



Environmental Audit Committee inquiry into carbon capture and storage

Response by the World Development Movement

June 2008

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1. Introduction

1. The World Development Movement (WDM) campaigns to tackle the root causes of poverty. With our partners around the world, we win positive change for the world's poorest people. We believe that charity is not enough. We lobby governments and companies to change policies that keep people poor. WDM is a democratic membership organisation of 15,000 individuals and 70 local groups.
2. We welcome the Environmental Audit Committee's decision to hold an evidence session into carbon capture and storage with particular focus on developments surrounding the proposed new Kingsnorth power station.
3. There are three issues which should be addressed separately: the UK government's competition for a 300-400MW demonstration carbon capture and storage power station; E.ON's application for a new 1600MW unabated coal power station at Kingsnorth in Kent; and E.ON's entering of Kingsnorth into the carbon capture and storage (CCS) competition. Whilst these issues are separate, unfortunately they are often conflated as being the same issue.
4. This submission makes the following three points:

The CCS demonstration project

5. The UK government's subsidy for a CCS demonstration project to research the effectiveness and cost of post-combustion CCS technology should be supported.

E.ON's application for a 1600MW unabated coal power station

6. The UK government should refuse to consent E.ON's application for a 1600MW unabated coal-fired power station at Kingsnorth. Any new unabated coal power stations in the UK would make it extremely difficult for the UK to meet targets for reducing emissions by 2020. Furthermore, there is and can be no guarantee that CCS technology would be added to Kingsnorth in the 2020s, and so any decision to consent Kingsnorth risks locking the UK into high-carbon infrastructure for decades to come. Instead, the UK government should set a greenhouse gas standard which any new power stations built in the UK have to meet.

Kingsnorth and the CCS demonstration project

7. *If* Kingsnorth wins the 300MW CCS demonstration project competition, the 300MW CCS plant should not be used to justify the 1300MW of unabated coal which would still exist if the government consents E.ON's application for a 1600MW power station. Around 80 per cent of Kingsnorth would be unabated coal and emit CO₂ at the rate of a supercritical coal power plant; around 0.9 tonnes of CO₂ for every MWh of electricity produced. The remaining 20 per cent would be CCS and emit at a rate of 0.16 tonnes of CO₂ for every MWh of electricity.

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8. Overall, a Kingsnorth with 300MW of CCS and 1300MW of unabated coal would emit at a rate of 0.75 tonnes of CO₂ for every MWh. This is still almost double the emissions of a modern gas power plant. If the UK government regards E.ON's CCS application as the best entrant into the CCS demonstration project competition, it should consent the 300MW CCS plant and only the 300MW plant.

2. The CCS demonstration project

9. Technology for CCS exists in separate plants around the world but there are no full-scale power plants currently operating capturing, transporting and storing CO₂.¹ Therefore, CCS is not yet deployable at scale. It is therefore not yet known whether the technology can be made to work and how expensive it will be.
10. The UK government has launched a competition to subsidise one CCS project with 50-100 MW of capacity by 2014, rising to 300-400MW "as soon as possible thereafter".² By 2014, the project will have to demonstrate the full cycle of capturing, transporting and storing the CO₂.
11. The IPCC says that current technology captures 85-95 per cent of the CO₂ generated.³ The UK government has said the demonstration plant should be able to capture and store "up to 90 per cent" of the CO₂ emissions.⁴ Given that this is an aspiration for 90 per cent, rather than a clear commitment, we will assume for the purposes of this submission that the CCS demonstration plant will capture 85 per cent of the CO₂ emitted. Coal CCS should therefore emit less CO₂ per MW hour directly from the power plant than modern gas power plants (see Table 1 below).ⁱ However, coal CCS still emits some CO₂ directly from the power plant, unlike renewable technologies such as wind.

Table 1. CO₂ emissions direct from power plants

Type of power plant	CO ₂ per MW hour
Subcritical coal	1.20
Supercritical coal	0.9
Gas (CCGT)	0.4
Subcritical coal with CCS ⁱⁱ	0.23
Supercritical coal with CCS ⁱⁱⁱ	0.16
Wind	0

ⁱ The indirect emissions from CCS coal and other technologies also need to be identified. Power stations cause indirect emissions from their construction, mining of fuel, transportation of fuel and (for CCS) transporting and storing the CO₂. Part of the CCS demonstration project should be to produce figures for the indirect emissions of the CCS coal power stations to be compared with the indirect emissions of other energy options such as gas and forms of renewable energy.

ⁱⁱ Subcritical with CCS: Efficiency reduced from 34 to 25 per cent. This is an increase in coal used of 26 per cent. 15 per cent of coal used still results in CO₂ emissions into the atmosphere. The relative emissions are 12.6 tonnes of CO₂ for every 100 tonnes of CO₂ emitted by a comparison subcritical coal power plant.

ⁱⁱⁱ Supercritical with CCS: Efficiency reduced from 43 per cent to 34 per cent. This is an increase in coal used of 16 per cent. 15 per cent of this coal used still results in CO₂ emissions into the atmosphere. The relative emissions are 17.4 tonnes of CO₂ for every 100 tonnes of CO₂ emitted by a comparison supercritical coal power plant.

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12. On current policies, if the government's targets are met, a 50 MW rising to 300 MW demonstration power plant will start operating from 2014-2016. Following the results of this trial, information might be available around 2018 to inform future CCS development in the UK. This means CCS might be deployable in other power plants from the early 2020s. Therefore, CCS cannot realistically play a part in meeting the UK's targets for reducing emissions by 2020.
13. The EU energy package has effectively set the UK a target to generate 40 per cent of electricity from renewable sources by 2020. After 2020, the generating capacity of renewables will hopefully continue to increase. But, unfortunately it is likely that from 2020-2040, fossil fuels will need to remain some part of electricity generation in the UK. Coal (and gas) with CCS may potentially have lower emissions than gas without CCS, so could be part of this mix, whilst helping to reduce emissions.
14. CCS could *potentially* be part of reducing emissions in the UK, and elsewhere in the world, from 2020 to 2040. WDM therefore supports the 300MW CCS demonstration project in the UK as part of a research programme into CCS.

3. E.ON's application for a 1600MW unabated coal power station at Kingsnorth

3.1 Emissions from Kingsnorth

15. E.ON has applied to build a new 1600MW unabated coal power station at Kingsnorth in Kent. E.ON are aiming for the plant to be generating electricity before 2015. By 2015 the current Kingsnorth plant will have to close having opted out of the EU Large Combustion Plant Directive.
16. Kingsnorth would be a supercritical coal power station. It is therefore likely to emit around 0.9 tonnes of CO₂ for every MWhour of electricity generated. This is in comparison with 1.2 tonnes per MWh for subcritical coal power plants, 0.4 tonnes per MWh for combined cycle gas turbine power plants and 0 tonnes per MWh for wind. If the new Kingsnorth plant operated for 60 per cent of the time, it would emit 7.6 million tonnes of CO₂ a year;ⁱ more than the total emissions of Ghana.⁵
17. The fourth assessment report of the IPCC released in 2007 suggests that to keep the increase in global temperatures to between 2°C and 2.4°C requires global emissions to peak between now and 2015, at the latest, and then fall by between 50 and 85 per cent, on 2000 levels, by 2050.⁶ For the UK to play its part in reducing global emissions by 50-85 per cent by 2050, UK emissions must fall by 80-95 per cent by 2050.⁷ For global emissions to start falling from 2015, and for the UK to be on track for

ⁱ Every hour it is operating Kingsnorth would emit 1,440 tonnes of CO₂ (0.9*1600). 60 per cent of the year is 5256 hours. 5256*1440 = 7,568,640

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reducing by more than 80 per cent by 2050, the UK needs to reduce emissions by 40 per cent on 1990 levels by 2020.

18. The UK government's current targets are to reduce CO₂ emissions by 26 per cent by 2020 and 60 per cent by 2050 compared to 1990 levels. However, in a speech hosted by WWF on 19 November 2007, the Prime Minister said: 'The evidence now suggests that, as part of an international agreement, developed countries may have to reduce their emissions by up to 80 per cent [by 2050]. So we will put this evidence to the committee on climate change and ask it to advise us, as it begins to consider the first three five-year budgets, on whether our own domestic target should be tightened up to 80 per cent'.⁸
19. In UK government models of how to reduce emissions by 2020, the electricity generating sector has to reduce the most. For instance, in the 2007 Energy White Paper emissions pathways are set for five sectors in the UK economy to meet the 60 per cent by 2050 reduction target.⁹ These show possible contributions towards CO₂ reductions on 2000 levels for the energy, industry, residential, services and transport sectors.
20. Of these, the White Paper suggests the energy sector should make the largest emission reductions; 15 per cent cuts on 2000 levels by 2020. For *electricity* this means reducing emissions from 158.3 million tonnes of CO₂ in 2000¹⁰ to 135 million tonnes in 2020. Unfortunately, these emission reduction pathways only cut the UK's overall CO₂ emissions by 14.5 per cent on 1990 levels by 2020, rather than the 26 per cent targeted in the climate change bill. Based on the emissions pathway in the Energy White Paper, we estimate that:
- For the UK as a whole to meet the 2020 target set in the current climate change bill – 26 per cent over 1990 levels – emissions from electricity generation need to be 26 per cent below 2000 levels by 2020: 117 million tonnes of CO₂.¹¹
 - For the UK to meet possible future emission reduction targets – those which are in line with the science of preventing dangerous climate change for the world's poor – total emissions from electricity generation need to be 40 per cent below 2000 levels by 2020 - 95 million tonnes of CO₂.¹²
21. With coal power stations that will still be operating in 2020, and current levels of emissions from gas power stations, we estimate that total UK CO₂ emissions from electricity generation in 2020 will be at least 120 million tonnes of CO₂ (see Appendix).^{13 14} This is:
- Higher than the level of emissions from electricity generation by 2020 required to meet the current UK government carbon reduction targets (117 million tonnes)

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- Significantly more than the level of emissions from electricity generation by 2020 for the UK to play its part in preventing dangerous climate change (95 million tonnes).

22. Given the scale of the challenge the UK faces in reducing emissions from electricity generation, it appears that any single, new, unabated coal fired power station, such as Kingsnorth, will significantly reduce the likelihood of hitting the government's current, inadequate 2020 target and put beyond reach any globally adequate target.

23. Furthermore, the energy industry is currently considering a further six unabated coal fired power stations at Tilbury (Essex), Blyth (Northumberland), Longannet (Fife), Cockerzie (East Lothian), Ferrybridge (West Yorkshire) and High Marnham (Nottinghamshire). Consenting Kingsnorth would likely prejudice decisions in favour of these new coal power plants as well, destroying any ability of the UK to meet its 2020 reduction targets.

3.2 Kingsnorth and the EU Emissions Trading Scheme

24. The reason the UK government thinks building new unabated coal power stations may be consistent with its emission reduction targets is because the electricity sector is covered by the EU Emissions Trading Scheme (ETS). This means that whilst emissions from electricity generation in the UK will not be reduced by enough by 2020 to meet the UK government's target, emissions may be 'offset' through buying carbon credits through the Clean Development Mechanism (CDM) and Joint Implementation (JI), or from elsewhere in the EU.

25. The way in which phase three of the EU ETS will operate is not yet decided. However, the European Commission has proposed that permits will be allocated centrally by the EU. The number of permits available from within Europe will fall by around 2 per cent per year from 2012 to 2020.

26. Buying ETS permits to emit will not be the only way for electricity generators to acquire permits. If no global agreement on tackling climate change post-2012 is reached, then one-third of required emissions reductions from 2013 to 2020 can be met through purchasing JI and CDM credits from overseas. If a global agreement is reached, then *half* of the additional emissions reductions required under the ETS can be bought from outside Europe.¹⁵

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27. Climate change cannot be tackled through accounting tricks. Rich countries, with 18 per cent of the world's population, account for 54 per cent of CO₂ emissions. Developing countries, with 82 per cent of the world's population, account for 46 per cent of emissions. It is a simple fact that to tackle climate change:
- Rich countries like the UK *have* to reduce *their own* emissions;
 - *And* rich countries like the UK need to help some developing countries, such as China, to curb the growth in, and ultimately reduce, emissions
 - *And* rich countries like the UK need to help some other developing countries to avoid large increases in emissions.
28. This *additional* financing and technology transfer requirement is already established in international law under Article 4.7 of the UNFCCC. This requires that emissions reductions in developing countries take place in as much as they are financed by industrialised countries, leaving developing nations to focus on poverty reduction and development priorities.
29. Phase three of the EU ETS will not reduce UK and EU emissions from electricity generation by enough to prevent global temperature increases of 2°C or more. By itself, the EU ETS will not lead the UK and EU to becoming low carbon economies, and the UK and EU will not develop the ideas and technology which can be transferred to other parts of the world to help mitigate climate change.
30. Furthermore, as the Environmental Audit Committee are aware, there are serious problems with the CDM. There is not space to revisit these problems here. The EAC has previously said: "there is plenty of evidence that much CDM investment is currently going into projects of dubious merit, concentrating on the abatement of exotic gases; not only will such investment do nothing to forestall the growth of carbon-intensive infrastructure in developing prosperity, but it will do little to improve their people's prosperity and quality of life".¹⁶
31. Additional measures beyond the ETS are needed to cut electricity sector emissions as needed to prevent disastrous climate change of 2°C or more. In some areas the UK government recognises the need for additional measures, such as energy efficiency and the development of renewable energy. The UK government therefore also needs to recognise that additional measures are needed in terms of consenting new power stations. One option, as adopted by the US state of California, would be a greenhouse gas emissions standard where a new power plant could only be built if it emits less than a certain amount of CO₂ for every unit of electricity generated. For instance, a standard of 0.35 tonnes of CO₂ for every MWh of electricity produced would allow CCS coal and gas to be built and non-CCS gas which made some use of the 'waste' heat.

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3.3 Kingsnorth and 'carbon capture ready'

32. E.ON claims that the new unabated coal power station at Kingsnorth would be 'carbon capture ready'. The UK government claims that it is supporting post-combustion CCS technology in the demonstration project it is subsidising because such technology can be added to pre-existing coal fired power stations; in countries such as India and China as well as the UK. Therefore, the logic of post-combustion CCS technology is that any coal power plant is 'carbon capture ready'.
33. 'Carbon capture ready' is a marketing ploy, not a robust concept. Because CCS has not yet been properly demonstrated, there can be no guarantee that CCS will one day be added to any power station. Furthermore, the costs of CCS are not yet known. The cost of CCS may be so exorbitant that there is no prospect CCS will be added to coal power stations in the future. It may be that various forms of renewable energy technology will be cheaper and more effective at reducing emissions, and so from 2020 government subsidies would be better spent on various renewable technologies than CCS coal.
34. The earliest CCS technology could be added to Kingsnorth would be the 2020s. As has already been highlighted, Kingsnorth's operations before 2020 would make it extremely difficult for the UK to meet emission reduction targets by 2020. If Kingsnorth began operating in 2013, by the start of 2020 it would have emitted 53 million tonnes of CO₂.ⁱ

3.4 Kingsnorth and international negotiations

35. The Bali decision on international climate change negotiations charts a twin track towards a more ambitious climate change agreement. On the one hand, talks will take place under the UN's Framework Convention on Climate Change (UNFCCC) aimed at securing actions to limit and reduce emissions in countries that currently have no legally-binding targets. On the other, industrialised countries covered by the Kyoto Protocol will discuss how to deepen and speed up reductions of their own and help finance the transfer to and use of clean technologies in poorer nations.
36. In the context of these negotiations, which are due to be completed in late 2009, rich, industrialised countries will have two responsibilities. The first will be to commit themselves to deeper cuts in a second commitment period of the Kyoto Protocol, post 2012. The second will be providing finance and technology to facilitate poorer countries' emission limitation and reduction activities. Both the financing and the corresponding activities must be done in a way that is measurable, reportable and verifiable.
37. Countries with high historical emissions and surplus wealth with which to rise to the challenge of financing clean development and transferring new technology are obliged, under Article 4.7 of the UNFCCC, to do so. Under the current negotiations, this is already a critical issue and, if rich nations meet their obligations, could unlock significant action in developing

ⁱ 7.6 million tonnes a year*7 years = 53.2 million tonnes of CO₂.

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countries. However, countries that are less responsible for climate change and less able to afford its solutions will need convincing that richer nations are cutting domestic emissions and willing to make the necessary financial and technological transfers.

38. Approving new, unabated coal fired power plants would undermine the UK's credibility as it would make meeting the targets we set ourselves in the climate change bill significantly more difficult, implying that poorer and less wealthy nations would have to shoulder additional burden. New coal would also take the UK further away from being able to fulfil its responsibilities as a rich country under the Bali negotiations as it would absorb finance in a carbon intensive activity and yield no new technology to transfer.

4. Kingsnorth and the CCS demonstration project

39. E.ON has now entered Kingsnorth for the CCS demonstration project competition. It is assumed that if Kingsnorth won the competition, and E.ON's plans for Kingsnorth are consented, 300MW of a new coal power plant would be CCS, with the remaining 1300MW an unabated supercritical coal power station.
40. This means that if the government consents to Kingsnorth, 80 per cent of it will emit CO₂ at a rate of 0.9 tonnes of CO₂ for every MWh of electricity produced. The remaining 20 per cent will emit at a rate of 0.16 tonnes of CO₂ for every MWh of electricity. This means overall, a Kingsnorth with 300MW of CCS will emit at a rate of 0.75 tonnes of CO₂ for every MWh. This is still almost double the emissions of a modern gas power plant.
41. In emissions terms, this means Kingsnorth would be likely to emit 6.3 million tonnes of CO₂ a year rather than 7.6 million as just a supercritical power plant. All the reasons given in section 3 above would still apply to why a Kingsnorth plant with 300MW of CCS and 1300MW of unabated coal should not be consented by the UK government.
42. If Kingsnorth wins the CCS demonstration project competition, the CCS plant cannot be used to justify the 1300MW of unabated coal. The UK government should refuse consent to the application for the 1600MW power plant at Kingsnorth. If the UK government regards E.ON's CCS application as the best, it should consent a 300MW plant and only a 300MW plant. If the 300MW plant requires the rest of the new plant to be built, the UK government should disqualify Kingsnorth from the CCS competition.

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43. We do not know of any comprehensive government estimate or analysis of how the addition of new coal power will affect the UK's electricity generation mix in 2020. We have tried to estimate CO₂ emissions from electricity generation in 2020 based on known changes in capacity of coal power stations by 2020, but these estimates do not include new coal power stations.
44. Six coal power stations are due to close in the UK between now and 2015. In addition, a further eight will only be able to operate for a maximum of 27.5 per cent of the time.¹⁷ Given this, we can estimate that the current capacity from coal and gas power stations which will be operating in 2020 will be emitting 120 million tonnes of CO₂. Any additional coal-fired power stations will push CO₂ emissions above this level.
45. The average annual emissions for 2005 and 2006 of the three coal power plants which will still be operational in 2020 were 38.5 Mt of CO₂. The average annual emissions for 2005 and 2006 of those coal power plants which will operate at a maximum capacity of 27.5 per cent in 2020 were 51.6 Mt of CO₂. Average capacity used for UK coal-fired power stations is 64 per cent.¹⁸ We can therefore estimate that emissions from these coal power plants will be 22.2 million tonnes of CO₂ in 2020 ($27.5/64 = 0.43$. $0.43 \times 51.6 = 22.2$ Mt of CO₂). CO₂ emissions from electricity generation, minus coal, were 60.9 million tonnes in 2005 and 57.8 million tonnes in 2006. $38.5 + 22.2 + 59.3 = 120$ Mt of CO₂.

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Table 2. UK coal power stations

Power station	GW	Status by 2016¹⁹	Current emissions (2005+2006)²⁰
Aberthaw	1.5	Limited use ²¹	12.6
Cockenzie	1.2	Closing	7.6
Cottam	1	Limited use	18.1
Didcot A	2	Closing	13.5
Drax	4	Operational	43.5
Eggborough	1	Operational	14.9
Ferrybridge	2	Half closing, half limited use	17.3
Fiddler's Ferry	2	Limited use	16.9
Ironbridge	1	Closing	6.4
Kilroot	1	Limited use	4.9
Kingsnorth	2	Closing	16.7
Longannet	2.3	Operational	18.5
Ratcliffe	2	Limited use	16.5
Rugeley	1	Limited use	8.3
Tilbury	1.2	Closing	10.1
West Burton	2	Limited use	17.3

Table 2. UK coal-fired power stations operating in 2006 (various sources).

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- ¹ IPCC. (2005). Carbon dioxide capture and storage: Summary for policymakers. IPCC special report. September 2005.
- ² BERR. (2007). CCS demonstrator will put UK ahead in global race for clean coal. News release 2007/073. BERR. London. 09/10/07.
- ³ IPCC. (2005). Carbon dioxide capture and storage: Summary for policymakers. IPCC special report. September 2005.
- ⁴ BERR. (2007). CCS demonstrator will put UK ahead in global race for clean coal. News release 2007/073. BERR. London. 09/10/07.
- ⁵ In 2005 Ghana emitted 6.67 million tonnes of CO₂ from the burning of fossil fuels. US EIA. (2007). World carbon dioxide emissions from the consumption and flaring of fossil fuels, 1980-2005. US Energy Information Administration. <http://www.eia.doe.gov/pub/international/iealf/tableh1co2.xls>
- ⁶ IPCC. (2007). *Climate Change 2007: Mitigation*. Summary for Policymakers. Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. 04/05/07.
- ⁷ See also, for instance, Baer, P. and Mastrandrea, M. (2006). High Stakes: Designing emissions pathways to reduce the risk of dangerous climate change. IPPR. 08/11/06.
- ⁸ Brown, G. (2007). Speech hosted by WWF. 19/11/07.
- ⁹ DTI. (2007). Meeting the energy challenge: Energy white paper. DTI. London. May 2007.
- ¹⁰ Defra. (2008). <http://www.defra.gov.uk/environment/statistics/globalatmos/download/xls/gatb05.xls>
- ¹¹ The 2007 energy white paper has emissions reduction pathways by sector. Energy has a pathway to reduce CO₂ emissions by 15 per cent by 2020 on 2000 levels. This is the most of any sector. When all sectors are calculated, total UK CO₂ emissions are only reduced by 14.5 per cent on 1990 levels (8 per cent on 2000 levels). Extrapolating from this, for the UK to actually meet its 26 per cent reduction target by 2020, based on the relative contributions of sectors in the energy white paper, the energy sector has to reduce emissions by 43 per cent on 1990 levels (26 per cent on 2000 levels).
- ¹² The assumptions for this are the same as above. For the UK to reduce emissions by 40 per cent on 1990 levels by 2020 would require a 53 per cent cut in CO₂ emissions from electricity by 2020 on 1990 levels (40 per cent on 2000 levels). None of these figures take into account the extra reductions which will be required of UK electricity generation to cancel out the planned increase in emissions from UK aviation. The Secretary of State for Transport, Ruth Kelly, has said: "any future growth in emissions from international air journeys would be balanced by compensating reductions elsewhere".
- ¹³ The calculations for this estimate are in the Appendix. It assumes that: three coal power stations which can keep operating until 2020 continue to emit at their current rate of 38.5 million tonnes of CO₂. A further eight coal power stations can operate at a maximum of 27.5 per cent of the time, which will together be emitting 22.2 million tonnes of CO₂. We have assumed gas power stations continue to emit at the current rate of 59.3 million tonnes of CO₂. This is a total of 120 million tonnes of CO₂. It is of course only an estimate, but highlights the contradiction between targets for reducing emissions and building new coal power stations.
- ¹⁴ Although this does not account for any increase in use of gas to compensate for the reduced use of coal power stations.
- ¹⁵ EC. (2008). Questions and Answers on the Commission's proposal to revise the EU Emissions Trading System. Memo 08/35. Brussels. 23/01/08.
- ¹⁶ EAC. (2007). The EU Emissions Trading Scheme: Lessons for the future. Environmental Audit Committee Second Report of Session 2006-2007. 20/05/07. <http://www.publications.parliament.uk/pa/cm200607/cmselect/cmenvaud/70/70.pdf>
- ¹⁷ BWEA. (2008). Renewable energy body calls for mixed energy economy in response to Government's nuclear energy announcement. BWEA News Release. 10/01/08.
- ¹⁸ The average capacity used for UK coal-fired power stations was 63 per cent in 2005 and 66 per cent in 2006 http://stats.berr.gov.uk/energystats/dukes5_10.xls
- ¹⁹ Based on Defra. (2007). UK National Emissions Reduction Plan for the implementation of revised Large Combustion Plant Directive (2001/80/EC) – February 2006. Update No. 1 December 2007. Tables A3, A5 and A6.
- ²⁰ EU ETS verified site emissions 2005-2006 <http://ec.europa.eu/environment/climat/emission/pdf/internetgb2006.xls>
- ²¹ Limited capacity is 27.5 per cent