



BULLETIN

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Clean Coal Technologies: Green Shoots for Poland's Energy Sector

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Although there should not be serious problems for the European Union to meet greenhouse gas emission limits by 2020, further CO₂ reductions could be a real challenge to numerous Member States. This concerns especially countries highly dependent on coal, such as Poland, where nearly 90% of its electricity is generated by coal combustion. Hence, clean coal technologies (CCT) most likely will be used to a much greater extent in these states than others to impede climate change and enhance economic competitiveness. Poland thus has the proper incentive and capacity to become a leader in CCT development, which could support the building of an innovative economy and boost Polish exports.

Coal remains one of the main resources used in the energy sector worldwide. More than 7 billion tonnes of coal was consumed in the world in 2011. In 2000–2010, demand growth amounted to 1.7 billion tonnes, mostly due to increasing consumption in Asia. Currently, coal combustion contributes to more than 40% of electricity production worldwide, although in Asia this level rises to as much as 60%. Coal will remain in the near future the main source of electricity generation around the world, although according to the International Energy Agency (IEA) coal's share in the world energy mix will shrink by about one-quarter to 33% by 2035. Coal demand is projected to fall significantly in developed countries due to ambitious environmental policies but consumption will rise concurrently by about one-third in developing countries, mainly in Asia. One of coal's main assets is its availability—it is or has been extracted in about 50 countries. Moreover, coal production technology is widely understood so the existing infrastructure and relatively low costs compared to other sources of energy are perceived as trump cards in the debate. However, the Intergovernmental Panel on Climate Change (IPCC) indicates that coal combustion should be recognised as a main factor in climate change. To mitigate the impact of coal on the environment, the development of clean coal technologies (CCT) is vital.

Clean Coal Technologies Worldwide. CCT embraces all solutions that aim to improve the efficiency of the extraction, conversion and consumption of coal to reduce adverse impacts on the environment. IEA has estimated that global CO₂ emissions could amount to 16 billion tonnes by 2050, which would be 42 billion tonnes lower in comparison to the baseline scenario of 58 billion tonnes (in 2010, worldwide CO₂ emissions amounted to 34 billion tonnes) and CCT could contribute significantly to achieving this reduction in emissions. CCT could also be beneficial from an economic point of view as it would lead to improvements in the efficiency of energy production and curb costs. It could also make a considerable contribution to the implementation of the idea of sustainable development through the more efficient utilisation of resources.

Currently, several countries have started manifold CCT projects. It is worth mentioning that even some developing countries such as China have made significant progress in the CCT development race. Several years ago, carbon capture and storage (CCS) technology was perceived as the most prospective CCT notion. Yet, its high costs and the controversies over CO₂ storage have made it difficult to implement CCS on a greater scale. Currently, there are only a few pilot CCS installations in Europe, e.g., in Norway. CCT based on technology called integrated gasification in the combined cycle (IGCC) has also been developed in several countries, including the U.S. IGCC technology gains much interest given predictions of deliverable efficiency at even 60%. However, again, the high costs of these types of

installations, along with their high level of unreliability, are serious barriers to wider implementation. Other trending technologies, such as high-parameter dust boilers or oxygen combustion, offer good prospects for the future.

Poland's CCT Potential. Poland is highly interested in the development of CCT given its energy sector's heavy reliance on coal and its obligations under EU climate policy plans. CCT has been determined as a priority in official documents related to Polish energy policy. However, Poland is still not perceived as an important player in this area. This could be the result of numerous factors, such as a lack of financial incentives for research and commercial implementation or the relatively low level of R&D expenditures (0.9% of GDP in 2012). Nevertheless, several public institutions, such as the Main Mining Institute (GIG) and technical universities (such as AGH in Kraków), have been conducting research on CCT. A report commissioned by the Polish Ministry of Economy even foresees that in an about a decade Polish firms could specialise in innovative CCT now at the research stage.

Among CCT ready at a commercial scale are various solutions related to biomass, i.e. to direct co-firing with coal, which is used by several Polish power plants. It is estimated that while electricity production in 2011 using this technology amounted to 4,000 GWh, it will grow to nearly four times that, or about 15,000 GWh, by 2030. However, it will be necessary to improve biomass quality and increase its share in the plant's combustible fuel to reduce CO₂ emissions. Moreover, biomass gasification with coal technology is also under development.. This technology could be used not only in the energy production sector but also by several industries, such as furniture makers or beverage and food producers.

Technology that allows for the operation of a dust boiler in ultra-supercritical (USC) mode has been indicated as one of the most prospective CCT methods to improve power plant efficiency to as much as 48% in the near term. It is plausible that power plants using high steam temperature (exceeding 700°C) will be capable of reducing CO₂ emissions by about 30% in comparison to today's global averages. However, a serious challenge seems to be the lack of available materials that can withstand these very high temperatures. Furthermore, relatively high quality coal will be required. One solution to this, fluidised bed combustion (FBC) technology, could raise the anticipated efficiency to 46% using low-quality coal.

Another CCT option worth mentioning is oxy-combustion. It increases CO₂ concentration in exhaust fumes and thus facilitates greenhouse gas separation, which improves the installation's efficiency. Moreover, it could arguably be used with existing power plants, which could reduce implementation costs. The challenge, though, is how to store and eliminate the CO₂. Some pilot installations of this kind have already been built in Germany, the U.S., and Canada.

Coal gasification is another area of interest. It is even estimated that by 2020, 1 million tonnes of coal will be processed in Poland annually using oxygen gasification technology, with about 4 million tonnes processed by 2030.

Some experts cite coal chemical looping gasification (CLG) and combustion (CLC), which uses chemical compounds such as metal oxides to limit CO₂ emissions, as important components of future energy production processes. Research in this field is conducted at the Clean Coal Technologies Center in Katowice.

In the near future, Polish CCT solutions could improve the efficiency of the country's energy sector but also could become an important and innovative element of Polish exports. Countries with a significant share of coal in their energy mixes, predominantly those in Asia, could become attractive export markets. China, which according to the U.S. Energy Information Administration, will remain dependant on coal, which by 2040 could compose more than 60% of the country's electricity generation. Polish CCT producers should also focus their export plans on such developing countries as India, South Africa, Turkey, and Kazakhstan, or the ASEAN member states, where growing energy demand will likely be satisfied by increased coal consumption. However, firms from Japan or the United States may become serious competitors on the global market.

Conclusions and Recommendations. In 10 to 15 years' time, CCT could play a considerable role not only in the Polish energy sector but also worldwide. CCT is especially important given the role of coal in the global energy mix along with plans for significant CO₂ emission reductions in the coming decades, especially in the EU. It is important for Poland to prepare for global competition in this area as the potential benefits could be sizeable. To develop the technologies mentioned above, reduce their cost, and enable production on a commercial scale, some actions must be undertaken in the near future.

Despite CCT's high priority in the country's energy policy, the Polish government should more actively support its development. Overall R&D expenditures should be increased as public spending plays a key role in CCT development, given the high costs of research and uncertainty in the results, which discourages the private sector. Therefore, a portion of EU cohesion policy funds, which will amount to €82.5 billion in 2014–2020, should be used to spur R&D activities in this area. Nevertheless, efforts should also focus on creating financial incentives for research institutions and companies to develop new technologies. It is also important to improve the cooperation between research institutions and the business sector in order to make CCT available to the market. Proper legislation as well as a national programme on the development of a particular technology could prompt deeper research. In the medium term, an intensive campaign promoting Polish green technologies, including CCT in foreign markets could be beneficial.

The pace of CCT development will be affected by EU climate policy, which anticipates a shift from coal to renewables. Poland should persuade its European partners that CCT could be a significant element of EU climate policy and mitigate the risk that economies based on coal-fired electricity generation lose competitiveness.