IEA COAL RESEARCH
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Profiles

Prospects for coal with other fuels to reduce GHG emissions

'Cofiring, reburning and repowering with natural gas reduce GHG emissions considerably'

'Co-utilisation of biomass with coal is a least cost option where the fuel prices are comparable'

'Hybrid and parallel cofiring systems with other fuels have the greatest potential'

Energy reserves, price and security of supply issues are discussed within the context of the prospects for coal and policies to reduce greenhouse gas (GHG) emissions. Coal is the most abundant of all fossil fuels by a considerable margin, and its reserves are more widely distributed than reserves of other fuels. Coal has been regarded as a strategic source of energy, protecting many countries from over-dependence on energy imports. According to projections, coal is expected to continue to be a major source of energy for the foreseeable future with most of the demand growth in developing countries. Coal has a competitive advantage due to its lower cost and stable pricing compared with other fuels. The flexibility mechanisms: the Clean Development Mechanism, Joint Implementation and emissions trading, outlined in the Kyoto protocol, should provide opportunities for clean coal technology transfer and diffusion. One option is partial substitution of more carbon intensive with less carbon intensive fuels and this report examines synergisms for coal with other fuels.

Currently available coal-fired power generating technologies, deploying other fuels (mainly natural gas and biomass, sometimes with refuse derived fuels (RDF) or petroleum coke, are examined, including a brief discussion of any technical problems and their solution. Examples of reductions in the use of coal by successful substitution of other fuels are highlighted in the table. The report includes the greenhouse gas reductions achieved as well as the costs where available.

The efficiency losses and gains are about equal when natural gas is partially substituted for coal so the CO_2 reduction is approximately in direct proportion to the emission factors. The higher price of natural gas is offset to some extent by reduced coal milling and handling costs.

There is a direct reduction in CO_2 emissions when biomass is substituted for coal as long as it is carbon neutral. That is the carbon released during fuel conversion is equal to that taken up during the growing period of an energy crop or forest. Substitution of waste wood for coal avoids the formation of CH_4 in landfills. Burning biomass in a large coal-fired power station is far more efficient than in a modern waste incinerator at net electrical efficiencies of only 21% or in small, inefficient boilers.

Hybrid gasification and parallel cofiring of coal with biomass and natural gas appear to have the greatest potential to reduce GHG emissions from coal-fired power stations. Much may also be achieved by cofiring, reburning and repowering with gas turbines. The best method differs between different power systems. Biomass generally costs more than coal and its high volume renders it problematic to transport over great distances, both for economic as well as for environmental reasons. Co-utilisation of biomass with coal is a least cost option to reduce GHG emissions where the fuel prices are comparable, usually due to subsidies or taxes.

Pulverised coal combustion

Cofiring and dual firing with natural gas may be a useful measure to reduce CO_2 but also SO_2 and NOx emissions with flexibility, depending on emissions requirements and seasonal fuel prices. Reburning with 20 th% natural gas may reduce CO_2 emissions by up to 10% in addition to 50-60% NOx reduction. This technology may be of interest for the power stations which require NOx reduction, a capacity in excess of 480GWe. The capital costs may be justified for NOx control in which case the CO_2 reduction would be an ancillary benefit.

Repowering with gas turbines brings the advantages of the lower carbon fuel as well as a considerable increase in output and net plant efficiency in reducing CO_2 emissions. The cost of CO_2 reduction for various repowering options in Europe and the USA indicate a significant potential role for partial repowering with natural gas when the price of natural gas is more than double the price of coal.

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Summary of rate of successful substitution of coal by other fuels (th%)				
Technology	PC	Cyclone	CFBC	IGCC
Natural gas				
cofiring	up to 100		10	
reburn	10–20		22–23	
repowering	up to 100			
Biomass				
added to coal pile	up to 10	1–15	50	10
separate injection	up to 20			
reburn	20	15		
gasification, cofiring product gas	3-5			

Direct cofiring of biomass with coal results in little combustion efficiency loss when burning about 10 wt% biomass and this is currently the upper limit for the acceptability of fly ash for utilisation in the Netherlands. However, research is in progress to allow evaluation of the ash quality based on technical parameters, rather than on the fuel. Laboratory tests of wood reburning indicated that N_2O emissions were typically less than those for either natural gas or coal reburning.

Cyclone boilers

Cofiring wood waste with coal reduced CO_2 emissions typically by about 3 t for each tonne of biomass burned, including CH_4 avoidance from otherwise landfilling the waste. Some efficiency losses due to high moisture content of biomass may be offset by the higher heating value of additional fuels such as tyre-derived fuel or petroleum coke. Tests on a cyclone boiler in the USA showed increases in boiler efficiency arising from adding wood waste and petroleum coke with the coal. The mixed fuel combined the advantages of increased volatile matter in the wood and greater heat content in the petroleum coke, resulting in considerable CO_2 emissions reduction.

CFBC

Higher proportions of biomass up to 50 th% are feasible in CFBC, giving 50% CO_2 reduction. However, elevated N_2O emissions with a high CO_2-e in FBC technology would detract from the overall reduction in GHG emissions. Also, CFBC has net plant efficiencies which are no better than those of subcritical PC combustion. Both straw and wood waste from paper mills are being used successfully at CFBC in Europe. Straw does not present any problems during combustion at lower proportions (<30 th%) but the high content of potassium in straw causes increased corrosion and fouling at higher straw to coal ratios. Various methods to reduce this problem are being tested.

Gasification and hybrid systems

Moderate CO_2 reductions appear to be achievable using biomass in gasifiers. However, the technical feasibility of co-gasification with straw in a purely coal-fired IGCC is still uncertain. Commercial applications so far appear confined to indirect co-utilisation by which a CFB biomass gasifier produces gas which is cofired either directly or as a reburn fuel in a PC power station. These applications and parallel co-utilisation of biomass and coal are helping to reduce CO_2 emissions in Europe.

Each issue of *Profiles* is based on a detailed study undertaken by IEA Coal Research, the full report of which is available separately. This particular issue of *Profiles* is based on the report:

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