Evading capture

Is the UK power sector ready for carbon capture and storage?

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Coal is the most polluting of all fossil fuels. Proposals for a new generation of coal-fired power stations in the UK and EU are therefore a cause for great concern.

New coal plants will operate for 40-50 years and pose a serious risk of locking us in to a pathway of high emissions – threatening fatally to undermine efforts by the UK and EU to show leadership on climate change.

The power sector and the UK government hope to square the circle by ensuring that new stations are 'capture ready' – so that carbon capture and storage (CCS) equipment could be retrofitted at a later date once the technology is proven. CCS is a promising technology but it has not yet been demonstrated on a large scale integrated with a power plant anywhere in the world. As a result, many observers fear that 'capture readiness' may be little more than a fig leaf that would open the door to a new generation of polluting coal stations while giving no assurance as to when – if ever – CCS will be fitted.

WWF-UK commissioned Edinburgh University's Scottish Centre for Carbon Storage (SCCS) to assess the use of the 'capture readiness' concept, and to explore what would be necessary to give meaningful assurance that 'capture ready' power stations would be fitted with full-scale CCS within a reasonable timeframe. This paper gives a background to the issue, summarises SCCS' findings, and presents WWF-UK's recommendations.

Introduction

To avoid the most serious impacts of climate change, the rise in global average temperatures must be kept to less than 2°C above pre-industrial levels. This target is the stated objective of the EU and the UK government. Last year's report by the Intergovernmental Panel on Climate Change (IPCC) gave a stark assessment that even to stabilise temperature rises at 2-2.4°C, global greenhouse gas emissions need to fall by 50-85% by 2050.[1]

Achieving such reductions will require radical changes in the way in which the world sources and uses energy. A study by WWF, *Climate Solutions,*[2] showed that a revolution in renewable energy and energy efficiency could deliver most of the necessary reductions in emissions. However, use of fossil fuels with capture and storage of the resulting CO_2 emissions could also play a significant role as a bridge to a truly low-carbon, sustainable energy system.

Industrialised countries have high per capita emissions, and have also benefited from economic growth in a world without carbon constraints. They need to take a strong lead in reducing their own emissions and in demonstrating the technologies and policy mechanisms that will pave the way to a low-carbon economy. Leadership by the EU and UK will be vital in ensuring a new international agreement to succeed the first phase of the Kyoto Protocol.

One critical example of UK leadership is the Climate Change Bill, which is completing its passage through Parliament. The Bill commits the UK to reducing CO_2 emissions by at least 26% by 2020 and by at least 60% by 2050. However, the 60% target was proposed eight years ago and is based on science which is now out of date. In late 2007, Prime Minister Gordon Brown accepted that the target may need to be tightened to 80% and asked the new Committee on Climate Change to review the targets for both 2020 and 2050 by December 2008.[3]

However, it is clear that the emission targets in the Climate Change Bill cannot be achieved without rapid decarbonisation of the power sector. The power sector is currently the biggest source of CO_2 emissions both globally and in the UK. Moreover, a decarbonised electricity sector could displace fossil fuels in sectors such as heating and transport. To achieve this goal will require urgent large-scale roll-out of renewable energy sources – and a potentially significant role for fossil fuels with CCS.

1. IPCC Fourth Assessment Report, summary for policymakers, www.ipcc.ch
2. *Climate Solutions: WWF's vision for 2050,* wwf.org.uk/filelibrary/pdf/climatesolutionreport.pdf
3. WWF, ippr and the RSPB published research based on models used by the government to show how the UK could reduce its total CO_2 emissions – including the UK's considerable share of emissions from international aviation – by 80% by 2050. *The 80% Challenge: Delivering a low-carbon UK,* WWF-UK, ippr and RSPB, wwf.org.uk/filelibrary/pdf/80percent_report.pdf

The roll to coal

The power sector is responsible for an estimated 37% of global CO_2 emissions. Moreover, emissions from the power sector are rising rapidly and under business as usual scenarios the sector is expected to take up a rapidly increasing share of global emissions.

Media reports frequently focus on the rapid rate at which new coal stations are being built in China. However, broadly similar numbers of new coal plants are also expected in industrialised countries – including the UK and the EU (where some 50GW of new coal capacity is forecast over the next 15 years). These plants attract less attention than new stations in China, largely because they often replace existing capacity, but the consequences for the atmosphere over the next few decades are just as worrying.[4]

In the UK, the power sector was responsible for 180 million tonnes of CO_2 in 2007, one-third of the country's total emissions. Indeed, emissions from the power sector have been rising steadily since 2000 – and the gains from the 'dash for gas' in the 1990s have been significantly eroded (see graph). The main reasons for this are the rise in electricity consumption and an increased use of coal for power generation in response to high gas prices.[5]

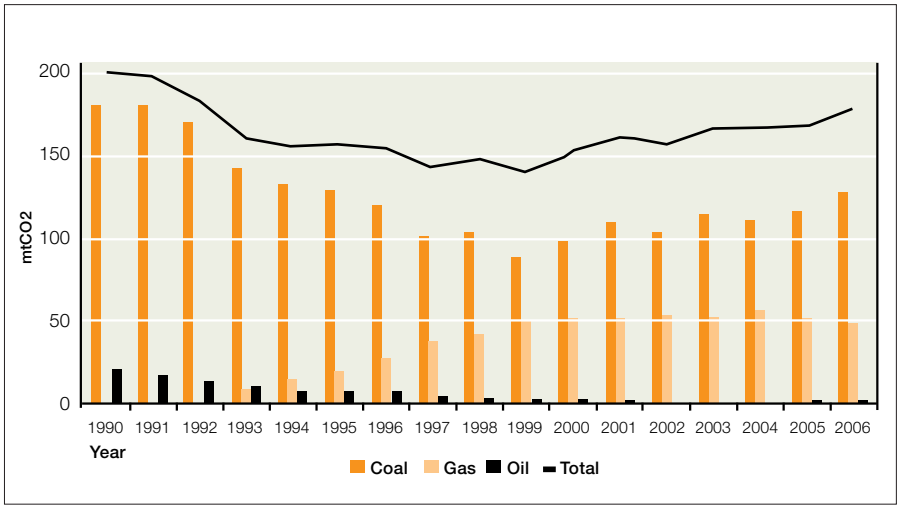
Emissions from existing coal stations should now begin to fall because EU legislation means that plant without sulphur scrubbers (some 8.5GW of coal plant) can only run for a limited number of hours and must close by 2015. After 2015, the remaining 20GW of existing coal-fired capacity faces further restrictions on air quality grounds.

However, the power utilities are considering building as many as six or seven new coal-fired power stations in the UK by 2015, with a total capacity of 10-11GW (see map).[6] These stations would use 'supercritical' technology which has higher efficiency than the existing fleet and so produces around 15-20% less CO_2 per unit of power generated. Even so, the power generated by these stations would be almost twice as carbon-intensive as that from a modern combined cycle gas turbine (CCGT) plant.[7]

Leading the pack is E.ON's proposed 1.6GW station at Kingsnorth in Kent. The company's application for consent is currently being considered by the Department for Business, Enterprise and Regulatory Reform (BERR). If built without CCS, the station would produce 8 million tonnes of CO_2 per year. The station would cost some £1.7 billion – but using the government's own shadow price for carbon, the economic damage caused by Kingsnorth's emissions would be more than £200 million per year, or a total of £13-14 billion if it runs to 2050 without CCS.

The combined emissions from six new coal-fired stations would be around 50 million tonnes of CO_2 each year – significantly more than the government is hoping to save through all energy efficiency measures proposed in its 2007 Energy White Paper. The new stations are, to varying degrees, claimed to be 'carbon capture ready' – but there is no guarantee that they will be retrofitted with CCS technology in the future. In the meantime, the UK would be locked in to very high emissions of CO_2 – potentially for the full 40-50 year lifetime of a coal station.

The drive to build new coal stations comes from several related factors. First, the power companies fear an 'energy gap' in the second half of the next decade as ageing coal and nuclear stations shut down. Second, there are political concerns over the security of gas supplies, fuelled by the fact that the UK has recently switched to being a net importer of gas and by recent high gas prices (driven by a link to the oil price). However, there are compelling grounds to believe that these issues have been over-played. New gas storage facilities and other infrastructure are coming on line which should reduce supply risks, and the UK obtains gas from a range of sources – with Norway being the most important supplier. Moreover, the focus on electricity generation tends to obscure the fact that UK will continue to be highly dependent on imported gas for



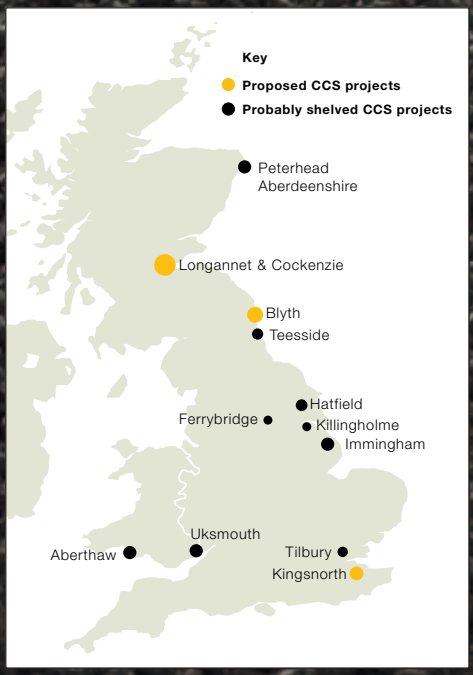
UK Power Sector Emissions

(Source: 'UK power sector emissions – targets or reality?' report by IPA Energy+Water consulting, March 2006.)

heating purposes for some decades to come.

The reality or otherwise of the claimed 'energy gap' deserves some scrutiny. First, a significant number of CCGTs (16GW of capacity) have already been consented to, or are applying for consent. Second, a further 16GW of on- and off-shore wind power is in an advanced stage of development. Third, a strong drive on energy efficiency can be expected to reduce the need for new power capacity. Most significant of all, last year the government committed the UK to meeting its "fair share" of a binding EU target to secure 20% of all of Europe's primary energy from renewable sources by 2020. The European Commission has proposed that the UK should deliver 15% of its energy from renewables. This would require some 35-45% of electricity to come from renewables by the end of the next decade – a very significant increase on the current penetration of renewables, but a reflection of the fact that the UK has some of the best wind and marine energy resources in Europe.

Put these factors together, and it is far from clear that there is really a case for building new unabated coal plant "to keep the lights on".



Proposed and shelved coal/CCS projects

"In 2007, the UK power sector was responsible for 180 million tonnes of CO_2 – one third of the country's total emissions."

4. According to the IEA World Energy Outlook 2004, 184GW of new coal is expected to be built in OECD nations between 2011-20, compared to 168GW in China and 48GW in India.
5. Data from *Energy Trends*, BERR, www.berr.gov.uk/energy/statistics/publications/trends/index.html
6. Four other coal gasification stations have also been mooted, with CCS installed from the outset. This technology is cleaner and more efficient than conventional pulverised fuel, and the energy penalty from 'pre-combustion' capture of CO_2 is smaller than for conventional plants with 'post-combustion' capture. However, these schemes will not qualify for support under the terms of the government's CCS competition and are now not expected to proceed.
7. According to the IPCC Working Group 3 report, supercritical coal plants emit 710g of CO_2 per kWh, compared to 404g/kWh from a modern CCGT.

Coal and CO_2 – squaring the circle

On the face of it, plans for new unabated coal stations in the UK are in direct conflict with emissions reduction goals in the Climate Change Bill. The government and industry rely on three related arguments to justify this apparent contradiction.

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EU EMISSIONS TRADING SCHEME

The first argument is that because the UK power sector is covered by the EU Emissions Trading Scheme (ETS), it does not matter if emissions are high because the generators will offset their emissions by action elsewhere in the EU or by use of imported carbon credits under the Clean Development Mechanism. This trend is already apparent – emissions from the UK power industry are already much higher than the ETS cap.

However, single-minded reliance on the EU ETS is not a credible basis for climate or energy policy. The government accepts this through its dedicated policies to bring forward renewable energy and to promote energy efficiency in electrical products. It would be worrying if decisions made now before the carbon price has matured locked the UK into long-lived, high carbon infrastructure such as new unabated coal stations.

The Stern Review also warned that carbon markets needed to be complemented by other policies, such as tax and regulation, and also by targeted action to promote the rapid deployment of emerging low-carbon technologies. The Review noted that: *"Carbon pricing alone will not be sufficient to reduce emissions on the scale and pace required.[8]" "In this transitional period, while the credibility of policy is still being established and the international framework is taking shape, it is critical that governments consider how to avoid the risks of locking into a high-carbon infrastructure, including considering whether any additional measures may be justified to reduce the risks.[9]"*

'CAPTURE READY'

The second argument used to justify new coal stations is that they should be 'capture ready', so that CCS could be fitted when the price of carbon is sufficiently high. The next section of this report explores what would be needed for 'capture readiness' to be a credible proposition.

However, it is important to note at this stage that although there are very significant uncertainties over the likely cost of CCS, it is very unlikely that the carbon price under the EU ETS will be sufficiently high to cover the full costs or give investors sufficient confidence to invest in a novel, high risk technology such as CCS. This raises serious concerns that 'capture ready' stations would never be retrofitted without strong additional policies outside the EU ETS.

CCS is unlikely to be a cheap option, even once an initial demonstration phase is complete. Full CCS retrofit at Kingsnorth is likely to cost more than £1.1 billion. Work for BERR put the cost of retrofitting CCS to a coal plant at around £30 per tonne of CO_2. However, independent researchers believe that this appraisal is too optimistic and that a significantly higher price would be required[10]. Other analysis of the full costs has identified a carbon price of 127 euros per tonne of CO_2 to make coal with CCS profitable – far above the projected carbon price of 30-40 under the EU ETS.[11]

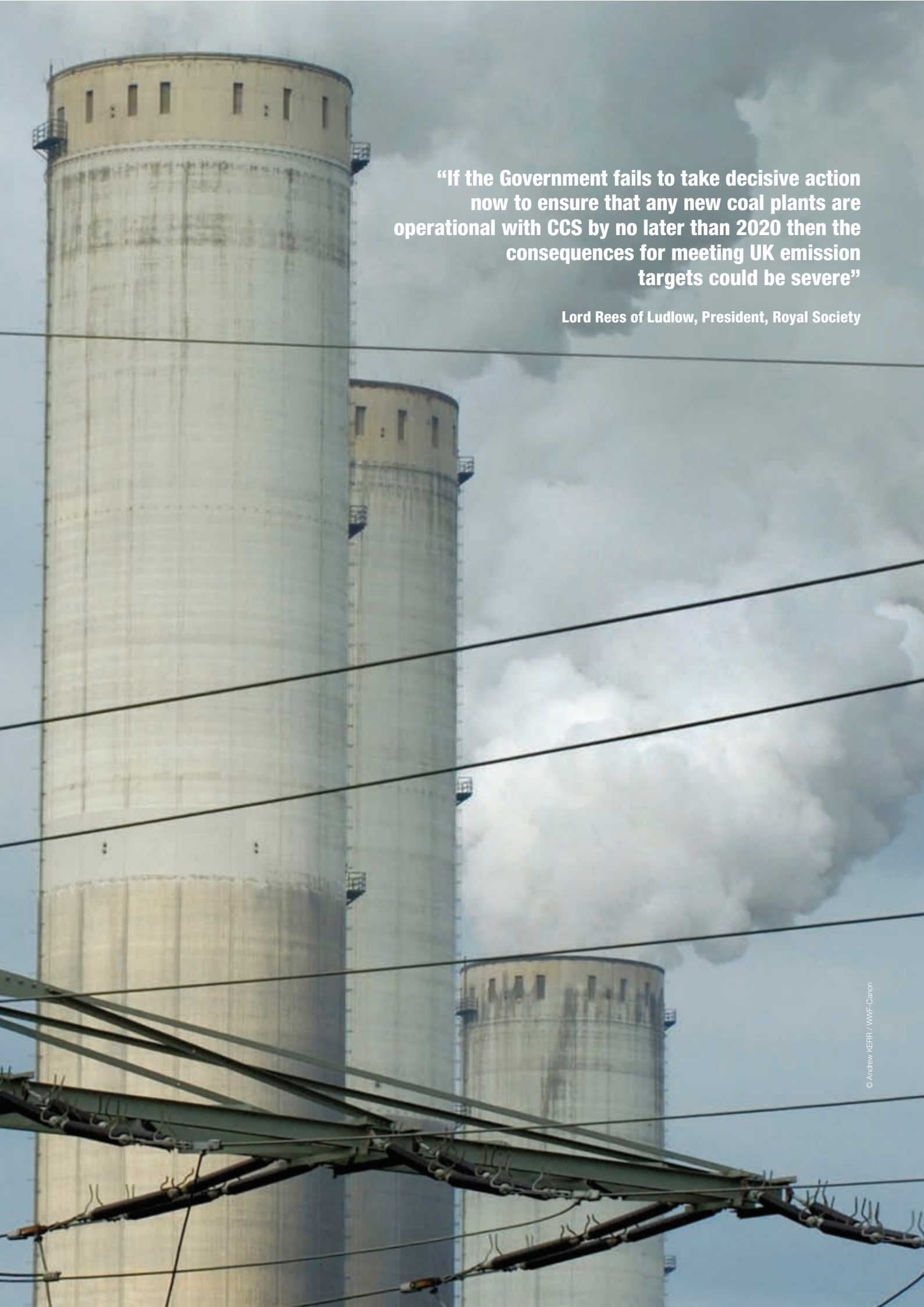
CCS DEMONSTRATION PROGRAMME

The third element of the government's approach is public funding for a CCS demonstration programme. The European Commission has proposed 12 CCS demonstration projects across Europe by 2015, but so far little progress has been apparent. The UK government launched a competition in November 2007 allowing utilities to bid for funds of £1 billion to cover the capital and operating costs of a commercial scale CCS plant. The initial phase would deliver CCS capacity equivalent to 50-100MW by 2014, rising to 300-400MW "as soon as possible thereafter".

The government restricted the competition to 'post-combustion' capture technology, disappointing companies such as Centrica, which had proposed 'pre-combustion' approaches based on advanced coal gasification plant. The decision was justified on the grounds that CCS retrofits may be required in China and elsewhere – however, it also legitimised a 'build now, capture later' mindset in the UK power industry.

E.ON has now submitted Kingsnorth into the CCS competition. However, even if the application is successful, the project will capture less than 25% of the station's emissions. There are real risks that a policy intended to accelerate development and learning of CCS technology is being used to legitimise much larger, investments in unabated (if 'capture ready') coal capacity.

8. *Stern Review*, Part IV: Policy response for Mitigation, Chapter 16 – Accelerating Technological Innovation, 30 October 2006.
9. *Stern Review*, Executive Summary, 30 October 2006.
10. Sussex University, response to Treasury consultation on barriers to commercial deployment of CCS, 2006.
11. *Climate Change Capital* (2007, ZEP: Analysis of funding options for CCS demonstration plants.



"If the Government fails to take decisive action now to ensure that any new coal plants are operational with CCS by no later than 2020 then the consequences for meeting UK emission targets could be severe"

Lord Rees of Ludlow, President, Royal Society

What is CCS?

- The Intergovernmental Panel on Climate Change defined Carbon Capture and Storage (CCS) as: "a process consisting of the separation of CO_2 from industrial; and energy-related sources, transport to a storage location and long-term isolation from the atmosphere". (IPCC 2005: 3)[12]

- Capture of CO_2 can be applied to large point sources using a number of industrial processes, such as amine scrubbers. The CO_2 is then compressed and transported under high pressure as a fluid, for storage in suitable deep underground geological formations. The technology involved in a typical CCS system consists of three main stages:
  i) carbon capture
  ii) carbon transport
  iii) carbon sequestration/storage.

- Storage would take place in depleted oil and gas wells, such as those in the North Sea, and experience to date gives reasonable confidence that storage would be secure and that low leakage rates are achievable. There is also potential to store CO_2 in deep saline aquifers, although further work is needed to give confidence that this would not have adverse environmental consequences. Storage in the ocean has been mooted, but would be completely unacceptable on environmental grounds.

- CCS is promising, with all of the various component parts already in use around the world, in places such as Texas and Norway, but it has not yet been demonstrated on a large scale on an integrated fossil fuel power plant anywhere in the world. However, CCS is unlikely to capture more than 90% of the emissions from a power plant – and it will also carry a very significant energy efficiency penalty, particularly when applied to conventional coal-fired power plant.

- The EU does not envisage commercial deployment of full-scale, integrated CCS with coal-fired power plants until 2020 at the earliest, as the 12 demonstration projects the EU hopes will be constructed by 2015 will need to be monitored for a few years once operational.

- The UK government has so far agreed to fund only one post-combustion CCS coal-fired power plant project between now and 2014. The deadline for power companies to submit bids to BERR was March 2008 and the competition winner is due to be announced in early 2009.

- The utilities say they will not consider CCS without incentives. To date there is no infrastructure in place or being planned for CCS. For example, none of the new coal plants so far proposed in the UK have concrete plans (such as financial provisions and contracts for agreed transport routes and storage sites) to prepare for CCS beyond setting aside land.

- WWF believes there could be a role for CCS in the power sector if the technology is demonstrated to be effective and the transport and storage can be shown to be safe and environmentally benign. WWF therefore supports the use of CCS by power companies if it is used to achieve a net reduction in CO_2 emissions and if a sufficiently robust regulatory regime (including independent monitoring and evaluation) is established.

12. IPCC report 2005: 3

How ready is **'capture ready'?**

WWF-UK commissioned the Scottish Centre for Carbon Storage (SCCS) to investigate the concept of 'CCS readiness' and the way in which the term has been used to date.[13]

SCCS was also asked to evaluate whether 'CCS readiness' could offer any robust assurance that abatement equipment would in fact be retro-fitted to a power station within a reasonable timeframe.

SCCS notes that one clear option to avoid the risk of high-carbon lock-in would be to prohibit construction of new coal-fired stations until CCS has been proven on a large scale and can therefore be installed from the outset. This approach is strongly favoured by WWF-UK.

However, the government intends to consult on 'capture readiness' over the summer. The report makes clear that if the government decides to permit the construction of 'capture ready' plant it must deal with several challenges:

- The difficulty of regulating a technology which is still under development, before its actual properties are well known.
- Developing the skills to build and operate the technology.
- How to guarantee future retrofitting once the new generation capacity is built and entrenched.

So far, experience with the 'capture readiness' concept does not give great confidence. Over the last year, the government has stipulated capture readiness conditions in consents for four gas-fired power stations. The conditions are not uniform, but do little more than refer to the need for the layout of the plant to leave space for future CCS equipment, and make no statement on a deadline, or even broad timeframe, for conversion to full CCS. As SCCS notes, the intention of 'capture readiness' is not the issue – "only the outcome matters".

No new coal-fired plant in the UK has yet been given consent. However, e-mail exchanges between E.ON, developer of the proposed Kingsnorth station, and the Department for Business, Enterprise and Regulatory Reform, give little confidence. The e-mails show that the officials yielded rapidly to E.ON's request to remove wording from the draft consent that would have imposed some meaningful requirements on CCS.[14]

SCCS makes clear that 'CCS readiness' is more than a technical issue. For a project to be credible in environmental terms, the economic, business and regulatory conditions also need to be favourable. SCCS considers five main areas where the scope of any 'CCS readiness' definition needs to be extended and enforced:

- **Modifications to power plant:** The plant should be designed to enable easy conversion to and operation with capture. This is the area that has received most attention, and in its simplest form requires little more than ensuring that sufficient space is available on the site to accommodate a future CCS facility.
- **Transport of CO_2:** Detailed plans should be prepared showing how the CO_2 will be transported to the storage site. These should be up to a level suitable for acceptance by the local planning authority, which could then safeguard the route. Early and full information should be provided to the public.
- **Storage:** Geological storage should be appraised in outline, using existing data, to provide assurance on timing, volume and performance and to obtain outline approval by regulators (regulation of storage activities is still unclear, but interim arrangements for demonstration CCS facilities are being introduced under the Energy Bill).
- **System integration and the business model:** Critically, the operator should be required to set out a plan for system integration and operation, including the full 'value chain' of capture, transport and storage. Documentation should be provided identifying potential operators of the transport and storage operations, including their relevant competence, and an indicative business model outlined for the full CCS chain. WWF's view is that operators should also be required to set out a clear and convincing financial plan to cover retrofit costs.
- **Stringent regulatory criteria to enforce early conversion to full capture, transport and storage:** SCCS recommends that the government sets a requirement that CCS should be operational on all 'capture ready' plants by 2020. If plants fail to demonstrate CCS by that date, or if CCS retrofits are not operational by the end of that year, SCCS recommends that "government should force closure of that coal or gas plant".

SCCS identifies preparing for storage, achieving system integration and guaranteeing effective and timely implementation of CCS retrofits as the most challenging and complex areas. These are also the areas that have received least attention from policy makers.

SCCS considers that with strong action to develop and trial CCS around the world, large-scale CCS "can be demonstrated in 2012, and so introduced widely from 2015. The 2020 deadline thus leaves a five-year margin for delays relative to this best-case timeline." Implementation of this policy would require regular assessments

13. *How ready is capture ready? Preparing the UK power sector for carbon capture and storage*, SCCS, available on wwf.org.uk
14. www.greenpeace.org.uk/media/press-releases/government-climate-policy-dictated-by-german-utility-giant-20080131
15. Letter to John Hutton, April 2008, http://royalsociety.org/downloaddoc.asp?id=5183

of progress towards full-scale demonstration (anywhere in the world).

A similar approach was advocated recently by Sir Martin Rees, President of the Royal Society, in a letter to Ministers:[15]

"I therefore suggest that the government only gives consent to any new coal fired power station, such as Kingsnorth, on condition that the operating permits are withdrawn if the plant fails to capture 90% of its CO_2 emissions by 2020. This would send a clear policy signal to industry of the need to develop and deploy CCS as quickly as possible."

WWF-UK welcomes the call from both the SCCS report and the Royal Society for action to effectively mandate CCS retrofits by 2020. However, we have significant concerns that in practice such a policy may prove very difficult to enforce – and as a result it will impose dangers to both the climate and the taxpayer. Our concerns are reinforced by the difficulties encountered in enforcing flue gas desulphurisation (FGD) retrofits to coal stations in the 1990s (see box, right).

First, there is a real danger of slippage in any demonstration programme, which could lead to repeated pressure to defer the 2020 deadline. Second, a future government would face extremely strong pressure to abandon the deadline should CCS technology not work on a commercial scale or only at prohibitive costs. Once the stations are built, the generators would be in a very strong negotiating position to press either for continued operation (in the name of keeping the lights on) or for the government to pick up the bill for the retrofit programme. This would represent a potentially large liability for taxpayers.

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The FGD story – lessons from the past

Recent history offers another case where the power sector has faced costly, large-scale retrofits of environmental clean-up equipment. In the 1980s and 1990s, the main environmental concern with coal-fired power stations was their contribution to acid rain. In the late 1980s, the Conservative government proposed a target to fit 12GW of coal-fired capacity with sulphur scrubbers, or flue gas desulphurisation (FGD) equipment. After industry lobbying, this figure was reduced to 8GW at the time of privatisation in 1990.

However, this commitment was not fulfilled. PowerGen (one of the two privatised power companies) fitted FGD to only one station instead of the two that were promised. PowerGen successfully fought off pressure from regulators, even though the £250 million cost of the retrofit had essentially been paid by the taxpayer through the debt level inherited by the company. Another problem arose with FGD in the 1990s. Because the technology has high running costs, the less polluting stations were more expensive than dirtier plants and so ran less frequently.

Eventually, a significant programme of FGD retrofits took place – some 15 years after privatisation. This was driven by an EU Directive which stated that only FGD-equipped plant could run at baseload from the start of 2008.

The FGD story illustrates the reluctance of utilities to invest in technology that is not profitable per se, and some of the difficulties in imposing investments when regulation is weak. SCCS makes several direct recommendations for the CCS case, including that "robust regulation should be formulated in such a way as to ensure that not only does retrofitting go ahead at the earliest possible date, but also that the generation capacity that is fitted with CCS is used".

WWF recommendations

Carbon capture and storage could play an important role in decarbonising the power sector in Europe and globally. However, WWF's strong view is that 'capture readiness' is a dangerous concept which carries strong risks of lock-in to high carbon emissions now and in future if CCS technology proves not to be technically or economically feasible, or if political will is lacking to enforce its uptake.

The report by the Scottish Centre for Carbon Storage offers some important recommendations which, if implemented in full, could mitigate this risk of non-delivery – but not eliminate it. To illustrate the problem, assume that there are six key links in the chain for fully operational CCS: technology; full-scale integration; CO_2 transport; storage; a viable business model; and economic viability. If one of these links fails then CCS will not happen. And if there is, for example, a 20% chance of failure in each link then the odds of achieving a fully operational CCS retrofit fall to an alarmingly low 26%.

In our view, a more robust approach would be to effectively rule out new unabated coal in both the UK and the EU. Denmark has a moratorium on new coal stations and New Zealand a moratorium on new fossil fuel plants.

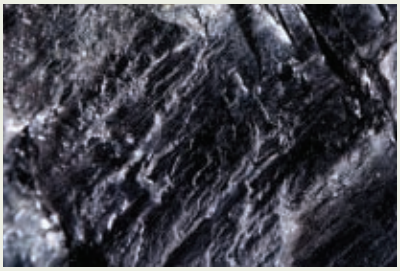
However, WWF-UK's preferred approach is modelled on the emissions standard introduced in California in 2006. This sets a limit on the amount of CO_2 that new and replacement power stations can emit. An emissions standard is a market-friendly approach that would not specify any particular technology – highly efficient gas stations, renewables and coal with operational CCS would all comply. It would also provide much greater certainty to investors and decision-makers than the alternative 'capture ready' approach.

Separately, there is an urgent need to demonstrate the feasibility of commercial scale CCS, to allow accelerated deployment of the technology. However, this objective should not be confused with wider market trends – notably the use of a small-scale CCS demonstration to provide a smokescreen for a much larger new coal station. Similarly, public funding should focus only on the initial demonstration phase – and particularly on the often neglected storage end of the CCS chain – and should not undermine support for renewable energy or energy efficiency. We note that the power sector has made very large windfall profits under the EU ETS,[16] some of which could usefully be spent on the development of low-carbon technologies.

WWF supports the European Commission's proposals for 12 CCS demonstration projects, and also the UK government's intention to host at least one demonstration plant in the UK. However, there is a need for greater coordination of activities across the EU to ensure that demonstration projects complement each other and that learning benefits along the full CCS chain are maximised.

16. According to a recent report to WWF by Point Carbon, power companies in the UK, Germany, Italy, Poland and Spain will receive windfall profits of up to 71 billion between 2008 and 2012, the second phase of the scheme. The profits in the UK were put at 15 billion.

An emissions standard such as that introduced in California would provide certainty to investors and avoid the risk of lock-in from investment in 'capture ready' power stations

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Our key recommendations are as follows:

Focus on renewables and energy efficiency: The strong focus of UK energy policy should be on delivery of the EU target for renewable energy in 2020 and the aggressive promotion of energy efficiency. Delivery of these goals is key to closing the 'energy gap' and building the UK's energy independence and security.

Introduce greenhouse gas emission standards for new power plants: The UK government and the EU should introduce new legal standards setting a limit on CO_2 emissions for all new generating plant that has yet to secure planning consent. This standard should be set at 350g/kWh, a level that could be achieved by an efficient CCGT with some heat recovery, but tightened significantly once CCS technology has been proven. To achieve a safe climate, over time it will be necessary to ensure that gas stations can also only operate with CCS.

Introduce emission standards for existing plant from 2020: Given the urgency of the climate change challenge, it will be important to apply an emission limit to such stations from 2020, or earlier if plant undergoes a significant upgrade. A standard of 350g/kWh should be applied to existing plant from 2020, although to mitigate against energy security concerns stations could be able to secure a temporary 'opt-out' provided they agree to run for a limited number of hours.

Accelerate demonstration of CCS technology: The government and EU should accelerate their proposed CCS projects to bring forward potential wider deployment of the technology, and ensure that the full range of technology options (including pre- and post-combustion capture) are demonstrated. Demonstration projects should be equipped with full CCS abatement, and be at a scale sufficient to enable full price discovery.

Introduce strong legislation on CO_2 storage and transport: The proposed CCS Directive and the Energy Bill begin to address the need for a regulatory framework to ensure that transport and storage of CO_2 is safe and well-regulated. These foundations need to be strengthened to ensure that there are robust provisions for storage site monitoring and aftercare, and to address liabilities for CO_2 leakage.

Apply stringent conditions to any 'capture ready' consent: As explained above, this is not WWF's favoured option. However, if the government decides to consent to any new 'capture ready' coal stations, it should ensure that it includes the criteria on site layout, technology, transport, storage and business plans in the report by the Scottish Centre for Capture and Storage. Most critically, it must impose binding requirements that full CCS should be installed by 2020 at the latest – if this does not happen, the government should force closure of that power plant.

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· ensuring that the use of renewable natural resources is sustainable
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