COMMISSION OF THE EUROPEAN COMMUNITIES

Brussels, 10.1.2007
SEC(2006) 1723

COMMISSION STAFF WORKING DOCUMENT

Commission Communication on Sustainable Power Generation from Fossil Fuels: Aiming for Near-Zero Emissions from Coal after 2020

Summary of the Impact Assessment

{COM(2006) 843 final}
{SEC(2006) 1722}
{SEC(2007) 12}

EXECUTIVE SUMMARY

1. PROBLEM DEFINITION

Fossil fuels are widely used but release CO_2 emissions, the most significant anthropogenic cause of global climate change.

The EU's agreed objective is to limit global temperature increase to max. 2°C above pre-industrial levels, implying global greenhouse gas reductions of 15 to 50% in 2050 with respect to 1990.

Coal is the fossil fuel with strongest negative environmental impact. While substantial improvements have been achieved on traditional pollutants (NO_x, SO_x, particulate matter), coal's high carbon content results in high levels of carbon dioxide from its combustion. In the EU27, around 950 million tonnes of CO_2 were emitted from coal-fired power generation in 2005. This represents 70% of Europe's total CO_2 emissions from power generation and 24% of EU CO_2 emissions across all sectors. The latest global figures available are even more striking: nearly 8 billion tonnes of CO_2 emitted from coal-fired power generation, representing 76% of emissions from power generation and around 30% of total global emissions of CO_2.

On the other hand, reserves of coal are more evenly distributed across the world than those of other fossil fuels. Coal can be procured from a number of countries practically from all continents through a vibrant and liquid global market. Reserves of hard coal are equivalent to close to 200 years of production at present rates; those of lignite should last for around 130 years of present production. This compares favorably to estimated reserves of oil and gas which are expected to last for about 40 and 60 years respectively (at current rate of production).

2. OBJECTIVES

A brief analysis demonstrated that the desired reduction of CO_2 emissions from coal-fired power generation cannot be achieved (on competitive basis) by simple application of either only efficiency improvements of the conversion cycle or only CO_2 capture and storage (CCS). Focus on efficiency alone can achieve significant reduction of specific CO_2 emissions in the initial period; it cannot, however, achieve a zero-emission target and in the longer term total CO_2 emissions from coal-based generation might even increase in case the proportion of coal-fired power generation in the overall energy mix increases for any reason significantly beyond current levels. Focus on CCS only can achieve the near zero emission target, but without efficiency improvements would compromise the competitiveness of coal-fired power generation. Even if this was of no consequence, the CCS-only route would require much larger quantities of coal for the same level of electricity production and could lead to a accelerated depletion of finite coal resources and consequently to further cost and security of supply constraints.

An integrated technological solution (called hereafter "Sustainable Coal" technologies) combining efficiency improvements of the conversion cycle (through application and advancement of existing Clean Coal technologies) with CCS modules is thus the only long-term technology option to deliver desired reductions of CO_2 while keeping coal competitive.

The goal of European-level policy should be to facilitate the conditions for development and widespread deployment of Sustainable Coal technologies in the shortest possible time.

This general goal can be translated in the following operational milestones:

(1) application of the best-available techniques on all newly built coal-fired power plants from early on.

(2) as of 2010, all newly built power plants to be built as "capture ready", i.e. capable of later CCS retrofitting.

(3) demonstration of zero-emissions technologies for coal-fired power generation on a commercial scale by 2020 (in line with the goals of The Zero-Emission Power Plant Technology Platform).

(4) after 2020, Sustainable Coal to become the technologies of choice for coal-based power generation, allowing the phasing out of non-zero emissions operations in the coal-fired power generation sector.

(5) EU to stay at the forefront of the development and deployment of Sustainable Coal Technologies as the global leader in technology transfer projects in this area.

3. STATE OF PLAY IN TECHNOLOGIES FOR SUSTAINABLE COAL AND REMAINING CHALLENGES

Sustainable Coal technologies will emerge from the combination of advanced Clean Coal methods of highly efficient coal combustion with CCS elements.

Pulverised Coal (PC) combustion represents at present the most frequently used conversion technology. Newly developed technologies, besides improved versions of PC (so called ultra super-critical combustion – USC), include the Integrated Gasification Combined Cycle (IGCC) and oxygen-rich combustion (OC) and offer ways for further increase of conversion efficiency while facilitating the implementation of CO_2 capture from the combustion process.

Research, development and demonstration of USC technologies are needed to take further the work on the materials development, component manufacturing, testing, and demonstration in real conditions. The IGCC and OC technologies must be strongly improved before such plants can be used for standard investment in power generation. Especially for IGCC, a more robust, efficient and reliable coal gasification technology is needed.

For CO_2 capture, technological solutions have been developed and are used by industry in other sectors. However, the size of existing processes is generally small in comparison with the quantities of CO_2 produced in a large-size power plant. Future

R&D as well as optimisation and redesign work is expected to strongly decrease the cost of CO_2 capture.

For long-term CO_2 storage, the technological solutions envision the use of geological formations such as deep saline aquifers, depleted oil or gas fields, oil and gas fields suitable for enhanced oil or gas recovery, and deep coal seams suitable for enhanced coal bed methane recovery. Further R&D in this area will address the integrity and safety of geological CO_2 storage and the liability issues. This work is expected to increase confidence in geological CO_2 storage.

The deployment of Sustainable Coal technologies will require storage of vast amounts of CO_2. In Europe alone retaining coal in the energy mix at current levels and with 30% penetration of Sustainable Coal by 2030 will lead to 300-400 mil. tonnes of CO_2 stored annually; 100% penetration of Sustainable Coal by 2050 will lead to annual injection of some 900 mil. tonnes of CO_2 under ground. Already proven geological storage capacities in Europe have sufficient capacity to store enough CO_2 – the North Sea aquifer formations alone are sufficient to store a volume of CO_2 corresponding to many centuries of coal use in Europe, in fact significantly more than the coal reserves are expected to last.

Commercial viability of Sustainable Coal technologies will need to be demonstrated through a number of industrial-scale demonstration projects which will run on the basis of technological solutions incorporating high-efficiency advanced Clean Coal conversion cycles with pre-combustion or post-combustion CO_2 capture and subsequent geological storage. To provide meaningful results, these projects will have to run for ca. five years in order to accumulate adequate track record. The size of each demonstration project may vary but the requirement of their industrial-like scale dictates that their installed capacities should be in the range of 250-500 MW_e. It is currently estimated that 10-12 such projects could be built in Europe in the coming years and be operational by 2015. This would allow assessing the commercial viability of the Sustainable Coal concept by 2020. The cost of each such installation using current PC technologies (at BAT level) with post-combustion CCS (assuming CO_2 storage in a distance no more than 350 km from the generation site) is estimated at around €1.7m/MW_e. In case of IGCC technologies with pre-combustion CCS, the cost could be just below €1.5m/MW_e. These costs are expected to gradually decrease as the technology matures.

4. REGULATORY/LEGAL AND POLITICAL/SOCIAL PRECONDITIONS OF SUSTAINABLE COAL

The present regulatory environment does not provide sufficient incentives to invest in radical CO_2 -reducing technologies. Current environmental legislation has been drawn up prior to the existence of the CCS technology and may be creating unintentional and unwarranted barriers. Planning regimes, regimes for disposal of gaseous waste and geological surveys may need clarification to remove the obstacles to CCS. These issues are currently the subject of a European Commission study as part of the European Climate Change Programme.

The absence of a CO_2 value chain and supporting infrastructure also currently represent barriers to Sustainable Coal. The ETS framework could provide the conditions for such a value chain to emerge, but it currently excludes CO_2 avoided through capture and storage from its permit trading system. A regulatory environment providing guarantees of long-term existence of CO_2 value chain would help the build-up of CO_2 infrastructure (pipelines etc.).

5. LIKELY IMPACTS OF TRANSITION TO SUSTAINABLE COAL

5.1. Costs of electricity produced

The Special report of the UN International Project on Climate Change (IPCC) indicates a wide range of cost estimates for CO_2 capture from power generation, ranging from US$15 to $75 (i.e. €12 to €60) per tonne of CO_2. The costs of transportation and injection of CO_2 equally vary from just over €1 per tonne of CO_2, for both transportation and injection together, to €13. According to some estimates, these figures, if reflected in the economics of power generation on the basis of current technologies, translate into an estimated additional cost of electricity from coal with CCS between 33 % and 57%, in comparison with electricity generated from coal without CCS. However, as the estimated cost increases have been established from models run for new power plants based on current technology, they do not include the technology improvements anticipated for the coming years. Gains in the energy efficiency of future plants and reductions in future CO_2 capture costs are highly probable and certain to strongly reduce CCS costs. There may also be side-benefits from CCS (such as use of CO_2 streams for Enhanced Oil Recovery) further reducing the net costs of CCS operations.

Available models and studies looking at the long end of power generation with CCS then allow us to expect that by 2020 or soon afterwards the costs of electricity produced could be just 10% above or even on the par with the current levels. It is envisaged that with further technological development in the coal conversion and CO_2 capture processes and with the scaling up of transport and storage operations the total cost for CO_2 capture and storage can be lowered to the level of €20 per tonne of CO_2 in the medium term.

Simulations run by the Commission in cooperation with the National Technical University of Athens on the basis of the PRIMES model show costs of electricity as low as €c 6/kWh for some realistically possible combinations of underlying variables. E.g. the cost of electricity produced in IGCC power plants with CCS under prices of CO_2 allowances at €40/tCO_2 and relative prices of coal and gas as observed today is calculated at €c 6.22/kWh in 2025 and €c 6.144/kWh in 2030 (in 2006 prices). These bear comparison with current costs of power generation form coal without CCS (at €c 3.5-6/kWh) as well as with current wholesale electricity prices.

5.2. Environmental impacts

The major positive environmental implication of CCS is a significant reduction (around 90%) of the CO_2 emissions of coal-fired power plants. In Europe alone retaining coal in the energy mix at current levels and a 30% penetration of CCS in 2030 reduce CO_2 emissions by 300 to 400 MtCO2 annually.

Certain existing impacts of coal use can be exacerbated if CCS were to imply an increased use of coal. These environmental impacts are known and controlled by existing environmental legislation.

The main new, negative impact of carbon capture and storage relates to the potential release of CO_2 from the storage site which can have both local and global impacts. However, the IPCC Special Report has estimated that the fraction of CO_2 retained in appropriately selected and managed geological reservoirs is very likely to exceed 99% over 100 years and is likely to exceed 99% over 1 000 years.

In addition, CCS can have net positive impacts on air pollution, in particular the emissions of sulphur dioxide (SO_2) and nitrogen oxides (NO_x). These pollutants are major contributors to acidification, eutrophication, ground level ozone as well as particulate matter. CCS used together with pulverized coal could imply an increase of NO_x emissions (but within the compliance limits of the Large Combustion Plants Directive) and a reduction of SO_2 by around 95%. Other technologies considered as part of the Sustainable Coal concept, such as IGCC with CCS, could reduce NO_x by around 80%; the impact on SO_2 emissions could be more or less neutral. In sum, these reductions could significantly improve air quality and bring about tangible net benefits in the form of improved public health and thus reduced healthcare costs as well as positive impacts for ecosystems. The air quality benefits of using pulverised coal with CCS would represent between 6% and 18% of the carbon capture costs in the EU as a whole. The benefits of IGCC with CCS could be between 26% and 70% of the costs.

6. POLICY OPTIONS FOR TRANSITION TO SUSTAINABLE COAL

Three policy options for support of demonstration and deployment of Sustainable Coal technologies have been analysed and quantified in the Impact Assessment:

Option 0: No policy change.

Sustainable Coal technologies do not benefit from increased R&D support. CCS remains without a proper legal framework, outside the Emission Trading System (ETS).

Option 1: Removal of the barriers to Sustainable Coal technologies.

Both technological barriers and regulatory barriers are removed. Increased R&D support and a proper regulatory regime for CCS are put in place. Once Sustainable Coal technologies are technically demonstrated and their costs reduced, their penetration in the power generation sector is left to the market (providing incentives by means of a price of CO_2 emissions established in a market for allowances).

Option 2: Incentives for demonstration and penetration of Sustainable Coal technologies.

In addition to the measures already foreseen under Option 1, Option 2 assumes additional incentives for achieving first commercial demonstration and second a wide penetration of Sustainable Coal technologies (once they are commercially viable). Such incentives may be triggered at an opportune time, particularly should the market signals or the commitments of the operators be considered not sufficient or if the agreed CO_2 reduction targets are at risk not to be met.

The analyses yielded the following results/conclusions:

Option 0 is not a suitable option if the twin benefits of secure energy supplies and environmentally sustainability are to be achieved with synergies regarding Lisbon goals.

Policy Option 1 could deliver the desired objectives. However, it leaves the penetration of Sustainable Coal Technologies to the existing market framework. The penetration of Sustainable Coal will be dependent on the comparative prices of competing fuel sources and the price of CO_2 emissions permits under the ETS. If power generators do not feel confident that EU ETS will consistently deliver sufficiently high prices for CO_2 emissions permits (€20-40/tCO_2), investments in Sustainable Coal technologies may not occur on truly large scale.

Policy Option 2 reduces the risk inherent in Option 1 by providing mechanisms that promote investment in Sustainable Coal Technologies even in situations where the EU ETS CO_2 prices do not compensate for the cost of CCS.

Coal industry and electricity industry representatives indicated during consultations that penetration rates should be determined by the markets for electricity, fuels and CO_2. Environmental NGOs indicated during consultations that regulatory measures would be desirable. It should therefore be concluded that their use be dependent on sensitive justification of their necessity.

7. IMPACT ASSESSMENT CONCLUSIONS

Delivery of sustainable, secure and competitive technologies for electricity generation from coal is dependent on both energy efficiency gains in the coal-fired power generation sector, and the timely deployment of CO_2 capture and storage. Policy changes should address both of these technology challenges.

Removal of the existing barriers to deployment of Sustainable Coal Technologies is a limited, and politically expedient, policy change that has the potential to deliver the policy objectives. However, it is dependent on a stable and high (compared to current levels) price of CO_2 emissions permits in the EU ETS to enable CCS deployment rates that meet the objectives.

Should regulatory improvements and market-based incentives prove insufficient for stimulating necessary commitment to either demonstration or subsequent wide up-take of Sustainable Coal technologies, more pro-active measures would be necessary to ensure EU objectives are met. Individual measures identified for such pro-active option would have to be subjected to further impact assessment to gauge the most effective selection, and combination, of such measures.