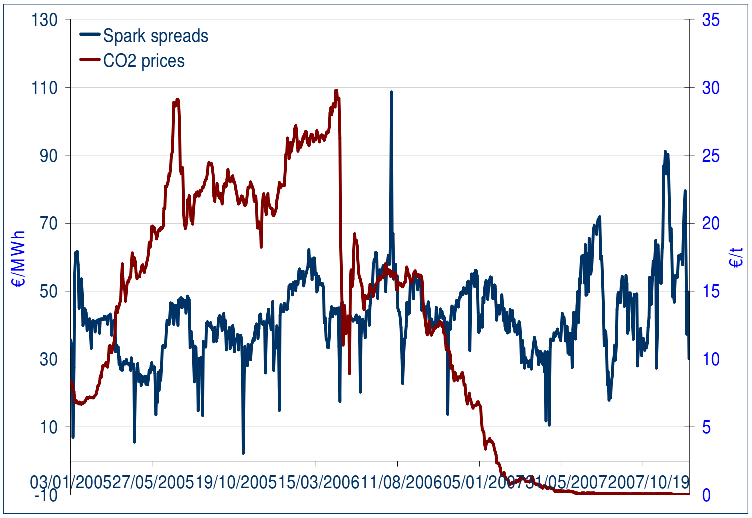
Conclusion:

- Robust concrete evidence of CO2 opportunity costs being passed through into spot power prices.
- Level of pass-through: HIGH

2.6.4 ITALY: PASS-THROUGH ANALYSIS

Italy pass-through: Spot spread analysis

Gas plant efficiency assumed: 52%, Use system average day ahead spot price (PUN)



Source data: GME

- The level of spot spreads shows no consistent pattern to the level of the CO_2 price, although this is expected given the market structure.

Correlation:

- CO_2 – spreads (daily) = - 0.14
- $C0_2$ – spreads (monthly average) = -0.19
- Italian results could be influenced by 2007 levels which were very hot, resulting in very high summer power demand and a consequent increase in average spreads. This occurred when the CO_2 price saw a consistent reduction. However, the correlation results do not improve significantly when we do not include 2007 patterns.
- Analysis of the data from 2005 and 2006 only shows no correlation.

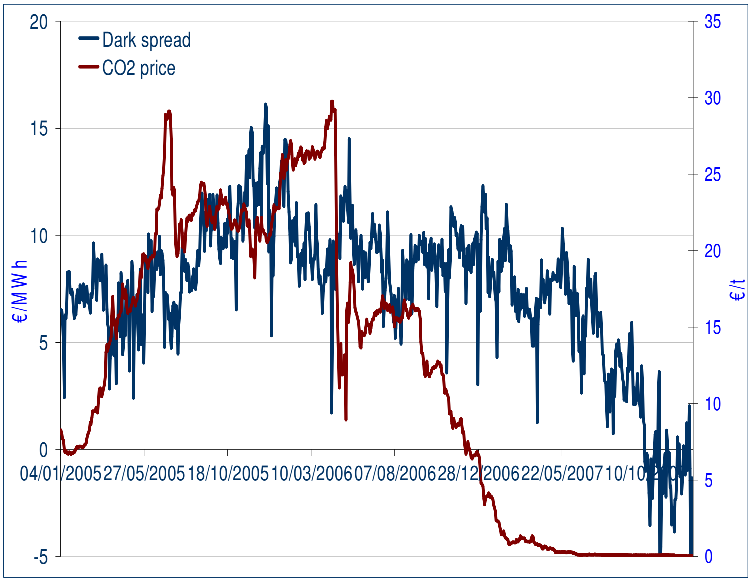
Conclusion:

- No concrete evidence of CO_2 opportunity costs being passed through into spot power prices.
- However, we note that the spark spreads in Italy have been significantly higher than in other European countries due to the monopoly structure of the power market. The high power prices have allowed for a level of fixed cost recovery that included the cost of purchasing allowances.
- During Phase 1, the power market in Italy was going through a period of transition from a more regulated structure to a more liberalised structure. If this process of liberalisation were to continue in Phase 2 then the level of pass-through would be greater as market power decreased and power prices were set according to generating costs.
- Level of pass-through: LOW (although we look at a higher pass-through sensitivity based on a more liberalised market structure)

2.6.5 Poland: Pass-through analysis

Poland pass-through: Spot spread analysis

Average coal plant efficiency =34%, Power prices = average baseload index



Source data: Towarowa Gielda Energii

- The level of spot spreads shows a good level of response to developments in the CO_2 price with spreads highest during periods of highest CO_2 prices.
- We note that there are several "must-run" power contracts, which may reduce the correlations somewhat.

Correlation:

- CO_2 – spreads (daily) = 0.45
- $C0_2$ – spreads (monthly average) = 0.61

Conclusion:

- Clear evidence of there being a correlation between CO_2 opportunity costs and spot power prices.
- Levels of pass-through between 45% - 60%
- Level of pass-through: MEDIUM

2.7 Summary of main assumptions

In Table 2-5 below we summarise the main assumptions we use in assessing the level of windfall profit to the power sector in each country in the second phase of the EU ETS.

Table 2-5 Main assumptions used in windfall profit calculation

	UK	Germany	Spain	Italy	Poland
CO_2 price levels	€21 - €32/tonne[1]				
Level of power sector emissions - Mt CO_2/year	178	338	105	152	156
Free level of power sector NAP allocation - Mt CO_2/year	107	230	54	100	106
% time coal / gas spent on the margin	35 / 65	75 / 25	25 / 40[2]	20 / 70[3]	95 / 5
Range of pass-through	75 – 100%	75 - 100%	75 – 100%	0 - 75%[4]	45 - 65%

[1] Based on forward curve price and implied fuel switching price from 24 January 2008.
[2] We note for Spain that hydro/co-gen plant are estimated to remain at the margin 35% of the time
[3] We note for Italy that oil-fired plant are estimated to remain at the margin 10% of the time
[4] We use a wide pass-through range for Italy to reflect possible changes to the market structure towards 2012

The level of windfall profit depends significantly on the level of pass-through assumptions, so we use a range of pass-through rates in the calculation. The range of pass-through rates used are based on empirical evidence from Phase 1, and in the case of Italy we have a sensitivity that covers a move towards a more liberalised power market structure (which would lead to similar pass-through rates as witnessed in UK, Germany and Spain).

We calculate the windfall profits using both a forward CO_2 price, which is consistent with the fuel prices used in our emissions forecasts, as well as an EUA price forecast based on the implied average fuel switching cost in 2009.

3 Summary results and conclusions

3.1 Summary of results

Table 3-1 shows both the total increase in revenue accruing to the thermal power generation sector in the countries looked at in this study and the range of estimated windfall profits for the second phase of the EU ETS (2008-12).

In terms of the revenue to the sector, this level of revenue would accrue to the sector even with no free allocation and be shared between all plant that sells power into the wholesale market. Thus, low CO_2 forms of generation such as hydro and nuclear will be sold at higher power prices and will seem more profitable than they would without the uplift in prices. This is an important aspect of the scheme as it provides important incentives for the generation companies to invest in forms of carbon intensity with lower forms of emissions. Without this lift to power prices, then positive incentives for such investment do not arise.

In terms of the windfall profits, the values are based on the range of pass-through assumptions identified in the previous section.

Table 3-1 Total revenue increase and windfall profit results

Country	Total revenue increase to power sector over 08-12 (€bn)	Windfall profit over 08-12 (€bn)	Total revenue increase to power sector over 08-12 (€bn)	Windfall profit over 08-12 (€bn)
CO_2 price	*21 €/t*		*32 €/t*	
UK	16 – 22	6 – 10	25 – 34	8 – 15
Germany	34 – 45	14 – 22	52 – 69	21 – 34
Spain	10 – 13	1 – 3	15 – 19	2 – 4
Italy[1]	0 – 15	0 - 6	0 – 22	0 - 9
Poland	8 – 12	2 – 6	12 – 18	4 – 9

[1] We note that the pass-through level in Italy is uncertain based on spot price evidence from phase 1. Our pass-through rate assumptions for Italy are from 0 to 75%. In the 0% case, our calculations register low or zero windfall profits although we note that a high percentage of costs (to purchase allowances) would be recovered from the power price, which is high compared to other EU countries. Higher pass-through rates, which would be consistent in a more liberalised market structure, result in windfall profits that are more comparable with the other countries in this study.

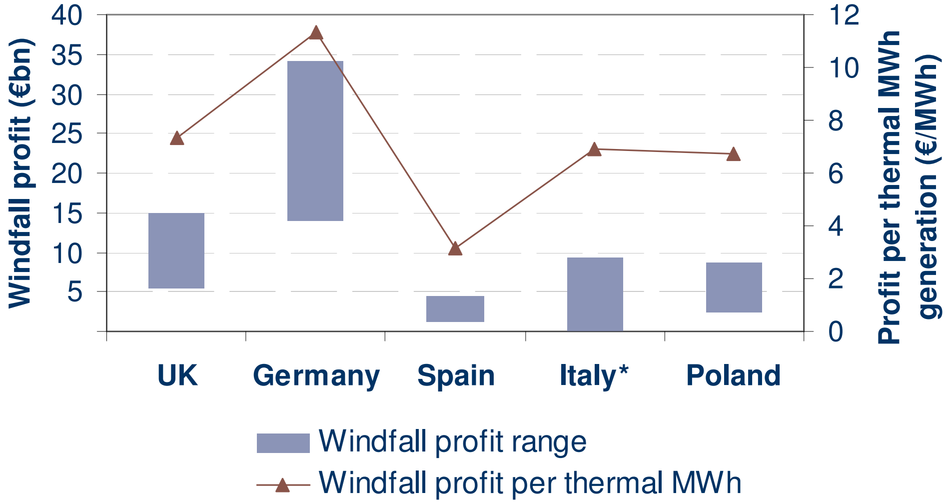
Figure 3-1 shows the full range of windfall profits for each country, taking into account the range of different pass-through assumptions and both CO_2 prices used to calculate these windfall profit values. This figure also shows the relative level of windfall profits taking into account the effect of the market size (normalised to the forecast level of thermal generation) in each country.

Figure 3-1 Range of expected windfall profits over 08-12 (€bn)

Figures based on range of pass-through and CO_2 price assumptions

Thermal generation based on estimates using fuel prices from 24th January 2007

Profit per unit thermal generation based on mid-point of windfall profit range except for Italy, which uses highest windfall profit



3.2 Conclusions from results

The results show that:

- Windfall profits are highest in countries that have a high level of pass-through of CO_2 costs into wholesale power prices, countries with emissions intensive (coal) plant setting the price the majority of the time, and countries that allocate the highest percentage of free allowances to the power sector;
- Given our modelling assumptions, the **German** power sector would be expected to gain windfall profits of between €14 and €34 billion during the second phase of the EU ETS. This is the largest absolute level of windfall profits for the countries included in this study. Taking into account the size of the German power market, the windfall profit per MWh thermal generation is €11/MWh (mid-point in range), which is the highest compared to the other countries in this study. We do note that windfall profits have been a very contentious issue in Germany and that a number of the large generation companies have been in discussion with German regulatory authorities about ways of alleviating the impact of the pass-through in phase 2;
- The **UK** has a high level of pass-through of CO_2 costs into wholesale power prices and the UK power sector would be expected to gain windfall profits of between €6 and €15 billion during the second phase of the EU ETS. Windfall profits are not as high as in Germany on a per MWh basis due to the fact that gas plants set the marginal price more often in the UK (meaning the power price increase is relatively less) and the relatively low level of free allocation to power installations in the NAP;

- Given our calculations, the **Polish** wholesale power market would be expected to receive windfall profits of between €2 and €9 billion during phase 2. When taking into account the relative size of power markets in different countries, Poland has the fourth highest level of windfall profits (per MWh of thermal generation). The comparatively lower pass-through levels are counteracted by the high emissions intensity of its generation plant. We note that final user tariffs in Poland remain regulated and relatively low against western European levels – thus it remains difficult to say how much of the pass-through into spot prices is reflected further down the value chain. There has been recent talk of liberalising end user tariffs although firm plans to remove tariff regulation have been put on hold. We would, however, expect Poland to move towards liberalisation in line with EC Directives over the coming years, which would mean that higher levels of the windfall profits are realised and may also lead to higher levels of pass-through in the wholesale market;
- In those countries where we have used spot price evidence, the **Spanish** power market passes-through a high percentage of CO_2 costs in the power price, although this is balanced out by the fact that gas plants set the marginal price the majority of time (with hydro and co-gen setting prices for significant time periods as well) and there is a relatively low level of free allocation to power plants. Given our calculations, the Spanish wholesale power market would be expected to receive windfall profits of between €1 and €4 billion during phase 2. Those generators with more coal plant than gas plant would be expected to do less well than the generators with a predominance of gas plant;
- In **Italy**, there is little clear evidence from the spot market about the level of pass-through of CO_2 costs into wholesale power prices. We note that the pass-through level in Italy is uncertain based on spot price evidence from phase 1 due to the monopoly pricing structure. Our pass-through rate assumptions for Italy are from 0 to 75%. In the 0% case, our calculations register zero windfall profits although we note that a high percentage of costs (to purchase allowances) would be recovered from the power price, which is high compared to other EU countries. Also, we note that the CIP6 market segment, currently around 40TWh thermal generation, does pass through full opportunity costs into the tariffs and so would receive some level of windfall profit. When we use higher pass-through rates, which would be consistent in a more liberalised market structure, the resultant windfall profits are between €6 and €9 billion, dependent on the CO_2 price.

We reiterate, with regards to our estimates of windfall profits that:

- These accrue due to the allocation of free EUAs to thermal power generation. As such, this is due to an aspect of allocation, which was a political decision, rather than due to any form of improper activity by individual generators. The EC is proposing to remove the free allocation of EUAs from 2013 and replace free allocation with auctioning of allowances, so this issue should only persist for the remainder of phase 2;
- These are dependent on the level of pass-through of CO_2 costs into the wholesale power price. We have used evidence from historic power prices to justify our assumptions but we note future levels of pass-through may change either due to structural changes in a power market or changes in behaviour from market participants. In general, a high level of pass-through is more consistent with each individual generation plant acting efficiently;

- Other underlying assumptions that may change over time include:
    - The level of free allocation – the NAPs are not all finalised yet and additional information may come to light with the publication of final installation-level details;
    - Fuel prices – our forecasts of emissions are based on recent forward fuel prices and we note that a change in fuel prices would affect the level of emissions (which in turn would affect the number of allowances a generation sector needs to purchase), as well as the CO_2 price.
    - The installed capacity within power sectors – these are likely expected to increasingly see penetration from renewable forms of power generation.
- The windfall profits calculated are to the wholesale market only and may not reflect the position of vertically integrated utilities, who also supply end-users with power. The profits of the full value chain in power will be more dependent on the ability of suppliers to pass-through higher generation costs to end-customers. This ability will be different in different systems – for example, in Poland and Italy, end-user tariffs remain regulated by the government (although there is EC pressure on these countries to remove such regulation);
- Windfall profits should be considered in the context of total power sector revenue increase due to the onset of CO_2 pricing into the power prices. This is part of the trading scheme design to provide additional revenue to low CO_2 forms of generation and also to encourage a reduction in energy demand and an increase in efficiency measures.

Appendix 1: Glossary of terms

Auctioning	Allocation mechanism in which in which allowances are provided to the installation on the basis of prices that the installation is willing to pay in an auction
Baseline and Baseline Scenario	The baseline represents forecasted emissions under a business-as-usual (BAU) scenario, often referred to as the 'baseline scenario' i.e. expected emissions if the emission reduction activities were not implemented.
BAT	Best available technology
Benchmarking	Allocation mechanism in which allowances are provided to the installation on the basis of a specific benchmark installation's requirement for such allowances
Business As Usual Scenario (BAU)	A business as usual scenario is a policy neutral reference case of future emissions, i.e. projections of future emission levels in the absence of changes in current policies, economics and technology.
Cap and Trade	A Cap and Trade system is an emissions trading system, where total emissions are limited or 'capped'. The Kyoto Protocol is a cap and trade system in the sense that emissions from Annex B countries are capped and that excess permits might be traded. However, normally cap and trade systems will not include mechanisms such as the CDM, which will allow for more permits to enter the system, i.e. beyond the cap.
Carbon Dioxide Equivalent (CO_2e)	This is a measurement unit used to indicate the global warming potential (GWP) of greenhouse gases. Carbon dioxide is the reference gas against which other greenhouse gases are measured.
CCGT	Combined cycle gas turbine
CCS	Carbon capture and storage – technology for capturing CO_2 from large point sources such as power plants and storing this in suitable storage sites (often deep geological structures including saline formations and exhausted gas fields),
CHP	Combined heat and power
Commitment Period	The five-year Kyoto Protocol Commitment Period is scheduled to run from calendar year 2008 to calendar year-end 2012.
Economies in Transition (EIT)	Countries that are in the transition from a planned economy to a market-based economy, i.e. the Central and East European countries, Russia, and the former republics of the Soviet Union.
EC	European Commission
EUA	EU Allowance
EU ETS	European Union Emissions Trading System
EU27	27 members of European Union (EU25 including Bulgaria and Romania)
Grandfathering	Method for allocation of emissions, where permits are allocated, usually free of charge, to emitters and firms on the basis of historical emissions.
Greenhouse gases (GHGs)	Greenhouse gases (GHGs) are trace gases that control energy flows in the Earth's atmosphere by absorbing infra-red radiation. Some GHGs occur naturally in the atmosphere, while others result from human activities. There are six GHGs covered under the Kyoto Protocol - carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulphur hexafluoride (SF_6).
International Emissions Trading (IET)	Emissions Trading allows for transfer of AAUs across international borders or emission allowances between companies covered by a Cap and Trade scheme. However, it is a general term often used for the three Kyoto mechanisms: JI, CDM and emissions trading.
Kyoto Protocol	The Kyoto Protocol originated at COP-3 to the UNFCCC in Kyoto, Japan, December 1997. It specifies emission obligations for the Annex B countries and defines the three so-called Kyoto mechanisms: JI, CDM and emissions trading. It entered into force on 16 February 2005.
NAP	National Allocation Plan – plan submitted by each EU Member State with details of allocations at national, sector and installation level.
NER	New entrant reserve – allowances set aside for new installations that are not included in an initial allocation
UNFCCC	United Nations Framework Convention on Climate Change. The UNFCCC was established 1992 at the Rio Earth Summit. It is the overall framework guiding the international climate negotiations. Its main objective is "stabilisation of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic (man-made) interference with the climate system".

Appendix 2: Theory of pass-through to power prices

THEORY – IMPACT OF CO_2 ON POWER PRICES

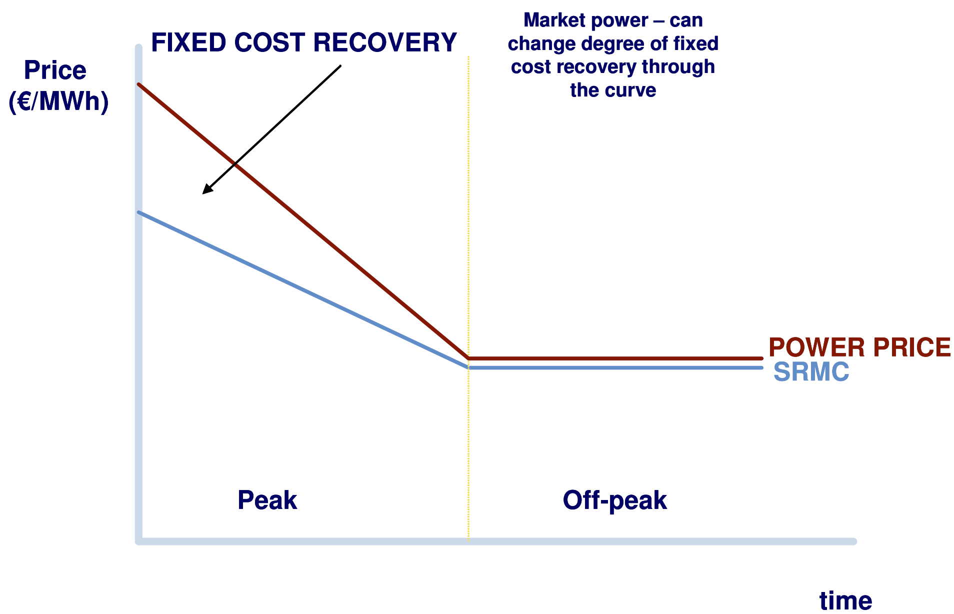
At its most basic level, power prices in the market are a function of:

- the short-run variable or marginal costs (SRMC) of the power plant that is needed to meet demand at any given time. As power demand increases, plants with higher marginal costs are needed to meet that demand and the power price increases; and
- the level of fixed costs that can be recovered depends on the capacity of plant that is available to generate compared with the demand level and the level of market power that exists. Where the merit order is most competitive, in the off-peak when the level of demand is lowest compared to the amount of capacity, prices may be bid down to SRMC. In other periods when demand is higher, there is less competition to generate and some additional degree of fixed cost recovery is likely to occur.

If there is considerable market power (such as one firm owning a large amount of the installed capacity in a given market segment), then a firm could ensure that it recovers all of its fixed costs over the year and possibly considerable additional profits. If one firm has enough market power, then it can affect prices in all hours of the day.

The process that we describe above is illustrated in that uses a schematic price duration curve (a curve that shows how long certain price levels in a market exist).

Price duration – setting electricity prices in a market



In looking at the impact of CO_2 on these market dynamics, it is important to realise that the proportion of the CO_2 price provided for free (through the allocation plan) will have a role to play. However, from an economic optimisation standpoint it is incorrect to assume that if all of the CO_2 allowances are provided free to the operator, then the CO_2 price will not subsequently influence power pricing. This is because the traded CO_2 price becomes an opportunity cost for the generator that it must take into account in deciding to generate.

CO_2 price as an opportunity cost

The CO_2 price is an opportunity cost because in deciding to generate, a power producer will use up both its fuel and the CO_2 allowances required to off-set the emissions from that generation. In most power markets, generators will only generate electricity therefore if the revenue from selling electricity exceeds the revenue that they could earn from selling their fuel and CO_2 permits in the respective spot markets. This will influence power prices as the electricity market needs to provide a higher level of remuneration for generators to secure the same volume of electricity. However, this does not necessarily mean that the CO_2 price will influence the electricity price in every hour.

As an opportunity cost, the combined opportunity costs of fuel and CO_2 must exceed the power price for the power price to adjust to secure the given level of generation. If the power price exceeds these short-run opportunity costs, for instance, because it is recovering some fixed costs, then the market price has no need to adjust. That is, since the costs are not incurred and are simply opportunity, the level of fixed cost recovery is not impacted and therefore it is more economic to generate even without changing the bid price.

As the off-peak power market is the most competitive, we would expect that this is when the CO_2 price will have its biggest impact on power prices. In periods when the power price is likely to exceed short-run marginal costs (fuel and CO_2), then generators do not need any additional incentive to produce generation to meet demand and prices should remain unaffected. Any significant market power – or indeed even an expectation that the market will price this in – could mean that prices would never-the-less be affected.

CO_2 as an incurred cost

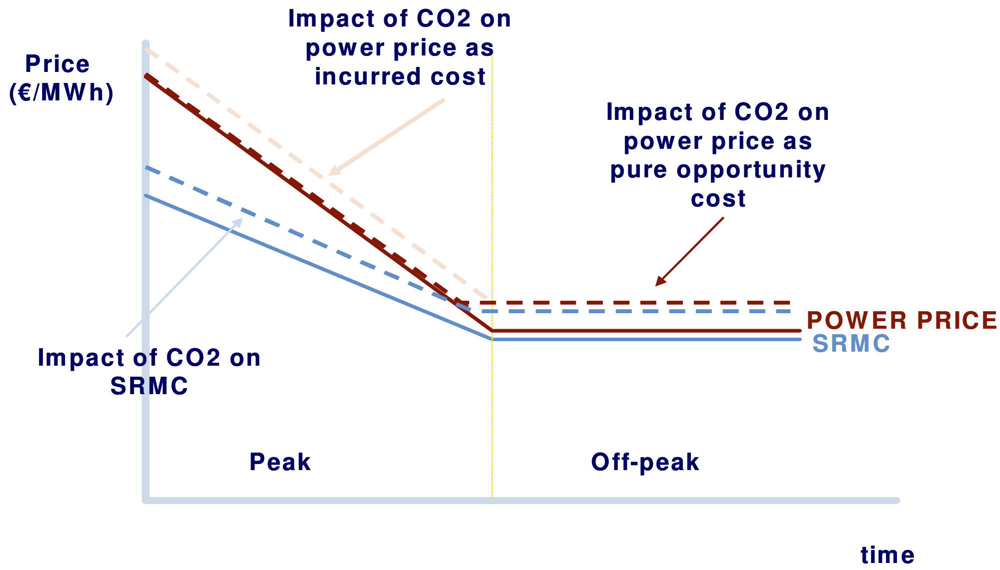
In addition to being opportunity costs, some cost of the EU ETS will have been incurred for this sector as power generation in aggregate was short allowances in 2005. Generators will want to recover any costs associated with the allowances they need to purchase on the market to off-set their generation. As this increasingly becomes the case (less free allocation and more incurred cost), then we expect that the impact on the power price will increase to all periods as this then does start to impact on the level of fixed costs that are recovered.

The net impact of CO_2

Returning to our schematic of how prices are formed, we see the impact of the EU ETS in theory being to:

- Cause a shift upwards in electricity prices at times when power prices are pushed down to short-run marginal costs; and
- Slightly reduce peak prices as the upward shift in off-peak prices increases total revenue while the level of incurred costs only slightly rises. As such, the total amount of fixed costs that need to be recovered in peak periods could only change marginally or even reduce (since there is more fixed cost recovery in off-peak periods).

The impact of the CO_2 price on power prices



The net effect of these two impacts is to:

- Increase the average (or baseload) level of power prices; and
- Reduce the margin between peak and baseload contracts (depending on how much was incurred).