Profiles

IEA COAL RESEARCH
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Potential for economic greenhouse reduction in coal-fired power generation

'Coal with other fuels has the greatest potential'

'CHP is one of the most cost-effective measures'

'Hot windbox repowering achieves moderate reductions at low cost'

Data on the Clean Coal Compendium indicate that there is probably around 100 GWe capacity of coal-fired plant still in operation after 40 years and approaching 500 GWe of plant over 20 years old. These are mainly in North America and Europe, including the Russian Federation. New coal-fired capacity will be built more in non-OECD countries such as China and India where the average conversion efficiency is currently lower than in OECD countries. Greenhouse gas emissions may be reduced much more by increasing the net plant efficiency from 25% to 35% than from 35% to 45%. Increasing the power generating efficiency in OECD countries does not currently offer as much as fuel substitution unless cogeneration or combined heat and power (CHP) can be fully exploited. In any case the best method for reducing CO_2 emissions differs between different power systems.

Analysis of potential greenhouse gas reduction in coal-fired power stations requires detailed knowledge of coal composition and energy flows to obtain accurate efficiency data for plant under representative operating conditions. This results in CO_2 equivalent emission factors per energy output but surrogate data from heat rates, boiler efficiency and fuel use also indicate greenhouse gas emissions reduction. Studies yielding such data are reviewed for the options of upgrading coal or using it with other energy sources, plant upgrading and optimisation, repowering and CHP. Only information on commercial, demonstration and planned power station units are included in this report. In future it may be necessary to capture and store CO_2. There might then be a premium on construction of units which would be more amenable to CO_2 capture at low cost. This approach is not considered here.

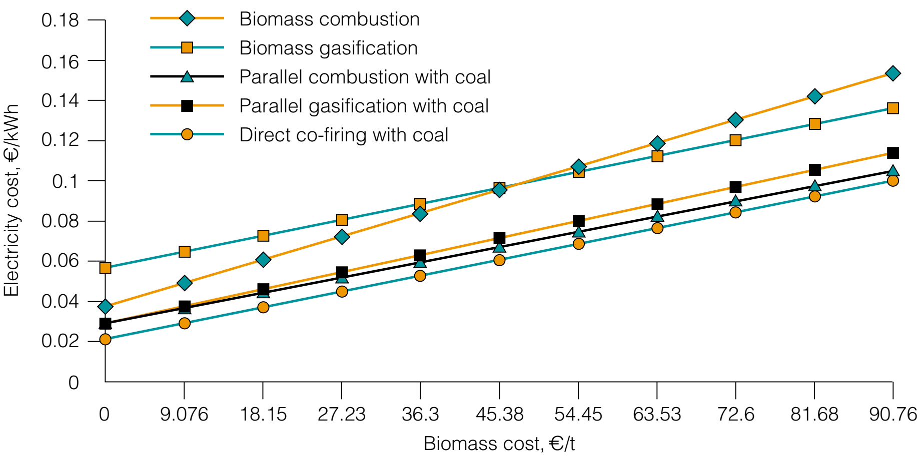
A substantial proportion of the plant over 20 years old would benefit by deploying more co-utilisation of coal with natural gas and biomass, plant upgrading and optimisation along with CHP in most regions. Much could be gained by improving the coal quality and power generating efficiency in those countries where these are a great deal less than the OECD average and where more coal will be used in future. Coal cleaning has considerable potential for CO_2 reduction in China, India and the transition economies. In OECD countries supercritical PC, IGCC and gas turbine repowering have good prospects. Their relative economic merits need to be decided for each case but it appears prudent to maintain fuel flexibility in reducing greenhouse gas emissions.

Coal and other energy sources

Hybrid gasification and parallel cofiring of coal with biomass and natural gas have the greatest potential to reduce greenhouse gas emissions. However, their economic viability depends on the prices of biomass and natural gas which vary considerably. Cofiring with biomass could be deployed globally on an installed capacity of 100 GWe. As shown in the Figure from a Dutch evaluation, the co-utilisation options of coal with biomass give a lower cost of electricity than biomass alone, even at zero biomass fuel cost. Natural gas is used as a reburn fuel in NOx control and achieves a CO_2 reduction of up to 10%. This technology may be of interest for the power stations requiring NOx reduction. The capacity with no NOx control exceeds 480 GWe. The capital costs may be justified for NOx control in which case the CO_2 reduction would be an ancillary benefit.

Plant upgrading and optimisation

Information on the achievements of plant upgrading and optimisation is scattered but there is probably potential for greenhouse gas reduction in most regions. An analysis of CO_2 emissions reduction with cost data is required for each case. The improvements may be small incremental changes rather than a single large increase in efficiency. For example in the USA, heat rate improvement projects are reported to the US DOE Voluntary Reporting Program.



Sensitivity of electricity cost to biomass cost

Utilities seek to maintain heat rates by replacing old, worn-out equipment. In one case, the HP feedwater heater was replaced, resulting in a 2% heat rate improvement and CO_2 emission reduction of about 67 kt. In an example of cooperation between the Netherlands and Romania, boiler and turbine rehabilitation was estimated to result in a 12% CO_2 reduction. Another study, of a power station in Germany, indicated that reheater improvements and LP retrofit involved the highest investment costs of the upgrading options considered but the LP retrofit achieved a much greater CO_2 reduction. Investment to improve efficiency, reducing CO_2 emissions, may be justified by the fuel savings.

Repowering techniques

This applies also to repowering which appears to be of interest in Europe, Japan and the USA. The greatest prospects for CFBC repowering are in central and eastern Europe and China. Gas turbine repowering has more prospects in North America, according to a technical survey. While supercritical PC, IGCC and gas turbines reduce greenhouse gas emissions considerably, FBC technologies are penalised by elevated N_2O emissions with a high CO_2 equivalent (CO_2-e). These may possibly be minimised by scale-up and higher operating temperatures. Repowering with NGCC has the lowest cost of CO_2 reduction with moderate capital cost and cost of electricity, according to both a European and a US study. Hot windbox repowering offers a moderate cost of CO_2 reduction for low capital cost and cost of electricity. Repowering with clean coal technologies costs more in terms of CO_2 reduction and capital costs but with moderate cost of electricity in these studies.

Cogeneration and CHP

There is potential to use CHP on coal-fired units in most countries. It is one of the most cost-effective measures to reduce CO_2 emissions and is applied mainly to NGCC but also to coal-fired units. Coal-based CHP may save up to a third of the fuel used when replacing a coal-fired power station and separate district heating plant. The amount depends on the power to heat ratio and on matching the heat and electricity loads. The appropriate method of calculating CO_2 reduction from CHP needs to be chosen for the plant under evaluation. The cost of CO_2 reduction should take account of income from heat sales. A European study found that the cost of CO_2 reduction for CHP based on either coal or biomass was around half the cost of exchanging old coal-fired power stations with new clean coal technology.

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