ENVIRONMENT

The problem with carbon

The days when power fundamentals were easy to understand are long gone. Not so long ago time falling fuel prices meant falling power prices. Now that is not always the case and the culprit is carbon. In following article **Matt Brown*** examines the, sometimes counter-intuitive, impact of carbon on power to date.

The impact of carbon on the power sector is not fully understood by the majority of energy players in Europe. This is because the market is still developing and evolving. But recent movements in fuel and carbon prices and fundamental analysis of the future can provide some useful insights.

One of the problems with carbon is the fact that it is an annual (or perhaps phase-length[1]) product whereas power is more granular – often hourly settled and with cost structures that change within year. This is especially true in the UK where seasonal gas prices cause the merit order to 'flip' so that gas is marginal in winter and coal is marginal in summer. As gas trading hubs develop across Europe then we expect to see this seasonality replicated in other regions.

We have recently seen the impact of gas prices on carbon prices, with rapidly increasing gas prices causing high carbon prices, and then the collapse in winter '06 gas prices reportedly leading to a collapse in the price of carbon.

Coal and carbon

Here we examine the interactions of coal, gas and carbon prices in the power sector.

Take the example of projected 2007 winter and summer merit orders of power stations in GB *(see Figure 1 and Figure 2)*. In winter, high gas prices mean that coal plant is running baseload. In summer, broadly speaking the lower gas prices mean that combined cycle gas-fired turbines (CCGTs) are baseloading. In shoulder months the coal and gas plant intermingle.

Holding all other things equal then with lower coal prices, coal plants are more likely to run baseload throughout the year. This in turn leads to higher carbon emissions from the power sector. This position is shown in Figure 3 and Figure 4. Comparing Figure 2 and Figure 4 the re-ordering of the merit order is clear, while coal plant are not running baseload, their operation is increased.

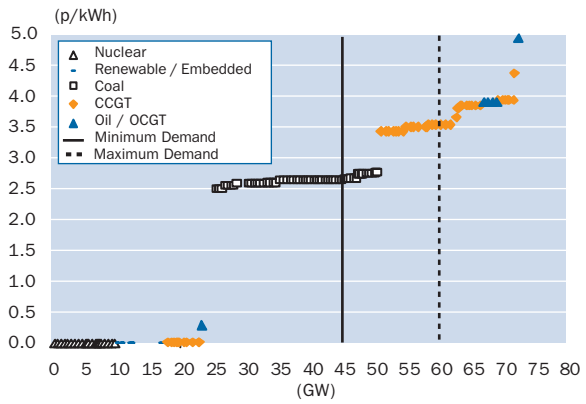
To achieve the same level of carbon emissions from the power sector the price of carbon allowances (EUAs) must rise so that in the summer the coal

Table 1: Impact of lower coal prices on CO_2 emissions & summer/winter wholesale elec prices (£/MWh)

	Base	Coal price 20% lower	EUA increases to compensate
Summer	31.1	29.9	32.3
Winter	43.3	42.1	44.6
Annual	37.2	36.0	38.5

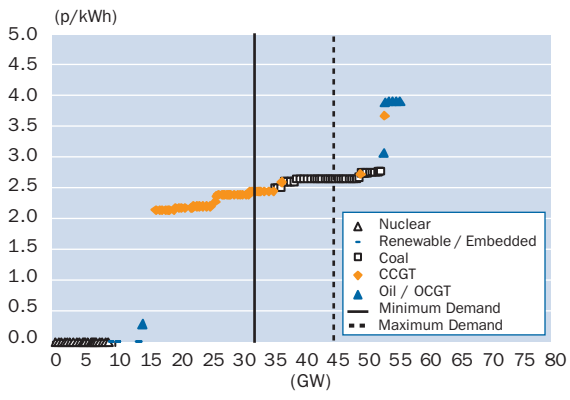
Source: Ilex analysis

Fig 1: Winter merit order 2007



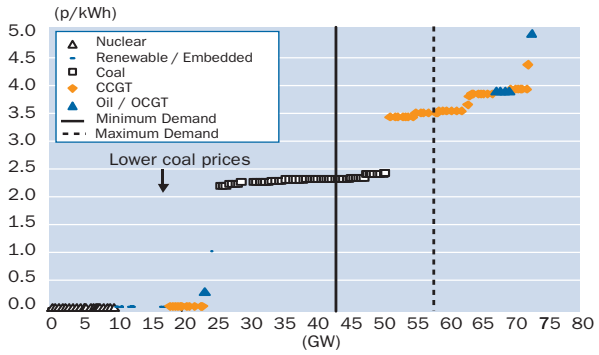
Source: Ilex analysis

Fig 2: Summer merit order 2007



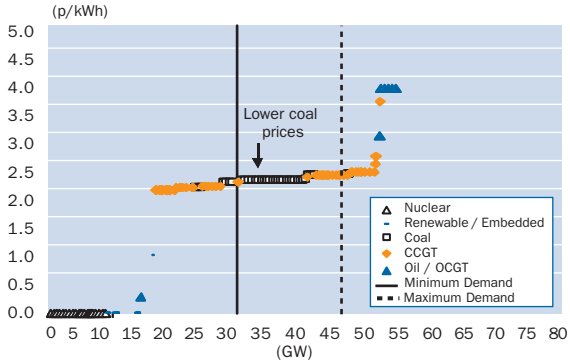
Source: Ilex analysis

Fig 3: Winter merit order 2007 with and without lower coal prices



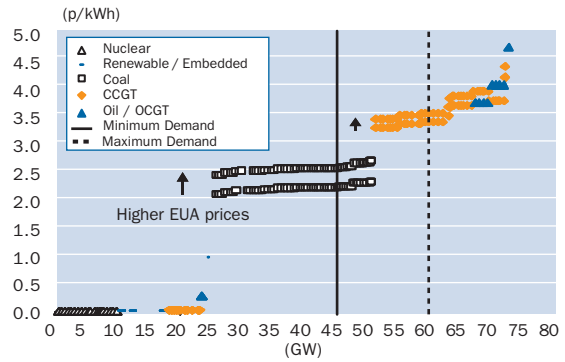
Source: Ilex analysis

Fig 4: Summer merit order 2007 showing impact of lower coal prices



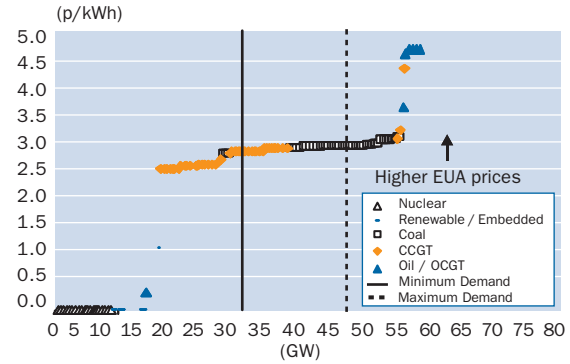
Source: Ilex analysis

Fig 5: Winter merit order '07 with lower coal prices, lower coal prices & higher EUA prices



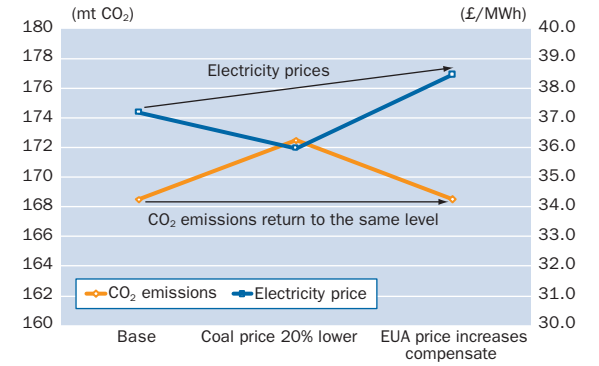
Source: Ilex analysis

Fig 6: Impact of lower coal prices & higher EUA prices



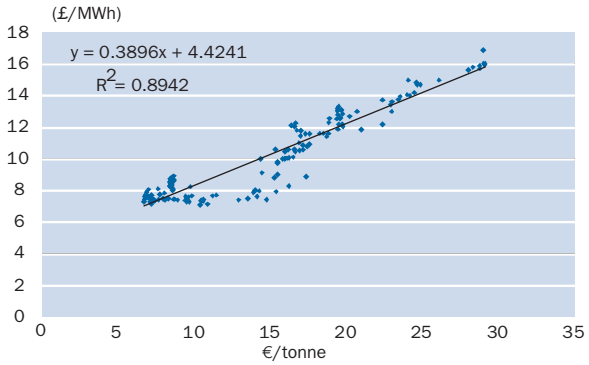
Source: Ilex analysis

Fig 7: Impact of lower coal prices on CO_2 emissions and annual wholesale electricity



Source: Ilex analysis

Fig 8: Forward trading of Summer '07 spark-spread and EUAs with linear trendline [4]



Source: Ilex analysis

plant is once again displaced by CCGTs (*as shown in Figure 6*[2]).

As the carbon allowance price rises to provide the summer fuel switching so the price of power will rise both in winter (a period when no emissions impacts are seen i.e. the plant operation has not changed) and summer (in which the fuel switching takes place). This shift is demonstrated in Figure 5 and Figure 6.

Impacts on power prices

Our modelling of prices in the GB electricity market (using our market model GBGen which includes optimisation of sulphur bubbles) shows the impact on prices and CO_2 emissions from the power sector. This can be seen clearly in Figure 7.

The impact on electricity prices depends crucially on the level of pass-through of the carbon price into the

power market[3]. At the margin a good relationship has now formed (see *Figure 8*) but this relationship is not reflective of a full pass-through.

The impact also depends on the initial relativity of fuel prices and any other constraints e.g. sulphur emission bubbles. It will therefore not be a permanent relationship, although our modelling of the fundamentals without sulphur bubbles in GBGen gives the same results in terms of a price shift.

The impact on summer and winter prices separately is shown in Table 1. What is clear is that, given our assumptions, the annual electricity price increases to deliver the same level of carbon emissions. The fuel switching occurs primarily in the summer but, due to the annual nature of EUAs, prices in winter also increase. This leads to winter prices being £2.5/MWh higher than they would be if EUAs were, for instance, a seasonal commodity.

Conclusions

From our high-level analysis we could suggest that based on fundamentals:

- Falling coal prices could lead to higher power prices through interaction with the EU ETS.

A corollary to this would be that:

- Lower winter gas prices should not impact carbon prices (unless the fall is very significant) – contrary to recent comment.

In addition, based on further analysis not presented here it is clear that:

- Tightening sulphur bubbles could reduce the price of EUAs significantly depending on the level of retrofitting of FGD on coal plants, as fuel switching into coal would be limited by sulphur restrictions on unscrubbed plant.

The future relationship between gas, coal, carbon and power is not only key to understanding future movements in power and carbon prices but is also key for risk management in multi-commodity utilities. The correlation coefficients that form the basis of calculations for value-at-risk (VAR) and profit-at-risk (PAR) are likely to misrepresent future correlations if based on historical data. To understand these risks, multi-commodity utilities should consider some detailed analysis of these new and developing relationships.

[1] The EU ETS is implemented in Phases, Phase One is three years and subsequent Phases are five years. As allowances are made available at the beginning of a year and settlement is not until March of the following year the annual allowances are interchangeable within Phase.

[2] This assumes that the main source of carbon abatement is fuel switching in the power sector which is broadly accepted. Whether the UK is the swing supplier of carbon allowances will also be important given the EU-25 coverage of the scheme but our fundamental modelling of carbon abatement across the EU-25 and all of the sectors covered by the EU ETS points to fuel relativities in the power sector being the main driver of carbon allowance prices. We assume that coal and gas demand levels in the UK power generation sector are not a major determinant of coal and gas prices.

[3] We assume full pass-through of the opportunity cost of carbon in power trading in our modelling for this article i.e. that the value of an allowance freely received is fully reflected in despatch decisions. Given current pass-through rates this may overstate the absolute level of price, but not the direction of the impact.

[4] The relationship is clearer in these Summer forwards than in Winter forwards. While correlation does not equal causality our understanding is that market participants increasingly factor in the opportunity cost of carbon when making despatch decisions.

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