CLEAN COAL – THE STRATEGY OF COMPREHENSIVE RESPONSIBILITY

M. Champsas-Kontogeorgakis
Diplom. Mining Engineer-Metallurgist - NTUA
9 Stavraetou str., 15772 – ATHENS
Phone: +30 210 5192367, Fax: +30 210 5150930, E-mail: mhamp@tee.gr

ABSTRACT

Recent estimations and predictions by international institutions for global energy demand trends are reviewed and evaluated. The eventual impacts of the energy mix on price and supply stability in the international power generation sector are commented with a focus on European Union’s (EU) future technical and socio-economic developments. The role that coal, lignite included, has to play, in the field of the essential conditions for achieving the objective of Lisbon Strategy for three percent a year until 2020 increase of economic performance in the EU, is demonstrated. Key aspects are considered like the contribution of various energy sources to the energy balance of both emerging macro-economies such as those of China and India but also for those of high-technology countries like the USA and Germany, the availability of resources as well as price and supply stability for the consumer. As a result of national emission controls, public health concerns and global climate constraints there is now real pressure for a justified comprehensive approach that has to be adopted for environmentally-friendly energy utilization. The impacts of Clean Coal Technology development and use on the actual contribution that can be made towards climate protection and the conservation of resources are tracked and debated. The visions for the future, such as the development of the low-CO₂ power stations or even further the zero-CO₂ emission technology, are finger-tipped accompanied by some thoughts for a timetable and the main milestones of R+D efforts for a pragmatic multistage Clean Coal concept.

A RELIABLE, COST-EFFECTIVE & ECO-FRIENDLY AVENUE FOR R&D IN THE ENERGY SECTOR

Many countries around the world depend on coal as a means to achieve their growth objectives and raise living standards. Coal not only makes a key contribution to the energy balance of emerging macro-economies such as those of China and India but is also fundamental to high-technology countries like Germany and the USA [1]. In this respect coal usage is based on quite different energy-policy considerations. While in one country local availability of resources may be the crucial factor, in another the key consideration may be to ensure the best possible price and supply stability for the consumer. In Europe coal is one of the central pillars that support the balanced energy mix. This mix has to develop in accordance with the economic criteria prevailing in the marketplace. Furthermore, the energy-policy framework
has to be kept open to all types of fuel and energy systems. Coal has lost none of its importance in the key economic areas: it is an essential feedstock fuel for iron and steel making, while in the electricity sector it remains a fuel of choice by reason of its security of supply and competitiveness. If coal is to continue to make a vital contribution to energy supply in the years ahead the industry must learn not to count on its economic advantages alone, for environmental considerations are becoming increasingly relevant.

The concept of Clean Coal embraces all currently available technologies and strategies designed to minimize the negative impact of coal utilization on our climate and environment. Clean Coal is a dynamic process that continuously assimilates and develops new technologies, but it also allows coal industries to follow different objectives for environmentally-friendly coal utilization, according to their situational framework. Clean Coal is not restricted to technological development alone, but also constitutes a socio-political response to the changing demands that are imposed on the way we use fossil-based energies. Clean Coal can make a key contribution to the sustainable and long-term acceptance of coal as a mainstream fuel. The building-block structure of the Clean Coal Concept means that it can be phased-in gradually as the technology becomes available.

Clean Coal is being introduced on a world-wide scale, but in a manner that takes account of the needs and opportunities presented by the local environment. The flexibility of the Clean Coal Concept therefore also contributes towards social equity in the sense of sustainable development.

The European coal industry supports the active promotion of the Clean Coal Concept and calls for it to be part of the energy and environmental strategy that underpins Europe's policy for a reliable, cost-effective and eco-friendly energy supply.

The global role of coal

If world energy consumption increases by 70% over the next thirty years, as has been predicted by the International Energy Agency (IEA), there is likely to be some serious conflict over the distribution of energy resources. The dynamic economic growth under way in the Asian and Pacific region is absorbing raw materials and logistics on such a scale that dramatic price rises and shortages are even now beginning to affect certain products worldwide. It is a fundamental social and political requirement that each country should be able to fulfil its energy and raw-material needs as effectively and as economically as possible. Such a demand cannot be met without using all available natural resources. This means that coal - which is abundantly available and geo-politically well distributed - has a key role to play. As a result of national emission controls, public health concerns and global climate constraints there is now real pressure on all coal users to introduce Clean Coal Technologies, but probably in a manner that is tailored to meet their particular conditions and requirements.

The Lisbon Strategy, which the European Union adopted in the year 2000, has set ambitious growth objectives. Economic performance in the FU is to be increased by three percent a year until 2020, making Europe the world's most competitive region. One of the essential conditions for achieving this objective is an optimal supply of energy. The demand for electricity is set to grow significantly and greater promotion of energy efficiency in power utilization can only help slow down this trend.

Part of the growth in demand is to be met by making greater use of renewable energies. According to the European Union, renewable sources' contribution to EU power generation is to be increased to 21% by 2010 - an extremely ambitious target that is not without risk. The extensive depletion of our natural hydro-electric power capacity has compelled us to push ahead with new and as yet uncompetitive energy engineering systems that are expensive and offer limited security of supply. Irrespective of the actual contribution that renewable energies are able to make to Europe's power supply industry, most electrical energy will still have to be generated from fossil and nuclear fuels. As western Europe is relatively deficient in natural resources the current high level of dependence on imported energy is bound to increase. In such a situation it is imperative that we make use of all our existing fuels and focus on the efficient utilization of indigenous resources. These strategic goals have imposed a number of requirements on European energy policy. For one thing, the existing energy mix must not be constricted, for all fuels are needed and must be used in line with the various regional distinctions. Market forces, and not political directives, create the best balance between the different energy sources. There needs to be greater security of supply in the oil and gas industries. Investment in the energy sector must remain predictable over the long term. A standard approach has to be adopted for environmentally-friendly energy utilization. Any interference in the structure of the energy supply sector with a view to providing climate protection has to be justified on strictly scientific lines and must be assessed in a global context.

Europe can take a leading role in the development of Clean Coal technology. The life-cycle of fossil fuel-fired power stations requires between 2% and 3% of the installed generation capacity to be replaced on an annual basis. This has to be part of a continuous operation, so that the best commercial technology is always made available. Delays to the construction work must never be allowed to interrupt the process, as this is not only bad for competition but also has a negative impact on the actual contribution that can be made towards climate protection and the conservation of resources.

Technological development and future potential

Europe leads the field when it comes to emission reduction technology. Processes developed back in the 1980s are capable of achieving substantial reductions in the emission of dust, SO\textsubscript{2} and NO\textsubscript{x}. The first European regulation dated from 1988[2] and was replaced by a more stringent version in 2001[3].

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Λεγόμενη και φυσικό αέριο στην ηλεκτροπαραγωγή της χώρας, ΤΕΕ, Αθήνα, 9-10 Ιουνίου, 2005
In adopting their own clean-air strategies EU Member States are able to choose between fixing emission thresholds for individual installations and setting emission budgets for specific sectors. The quantity of SO\textsubscript{2} emitted by coal-fired power stations depends on the type and quality of the coal being used. It has now been established that SO\textsubscript{2} emissions are harmful to plants and soil. The technology currently available allows more than 90\% of the SO\textsubscript{2} to be removed from the flue gases of coal-fired power stations. Almost all of the by-products resulting from flue-gas desulphurisation can be used in the building and road-construction industries mainly. Europe has taken a leading role in this area.

Electro-static precipitators (filters) can now separate practically all the fly-ash from the flue gases of coal-fired power stations. This technology is now in standard use. Large-scale fly-ash recycling is now well established in the cement and concrete industry, as well as in other commercial applications. The “high-dust process”, whereby the flue gases are catalytically cleaned as soon as they emerge from the boiler plant, has established itself as an economically efficient method of nitrogen removal for new coal-fired power plants. Certain combustion strategies can also be used to reduce the emission of nitrogen oxides from coal-fired power stations. Although flue-gas cleaning technology has been available for many years for removing SO\textsubscript{2}, NO\textsubscript{x} and dust, there is great disparity in the application of such systems within the various EU member states. With the recent phase of EU enlargement complete it would seem that now is the most propitious moment to implement the first stage of the Clean Coal Process in full. Countries outside the EU zone generally observe the guidelines laid down by the World Bank, although many are already failing to comply fully with these standards.

The climate change issue and THE EU’s emissions trading system

The environmental debate of the mid-1990s opened up a new phase in the Clean Coal Strategy. Environmental opinion became convinced that additional man-made emissions of the trace gas CO\textsubscript{2} were primarily responsible for the observed phenomenon of global warming. 2003 was another year to add to the row of increasingly warmer years. The indications we see are not proofs, but they will continue to fuel the debate and the climate change policy. The International Panel on Climate Change (IPCC) will soon in a new report reinforce the assessment of Green-House Gases (GHG) as the driver of Climate Change. And climate change policy is not only an indication for the energy market – it is now hard facts after the decisions taken by the EU to implement a GHG emissions trading system. The climate change issue will remain a reality, especially in Europe.


Environment Commissioner Margot Wallström then declared: “It means that the largest emissions trading scheme in the world to date will be a reality from 2005…” “Companies across 25 countries must now start incorporating climate change into day-to-day commercial decisions, and begin assessing what innovative steps they can take to reduce emissions.” We are convinced that a society that is less carbon dioxide intensive is also an electricity-intensive society. Electricity is smart. In the future, energy systems will become increasingly electrified. The long-term demand for electricity will be stipulated.

Since the EU trading system covers about 46\% of the total emissions in Europe, it doesn’t seem that commissioner Margot Wallström exaggerated when she concluded that companies in EU have to incorporate climate change into their daily life. This is especially relevant for the electricity and heat industry in Europe, which constitute as much as 2/3 of the trading system.

We must recognize that the Emissions Trading System has basic advantages in terms of cost-efficiency. With a trading system, the most cost-effective measures can be commercially prioritized. And – also important – costs for measures can be distributed in a reasonable and fair manner among the countries taking part in the trading system.

However, we should also be aware of the imports on international competitiveness. Today, of 80\% of the energy consumption in Europe (“EU-30”) derives from fossil fuels. The introduction of carbon dioxide restrictions does not come without cost and could weaken the competitive strength in many industries compared to companies and production facilities in the USA, Asia and elsewhere. To avoid this, further climate measures, including the following periods of the Trading System, should be introduced on a much wider, ideally global level and in a longer perspective. Otherwise the measures taken will prove inefficient by just moving emissions to other countries.

The consequences – the alternative options

National and international efforts to limit or reduce CO\textsubscript{2} output focussed mainly on energy-related emissions. However, with fossil fuels in general, and coal in particular, being of fundamental importance for the world’s energy supply, any drastic curtailment in the use of fossil-based fuels would seem to be ruled out.

We know that there is a whole spectrum of different measures at different costs in different sectors of the society. Regardless of the details in climate policies, the results will be increased costs for using fossil fuels. The price of electricity, is expected to increase significantly in the greater part of Europe. This is a consequence of the emissions trading system. As allowances become scarce there will be a market value for them. Hence the allowances must be regarded as a production cost irrespective of whether they are purchased or received for free. This will increase the spot price of electricity. How much will depend on the price of allowances. The price of allowances can be roughly estimated on the basis of
anticipated reduction requirements and the costs to physically accomplish that reduction. We have estimated that allowances by 2012 may cost up to 20€/ton CO₂ if the old EU member-states (EU-15) have to meet their remaining Kyoto reduction and the new 10 EU member-states receive no credits for their reductions since 1990. For the estimated 20€/ton the electricity wholesale price increases are significant, in the order of 12-15 €/MWh in the worst hit markets.

If the trading system on the other hand does recognize at least some of the achieved reductions of the new EU members, through their national Allocation Plans, the estimated allowance cost is reduced to 8-11€/MWh[4]. The impact will be considerably larger in the case of higher trading prices (at the level of 20€/ton) and will result in significantly higher electricity prices. What will then be the reactions if the trading system permanently make key industries (steel, pulp & paper) suffer badly both from direct cost for allowances for their own process emissions and from significantly higher electricity prices?

The Clean Coal strategy

For Clean Coal the preferred option is to increase the efficiency of existing and newly-constructed installations. Coal-fired power stations have already benefited from a one-third improvement in efficiency over the last thirty years. Modern installations are now capable of running at 40% to 45% efficiency and plant availability has also been increased. The ongoing and large-scale replacement of Europe’s power station capacity has already opened up the perspective of dramatic gains in efficiency and significant savings in CO₂ emissions.

The modernization of existing installations, combined with the replacement of outdated plants, essentially means that any single percentage-point (1%) improvement in efficiency results in a 2% reduction in CO₂ emissions.

The Clean Coal Strategy opens up two routes to greater efficiency. Firstly, outdated plant can be brought up to standard as part of a continuous process of modernization. This is the approach that German power-station operators have taken for the past ten years as part of a comprehensive program for the modernization of lignite-fired installations. The second route can, for example, involve the construction of new generating plants. These new installations have set international standards for efficiency and CO₂ emissions and have done much to make Germany a frontrunner when it comes to the reduction of power-industry CO₂ emissions in Europe.

Yet there is still plenty of scope for further development in the area of efficiency improvement too. New materials are being tested that will permit higher boiler temperatures and steam pressures. The concept of the “700 degree (°C) power station” promises to bring another dramatic improvement in power-station efficiency within the next decade.

In the European coal industry’s view, it is extremely important for the European Commission to keep efficient coal utilization at the center of its next Research Framework Program and to send a clear signal when it comes to reducing CO₂ output in the short term.

When examining the production costs of a coal-fired or nuclear power plant, on the one hand, and those of a gas-fired power plant, on the other, we see, that coal-fired and nuclear installations are expensive to construct but their operating costs and primary-energy and generation costs are low.

In the case of gas-fired plants the picture is exactly the reverse: the investment and operating costs are fairly low, but the fuel prices have a substantial impact on the installation’s competitiveness. A logical consequence of this technology-based difference would therefore be a rational division of generation: coal and nuclear power for the base load, coal for the mid-range loads and gas mainly for peak or for combined heat and power generation. Coal and nuclear energy often act as price indicators for competitive energies in the power sector. In this way they constitute an important counterbalance, especially as far as the gas producers are concerned.

Such a strategy has served Europe well to date, and indeed the USA, Japan and China all apply a similar model for their power generation industry.

Visions for the future

Clean Coal has a clear vision for the future, namely the zero-CO₂ power station. As well as continuously improving plant efficiency and environmental compatibility as part of the cyclical plant modernization program, Clean Coal also embraces future technologies. Preventive climate protection demands the timely development of processes for the technically and economically rational separation of environmentally-relevant trace gases from power-station emissions with a view to preventing the release of CO₂ into the atmosphere. It is here that the preventive impact of the Clean Coal Concept is most effective. The introduction of these advanced technologies can only be triggered by radical changes in climate policy based on secure scientific findings.

From today’s perspective the development of CO₂ separation technologies appears to be simpler to achieve than the reliable and long-term storage of the CO₂ after separation. The Carbon Sequestration Leadership Forum (CSLF) brought together 15 countries and the European Union with the aim of identifying technical, cost-effective and eco-friendly solutions for CO₂ capture and sequestration[5]. This major multi-national effort illustrates that there is a substantial need for research, especially in the area of CO₂ storage. There is, for example, very little known about the long-term behavior of large quantities of CO₂ in enclosed storage chambers. At the present time the debate is focussing mainly on sequestration in depleted oil and gas measures or in deep salt aquifers. Such an undertaking will require substantial logistical investment. One of the most promising techniques for CO₂ separation is coal gasification and intensive R&D effort has already produced tried and tested commercial-scale plants of this type.

The European coal industry has pointed out, however, that the capture and storage of CO₂ holds significant risks for
the economic efficiency of the electricity generation process.

The installation of the equipment needed to separate carbon dioxide in a zero-CO₂ power station produces a detectable loss in plant efficiency and this in turn increases the cost of the end product. Reliable estimates for the cost of CO₂ storage are not yet available.

**The strategy of comprehensive responsibility**

The multi-stage Clean Coal Concept is part of a long-term strategy designed to provide economic and ecological safeguards for coal utilization. Clean Coal's ongoing contribution is helping to balance out national differences between eco-friendly coal utilization processes. At the same time Clean Coal includes pragmatic future developments based on continuous efficiency improvements. The global potential for CO₂ reduction that can be harnessed through efficiency gains at coal-fired power stations is sufficient to achieve a large part of the CO₂ savings that have been agreed, or are considered necessary, at international level.

What is special about the Clean Coal Concept is that its potential can be fully exploited without jeopardizing the reliable and efficient supply of electricity. The zero-CO₂ power station is Clean Coal's visionary concept for the future. According to current expertise there is no insurmountable technical obstacle to such a development, though the concept is fraught with considerable economic and ecological risk[6]. Minimizing this risk is one of the major tasks facing both industry and governments in the years ahead.

The European coal industry is determined to do everything it can to ensure that the 7th Research framework Program contains concrete proposals for the timetable and measures needed to develop CO₂ capture and sequestration technology. The coal industry believes that by 2010 feasibility and pilot studies will have identified the most suitable and most economically promising of these new technologies. The legal bases and framework conditions will then have to be laid down in the course of the following decade. The first of the new installations, along with a reliable storage concept, could be in operation by 2020, if by this time it has become absolutely clear that drastic measures are needed to further reduce CO₂ emission levels [7].

**CONCLUSIONS**

The scope of this presentation is to highlight the importance of coal's contribution to security of energy supply within the enlarged EU, to price stability, to added value and to environmental protection. Coal sector must enhance its active communication, doing all that is necessary in order to create an appropriate framework within which the European coal industry and coal consumers can operate. Almost 25% of the power generated in the former EU-15 and nearly 50% in the New Member States are coal-based. Steel producers and other energy-intensive industries all need large quantities of energy. Coal has therefore established itself as a permanent and reliable source of energy in its own right and will remain a vital source of EU energy supply for the years to come. The importance of coal for the European power supply defines itself as a substantial source with an active long-term role in the future energy policy of the whole EU. This includes the entire process chain beginning with coal extraction, marketing and transportation rights through to its utilization at power plants, in the steel industry and in other industrial and private sectors. Coal research plays an important role here. Coal industry as well as all public or private groups or individuals, related to coal sector, (energy consumers, research/technological development institutions, regional and/or central authorities, etc), must be actively involved in balancing the political requirements for a secure and cost-effective supply of fuel on the one hand with the objectives of environmental policies on the other. The EU has to create and to maintain adequate framework conditions for coal utilization, as this fuel is vital if we are to achieve a balanced European energy mix.

**Acknowledgement**

Substantial contribution for making this presentation was gained by the fruitfull participation of the author for the last four years, as representative member of Public Power Corporation S.A./GREECE, to the Environment Committee of EURACOAL. The European Association for Coal and Lignite (EURACOAL) is the umbrella organization of the European coal and lignite industry. The associations and companies representing the coal industries of Belgium, France, Germany, Great Britain, Greece and Spain, the relevant organizations of the New Member States Poland, the Czech Republic and Hungary, Slovakia and Slovenia as well as Romania, Bulgaria, and Serbia work together in EURACOAL, where they have equal rights. Importers, dealers and consumers have a seat and vote in EURACOAL. The new Association, which evolved from CECSO (the European Solid Fuels’ Association) after the expiry of the Treaty establishing the European Coal and Steel Community (ECSC Treaty) now, has a much broader remit.

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