

# Final Report



## UK Power Sector Emissions – targets or reality?

to

**WWF-UK**

March 2006



**IPA Energy + Water  
Consulting**

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# TABLE OF CONTENTS

<b>UK POWER SECTOR EMISSIONS</b>	<b>2</b>
2006 Emissions	2
Historical Trends in Emissions	3
Impacts of Phase I of the EU ETS	6
Effect of Carbon Prices	7
Committing to Coal	8
Forecast Emissions	10

# UK POWER SECTOR EMISSIONS

The UK government is committed to achieving its international goals of reducing total greenhouse gas emissions on average by 12.5% over the period 2008-2012, based on 1990 levels. However, it has admitted that it will fail to meet its long-standing domestic target to reduce emissions of carbon dioxide by 20% between 1990 and 2010. Nevertheless, in March the government announced new domestic targets in its draft Climate Change Bill aimed at reducing the UK's carbon emissions by 60% by 2050 and between 26% and 32% by 2020, based on 1990 levels.

Electricity generation is the biggest single source of CO<sub>2</sub> emissions in the UK, responsible for approximately a third of total emissions. Therefore in order for the UK to meet its international and domestic emission reduction goals there is a need for relatively large emissions reductions from this sector.

WWF has commissioned IPA Energy + Water Consulting (IPA) to investigate the emissions from the UK power sector in 2006 and compare this with historical emissions data from the sector since 1990 to see if the UK is on track to meet these emission reduction goals. In particular IPA has been asked to:

- Provide a robust estimate of the emissions from the UK power sector in 2006;
- Review and compare the trends in emissions since 1990 with 2006 emissions;
- Discuss the impacts of Phase 1 of the EU ETS on the power generation sector; and
- Review the DTI's forecast of emissions to 2020

This paper follows the scope of works as highlighted above.

## 2006 Emissions

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2006 emissions from the UK power sector have been calculated based on the running of each of the major generating stations<sup>1</sup>. A number of fossil fuel generating stations have been co-firing with biomass fuels. Under the accounting rules for the EU ETS, this output is treated as carbon neutral and does not contribute to overall emissions. Data on co-firing, however, is currently only available up to August 2006 and so an estimate of the co-firing based on previous plant running has been undertaken, allowing for current limitations on co-firing under the Renewable Obligation. Taking an emission intensity per MWh based on the verified emissions and plant running from 2005 the total emissions for the power sector were estimated for 2006.

There is some uncertainty associated with the emissions forecast, relating both to data availability for the current year, as well as the different categorisations for installations under different Government statistics reports. Whilst the forecast does not take account of emissions related to generator warming, start up etc, it does utilise data on notified MWh production for major GB power generators. We therefore believe the emissions projections for 2006 are likely to be accurate to within +/-3%.

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<sup>1</sup> Note: Actual generating station running for 2006 has only been obtainable for those stations participating in the Balancing Mechanism (BM). There are a number of other stations which do not operate within the BM, however, their overall emissions are relatively small (~3% of total emissions from the power sector). As a result we have assumed that verified emissions from these stations for 2006 will be the same as for 2005.

**Table 1: Power Sector CO<sub>2</sub> Emissions**

<b>Estimated 2006 MtCO<sub>2</sub> emissions</b>
178

In order to put these figures into context, a comparison with the historical emissions from the power sector is required. In the following section we investigate the historical power sector emissions and highlight the key policy measures that have been introduced to try to reduce emissions.

## Historical Trends in Emissions

Historical emissions data has been obtained from the Office for National Statistics (ONS)<sup>2</sup> for data for the period from 1990 to 2004. Data by fuel type and end user for 2005 are not expected to be available until April 2007<sup>3</sup> and so we have determined the emissions from the power sector from verified emissions data for 2005 under the EU ETS,

The following figure (Figure 1) shows the emissions from the UK power sector, by fuel type, since 1990 together with our estimate of the 2006 emissions. Key policy measures aimed at reducing emissions from the power sector are shown in the table below.

**Table 2 UK Power Sector Emissions Policies & Measures**

Measure/Programme	Commencement Dates
<ul style="list-style-type: none"><li>• Non-Fossil Fuel Obligation (NFFO). Primarily set up to support the Nuclear power industry and expanded to include other forms of non-fossil fuel generating stations such as Renewables. There were 5 NFFO orders with contracts running to 2018.</li></ul>	1990
<ul style="list-style-type: none"><li>• Renewables Obligation on electricity suppliers to increase their share of electricity generated from renewable sources.</li></ul>	2002
<ul style="list-style-type: none"><li>• Aim of at least 10GWe of 'good quality' CHP to be installed in the UK by 2010.</li></ul>	2003
<ul style="list-style-type: none"><li>• Climate Change Levy (CCL) package, including negotiated Climate Change Agreements with energy intensive sectors and an Enhanced Capital Allowances scheme.</li></ul>	2001
<ul style="list-style-type: none"><li>• EU Emissions Trading Scheme.</li></ul>	2005
<ul style="list-style-type: none"><li>• Integration Pollution Prevention and Control Legislation (IPPC)</li></ul>	1998
<ul style="list-style-type: none"><li>• Large Combustion Plant Directive (LCPD)</li></ul>	2008 <sup>4</sup>

In addition to policies aimed directly at the power sector, there are a number of other measures aimed at other sectors (industry, domestic), which have the aim of reducing

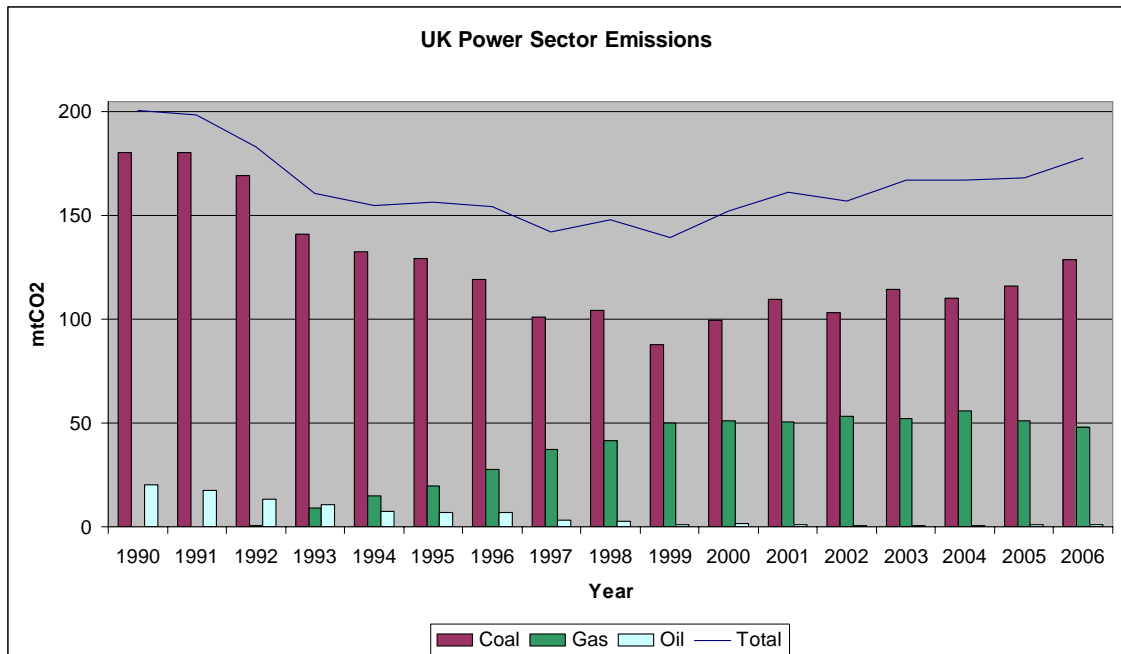
<sup>2</sup> <http://www.statistics.gov.uk/cci/nugget.asp?id=901>

<sup>3</sup> <http://www.defra.gov.uk/environment/statistics/globalatmos/gaarcunece.htm>

<sup>4</sup> Whilst the emission limits on sulphur dioxide under the LCPD do not come into force until 2008, coal generators have and are currently modifying their plant to be compliant with the scheme.

energy demand and consequently power sector emissions. Such schemes include the Energy Efficiency Commitment (EEC) - successor to the Energy Efficiency Standards of Performance, improvements in the energy efficiency requirements of the Building Regulations, EU product standards and the market transformation programme.

**Figure 1: UK Power Sector Emissions**



Prior to 1999, the overall trend in emissions from the power sector was downwards, in part due to the shift from coal to gas. However, since the turn of this decade the sector’s emissions started to rise with an increase of about 28% between 1999 and 2006. The emissions projections for 2006 show an estimated ~6% rise over the 2005 verified emissions data. The projections are based upon a robust methodology which has been verified against the 2005 data and so can be seen to be comparable with the historic trend. Whilst there is likely to be some inaccuracy associated with the 2006 projections and there may be some differences between the installation categorisations under ONS and EU ETS verified emissions reporting, these are unlikely to be significant enough to change the overall conclusions.

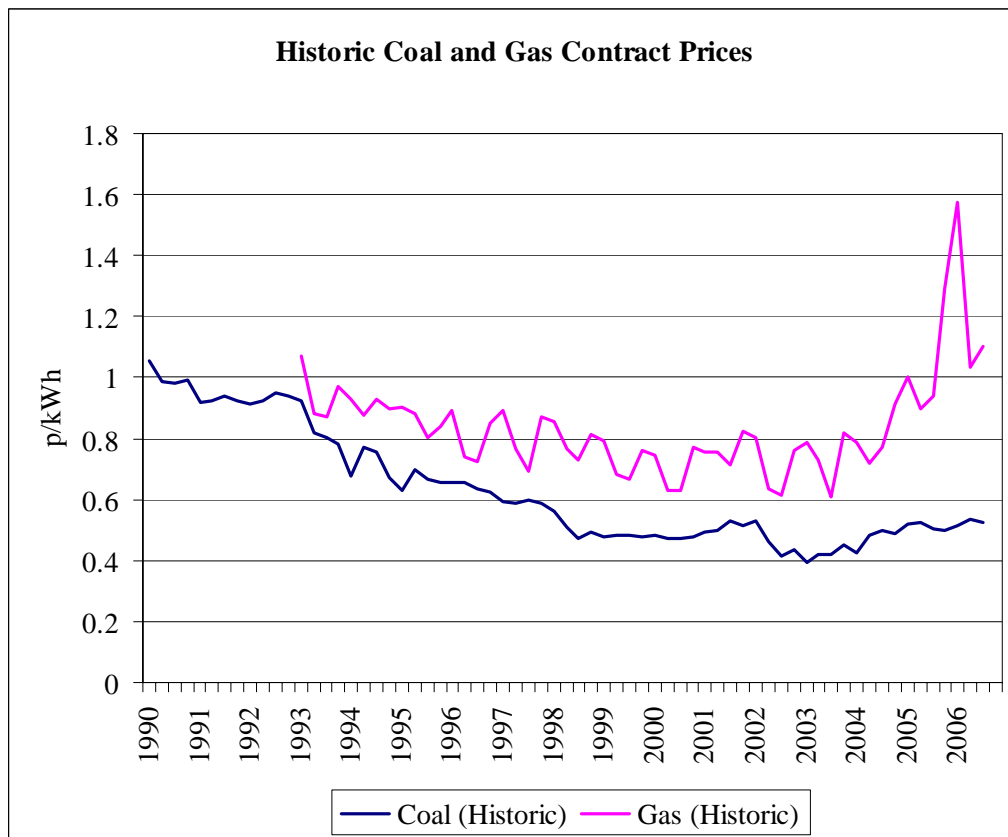
Gas burn has been relatively stable over the period from 1999, although it has fallen slightly over 2005 and 2006. However, coal emissions have increased by almost 50% since 1999. In fact the total emission estimates for 2006 are the highest since 1992 prior to the start of the “dash for gas”.

The majority of policy measures aimed at reducing power sector emissions, as highlighted previously in table 2, have been put into place in the last six years or so which also corresponds to the period over which power sector emissions have been increasing. Thus, whilst the measures put in place may have served to suppress the emissions from the power sector they have not led to a reduction in overall sector emissions. It is conceivable then, that without these measures emissions from the sector would be much higher. However, the policy framework has clearly been insufficient to put the power sector emissions onto a downward path.

One of the main “externalities” and a key driver behind power sector emissions in the UK is the relative cost of coal and gas – i.e. the coal/gas price spread. The following figure

shows the quarterly historic prices for both coal and gas taken from the DTI's energy statistics.

**Figure 2: Quarterly historic power sector fuel prices**



Throughout the 1990s there was a general decrease in both coal and gas prices, but from near the start of this decade gas prices have increased dramatically following the global increase in oil prices. Whilst gas prices have softened considerably since the price peaks seen last winter, gas remains trading at a significant premium to coal on an energy content basis, and this price level is forecast to be supported over the medium to long term. Coal has not followed this trend and prices to the power sector have been relatively stable over the last 5 years, despite higher volatility in the international coal markets. However, coal markets have recently exhibited lower volatility, and are forecast to be relatively stable over the medium to long term.

The lower price of coal relative to gas (on an energy content basis) has encouraged increased use of coal in power generation, and relative energy prices would support high levels of coal generation in the future. However, this discussion does not factor in the price of carbon, and as coal has a significantly higher carbon emissions intensity than gas it would be expected that the competitiveness of coal generation could decrease in the future. In the following section we look at the impacts of the EU ETS on power sector emissions and plant running.

## Impacts of Phase I of the EU ETS

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Of the policy measures highlighted in Table 2 the EU ETS is seen as the key policy measure for reducing power sector emissions. Emissions allowances are “grandfathered” down to individual plants which are then responsible for meeting these emission caps or pay a fine – currently €40/tCO<sub>2</sub> and make up any shortfall in the next Phase. Under the scheme, installations which emit more CO<sub>2</sub> than their allocation need to buy allowances to cover the extra emissions (or else pay the fine), and installations that emit less are able to sell allowances.

As the emissions allowances are issued for “free” the power sector is open to gaining from windfall profits – essentially passing through the value of the allowance to consumers. This arises because the power sector is not subject to competitive pressures from outside of the EU, with the UK sector only subject to limited European competition through interconnections with mainland Europe and Ireland. Generating plant can therefore pass on the price of an allowance to the price of electricity. The value of the free allowances to the power sector has therefore been a “windfall” gain. A recent Carbon Trust report estimated that this windfall is of the order of €1 billion in the first year of the scheme (2005)<sup>5</sup>.

The report states that *“the first year also confirmed economists’ predictions that sectors – especially power generation – would pass through most of the carbon costs in their product prices, and as a result profit from their free allocations”*.

Whilst the generators have been gaining from these windfall profits, they have also been complaining that they have not been given sufficient allocations to cover their emissions. The table below shows a comparison of the verified emissions for 2005 from the power sector with their annual allocations.

**Table 3: Emissions versus Allocations**

Generation Technology	Allocations (tCO <sub>2</sub> )	Verified Emissions (tCO <sub>2</sub> ) 2005	Estimated Emissions for 2006
Coal	79,989,047	116,260,798	128,797,438
Gas	50,028,408	51,242,057	47,982,208
Oil	554,323	905,949	1,218,262
Total	130,571,778	168,408,804	177,997,909

In total the power sector’s verified emissions were around 30% greater than the total allocations in 2005, with coal stations being shortest. However, the shortage of allocations has not restricted the running of coal plant which has seen its highest running since 1993. Clearly then the price of carbon under the EU ETS has not restricted generator running – indeed, with a relatively high spread between coal and gas prices and estimated windfall profits of around €1 billion in the first year of the EU ETS scheme alone, it could be said that coal has not had it so good since before the start of the dash for gas! This is further compounded by the estimated emissions for 2006 which shows an increase in coal emissions by over 10% compared to verified emissions in 2005 and an increase of around 6% for total power sector emissions.

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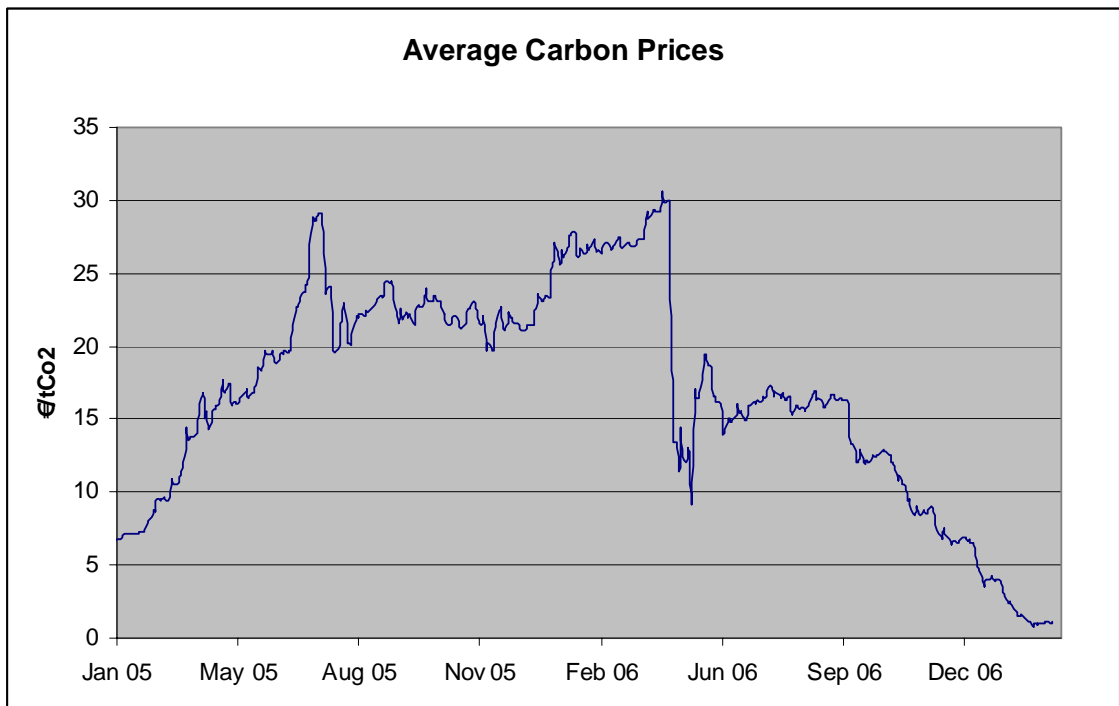
<sup>5</sup> Allocation and competitiveness in the EU Emissions Trading Scheme – options for phase II and beyond. The Carbon Trust, June 2006.

Coal running has remained high in part because the price of carbon has not been high enough to impact upon its competitiveness as a generation fuel relative to gas. The following section therefore investigates the effect of carbon prices on power station running.

## Effect of Carbon Prices

As discussed above, those installations which emit more CO<sub>2</sub> than their allocation need to buy allowances to cover their extra emissions. Phase I Carbon prices have varied significantly over the first phase of the EU ETS – from a high in April 06 of around €31/tCO<sub>2</sub> to the current low values of around €1/tCO<sub>2</sub>. This trend is shown in the figure below, showing the average of the bid-offer prices.

Figure 3: Carbon Prices (Phase I)



Source: Spectrometer

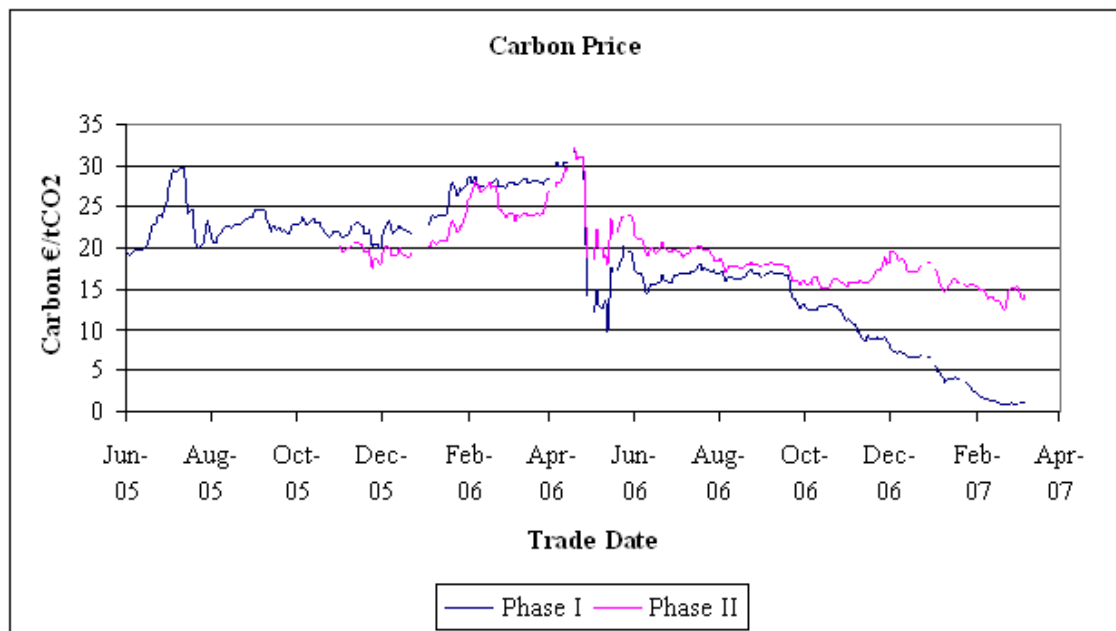
From the start of carbon price reporting until mid April 2006 there was a gradual increase in the overall price. However, following the reporting of the verified emissions for 2005 from EU member states, which showed a significant over allocation of emissions for Phase 1 of the scheme, the carbon price collapsed and has continued to decline to the current day.

As a result of this collapse the incentive for power stations to reduce their overall emissions has reduced, as the penalty for not doing so (i.e. currently around ~€1/tCO<sub>2</sub>) is not prohibitive. Clearly then, the first phase, whilst providing experience of the process and administrative regime, has not provided sufficient incentives to reduce overall CO<sub>2</sub> emissions. For the second phase (2008 – 2012), however, the European Commission has applied stricter emissions reductions targets which should lead to reducing overall emissions. The following figure shows a graph of both the carbon prices for phase I and phase II. It can be seen that the carbon prices for phase II are trading at a significant premium to the Phase I allowances – highlighting the greater confidence the market has in the phase II allocations. The carbon price is determined by the number of “excess”

emissions allowances, as well as the number of project credits (JI/CDM<sup>6</sup>) that can be declared, and banking and auctioning rules. Whilst it is not anticipated that a collapse in the carbon price will occur for phase II - given the stricter allocations as well as the possibility to “bank” allowances in to later phases - this cannot be ruled out. Moreover, widespread reliance on relatively cheap imported CDM credits could maintain a downward pressure on the EU carbon price, potentially meaning that it may remain too low to significantly affect power sector emissions in the UK.

In fact, we estimate, based on annual coal and gas price scenarios for 2008, the carbon price would need to be of the order of €30/tCO<sub>2</sub> in order to restrict coal running - i.e. the point at which coal becomes more expensive than gas as a power generation fuel.

**Figure 4: Phase I & Phase II Carbon Prices**



Source: Spectrometer

## Committing to Coal

As we have highlighted previously, increasing coal running has been the key driver of increasing emissions from the power sector. However, the future will see increasing environmental restrictions as coal plant are regulated under the Large Combustion Plants Directive (LCPD, 2001/80/EC) and the Integrated Pollution Prevention and Control (IPPC 96/61/EC). These controls define limits on emissions of SO<sub>2</sub>, NO<sub>x</sub> and particulates, through rate and mass limits as well as cap and trade arrangements.

Beyond 2008, the SO<sub>2</sub> emission limits for plant “opted-in” under LCPD are low enough to effectively exclude plant which is not equipped with sulphur scrubbers, known as flue gas desulphurisation (FGD) equipment. In theory at least plant could source very low sulphur coal but this is not widely available and is unlikely to be compatible for burning in existing boilers. However, the alternative is for plant to “opt-out” of the LCPD – this

<sup>6</sup> JI – Joint Implementation – Emissions Reduction projects implemented in Annex I countries. CDM – Clean Development Mechanism – Emission Reduction projects implemented in non-Annex I countries. Arise from the Kyoto Protocol and are joined to the EU ETS via the “Linking Directive”. Credits attributable to the emissions reductions from JI/CDM projects can be used against the organisations emissions reduction targets, subject to a cap.

means that investment in FGD can be avoided, but such stations are limited to running for a maximum of 20,000 hours over the period 2008 to 2015, at which point they must close.

The clarification of the rules that will govern coal plant operation has led to a spate of investment decisions, with six coal stations announcing that they will retro-fit FGD. Although the new rules on sulphur emissions are restrictive for non-FGD plant, it is perhaps surprising that in a world that should be increasingly incentivising low carbon generation, so many companies are making significant capital investments to ageing coal plant, many of which are approaching the end of their design lives. A major reason for this may be the fillip announced for FGD coal generation under the UK Phase II Draft NAP.

For existing power stations, the allocation methodology for Phase II of the EU ETS is based upon a benchmarking approach for different generation technologies, with each technology assigned a load factor, efficiency and associated emissions factor. Coal allocations reflect the higher carbon intensity of the fuel and the lower efficiency of the plant. Critically the benchmarking distinguishes FGD and non-FGD coal (despite the fact that FGD does not reduce, and in fact marginally increases carbon intensity), representing a significant shift of approach since the Phase I NAP.

In its national allocation plan, the UK Government has allocated approaching twice as many free carbon allocations to FGD coal plant than non-FGD coal, reflecting the fact that FGD plant are likely to generate at higher load factors. In effect, this provided a significant financial incentive for operators to retro-fit FGD to plant. The Phase II power sector allocation is likely to be around 107MtCO<sub>2</sub> per annum. A 500MW FGD coal unit will receive in the order of 0.64MtCO<sub>2</sub> more free carbon allowance per year over Phase II than a similar unit without FGD. These extra carbon allowances have a market value of £6.6m each year over Phase II assuming a carbon price of around €15/tCO<sub>2</sub>. Thus, the additional carbon allocations are likely to be more than sufficient to cover the £30-40m cost of FGD installation, especially as the work also provides the plant with additional running flexibility and a life extension. This approach to ETS allocation has clearly provided sufficient incentive to send the industry scurrying to install FGD on a number of coal plant – essentially incentivising a high level of coal burn beyond 2008.

The government has acknowledged this effect, by stating that *“We are aware that EU ETS proposals for the Phase II electricity sector benchmarks may have had an influence on decisions by some installations opting into the Large Combustion Plant Directive. These opt-in decisions tend to increase projected emissions for the Phase II period”*. As a result the Government decided to reduce the power sector allocation of CO<sub>2</sub> allowances under Phase II of the EU ETS by 8MtC a year.

Coal plants are therefore likely to run longer than would be expected as government policy has encouraged the retrofitting of FGD to coal plant. FGD does significantly reduce SO<sub>2</sub> emissions, but it does not deliver any CO<sub>2</sub> benefit – in fact it marginally increases carbon emissions. Indeed, the detailed implementation of the EU ETS – a policy aimed at reducing CO<sub>2</sub> – has in fact encouraged further burn in coal stations and hence increased emissions of CO<sub>2</sub>.

In addition to its international commitments, the UK has also a number of domestic emission targets, a 20% cut by 2010 and more recent proposals for reducing carbon emissions by 60% by 2050 and between 26% and 32% by 2020 - in each case relative to 1990 levels. The following section investigates whether these targets will be met and what the future outlook is for emissions from the UK power sector.

## Forecast Emissions

The forecast UK emissions and generator fuel mix in TWh are taken from the DTI's 2006 energy review document<sup>7</sup> and are shown in the table below.

**Table 4: Emission Forecasts**

	Central Scenario Favourable to coal			Central Scenario Favourable to gas		
	2010	2015	2020	2010	2015	2020
Power Station Emissions (mtC)	44.1	47.6	46.5	42.5	45.4	45.0
Coal (TWh)	119	116	94	106	100	82
Oil (TWh)	3	2	2	2	2	1
Gas (TWh)	122	164	219	137	183	235

Whilst the DTI's carbon projections do not take account of proposals set out in the energy review, the energy review states that the Government's target of 20% reduction in emissions relative to 1990 levels by 2010 are unlikely to be met through its existing climate change programme measures. Figure 1 shows that power sector emissions have been increasing since 1999 and estimates for 2006 predict the highest emissions on record since 1992. Additionally, from 2010 to 2015 under both scenarios above, there is an overall rise in power sector emissions as a result of fossil fuel plants replacing retiring nuclear plants and only a relatively small decrease from 2015 to 2020. The overall picture is therefore somewhat bleak with total emissions from the power sector increasing over the forecast period. As it stands the 2010 emissions reduction target of 20% is unlikely to be met even by 2020 (based on current projections).

The UK Government does, however, appear to be committed to reducing its overall carbon footprint and the recently published draft Climate Change Bill includes proposals for reducing carbon emissions by 60% by 2050 and between 26% and 32% by 2020, based on 1990 levels. Clearly then, in order to achieve these targets significant extra work is required in both strengthening existing climate change measures and introducing new schemes. Other proposals from the draft Climate Change Bill include:

- Greater energy efficiency, with more consumers becoming "producers" of their own energy at home
- Investment in low-carbon fuels and technologies, such as carbon capture and storage, wind, wave and solar power
- Carbon "budgets" - which cap emissions levels - set every five years
- The government reporting annually to Parliament on its progress in controlling emissions

Other measures are also likely to be included in the much anticipated Energy White Paper, which is now likely to be delayed until May of this year as a result of the judicial ruling which has forced the government to reopen the consultation on a decision to build

<sup>7</sup> Annex C UK CO<sub>2</sub> Emissions Projections. DTI, The Energy Challenge, 2006. The figures presented are Business as usual (BAU) projections.

new nuclear stations following a successful Greenpeace challenge. Both the nuclear consultation and Energy White Paper are expected to be published at the same time.

There are clearly a number of significant steps that the government can take to reduce power sector emissions. WWF recently commissioned a report<sup>8</sup> on measures to reduce CO<sub>2</sub> from the power sector and found that a relatively modest package of policies to reduce electricity demand, deliver on renewables targets, increase levels of micro-generation and to bolster the EU ETS could reduce the power sector's emissions by well over 50% from 1990 levels by 2020 – without resorting to new nuclear power.

The nuclear debate is likely to continue for some time. The government has been increasing their focus on new nuclear build, but it is unlikely that new nuclear power stations will be commissioned within the next 10-15 years and so make any contribution to the Governments proposals for cuts in emissions of between 26% and 32% by 2020. In addition, there are still many unresolved issues such as waste disposal, costs and public acceptability.

The level of coal running is the key driving factor in power sector emissions in the UK. Coal generation is currently enjoying high levels of running and investment (in addition to the FGD plants, investment in turbines is planned at Aberthaw, Cottam Drax and West Burton power stations).

The increase in coal running is particularly counter-intuitive, given that coal prices have increased over the last few years, environmental constraints have limited plant running, (particularly through the tightening of sulphur bubbles) and the introduction of carbon trading has reduced coal's competitiveness. The reason for the resurgence of coal is simple; the cost of gas to fire CCGTs, coal's main competitor for the spot of marginal technology, has increased significantly.

The announcement of a review of the rules governing co-firing with biomass under the energy review<sup>9</sup> could further incentivise the development of co-firing, which has provided coal-fired plant access to a renewable energy fuel source and the revenue from ROCs<sup>10</sup>. This is likely to further increase coal running and investment in co-firing equipment has already been announced (investment in direct injection at Drax, Fiddlers Ferry and Ferrybridge). In addition, considerable effort has been put into developing energy crops, with potential planned cultivation leaping from 1,000 hectares to 60,000 hectares over the next 3 years.

Whilst targets for renewable energies and increasing energy efficiency programmes will reduce overall emissions, these may not be sufficient to offset the increasing emissions from coal plant in order for the government to meet its emissions targets. It is clear then that if we are moving to scenarios of increasing and not reducing coal burn sufficient incentives must be provided for "clean coal" developments with carbon capture and storage (CCS). There have been a number of announcements regarding new coal developments, with possible developments at Tilbury (RWE), Kingsnorth, High Marnham and Killingholme (Eon), Ferrybridge (SSE) Teesside (Centrica) and Hatfield (Powerfuel), with EdF having a stated objective to bring clean coal technologies into commercial operation within 5 years. Indeed, the potential to redevelop non-FGD coal plant, retrofitting plant with advanced super-critical boilers, dedicated biomass feed

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<sup>8</sup> [http://www.wwf.org.uk/filelibrary/pdf/summary\\_of\\_ilex.pdf](http://www.wwf.org.uk/filelibrary/pdf/summary_of_ilex.pdf)

<sup>9</sup> Malcolm Wicks' speech to the House of Commons on the Renewables Obligation Order, 1 March 2006.

<sup>10</sup> ROC – Renewable Obligation Certificate. Awarded for each MWh of generated renewable electricity.

Electricity Suppliers have an obligation to source a percentage of their supplies from renewable sources of power. Electricity Suppliers produce ROCs as evidence of compliance with this obligation.

systems and burners, and potentially developing CCS systems could yet see coal stations with a new lease of life and re-licensed to operate beyond 2015 with effectively lower emissions than the existing coal fleet.

The UK government has emphasised its support for clean coal technologies and CCS and has announced it is to hold a competition to build the world's first, full-scale demonstration of CCS. However, there is significant uncertainty over the specifics of the competition, not to mention the ensuing legal, regulatory and technical issues surrounding the technologies.

Fossil fuel generating stations, and particularly coal, are likely to have their challenges in the future and tightening carbon markets and volatile commodity markets could yet undermine coal's competitiveness. However, coal plant appears to have managed to withstand a twin regulatory assault from both the LCPD – due to come into force in 2008<sup>11</sup> - and the EU ETS, and current investment plans suggest that it will take a lot more to kill off coal plant; indeed it seems that coal is thriving!

This then is clearly not good news for UK emissions. Unless sufficient incentives are provided for existing and new coal stations to reduce their emissions through stricter environmental regulations and incentives for clean coal and CCS, and there is more aggressive promotion of energy efficiency and renewables, – power sector emissions are likely to remain high for the foreseeable future. This will then place a very tough burden on other sectors – domestic, industry, transport etc – and may even make the government's emission targets for 2020 and 2050 impossible to reach.

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<sup>11</sup> IPA Briefing Paper: Coal's Renaissance, Power UK, May 2006, Platts.