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Profiles

IGCC roadmaps for the Asia-Pacific region

The Asia Pacific Partnership Cleaner Fossil Energy (CFE) Taskforce meeting held on 4-5 July 2007 in Beijing agreed to establish an IGCC working group with the Terms of Reference to be developed jointly by Australia, the United States and Korea. The working group asked IEA Clean Coal Centre to assist its work by undertaking a review of the issues associated with the introduction of IGCC-based clean coal technology into the APP member countries. Agreement was reached to make the results of the study available to the IEA CCC members.

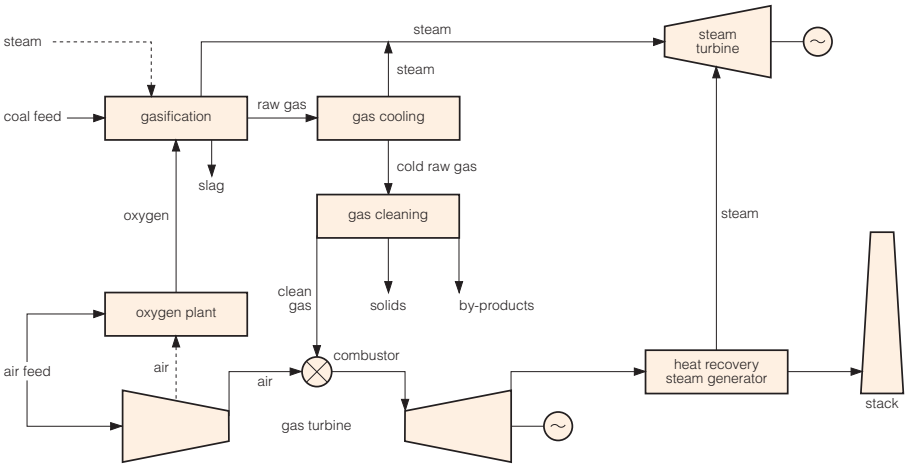
The study sets out suggested roadmaps for the APP countries, namely Australia, Canada, China, India, Japan, Republic of Korea and the United States, by considering the issues pertinent to IGCC development under three headings:

- **Technical issues**. The current position, and the technical developments necessary to take IGCC to full commercial operation as a high efficiency power generation technology with full carbon capture and storage.
- **Carbon capture and storage issues**. The CCS issues that need to take place alongside the technical development to ensure that CCS is ready to be deployed for IGCC as the IGCC technology matures.
- **Accompanying issues**. The issues that have an impact on the development and acceptance of IGCC technology such as financing, policy and regulations, and public perceptions.

Integrated Gasification Combined Cycle (IGCC) is a high efficiency power generation technology which gasifies coal to generate the fuel ('syngas') for a high efficiency gas turbine. Compared with conventional pulverised coal (PC) fired power plants IGCC has potentially many advantages including:

- High thermal efficiency on a par with the best existing PC plants and potential for further increases (for both technologies). Shell estimate an IGCC generation efficiency based on their gasifier of 46–47% net, LHV basis (44–45% net, HHV basis), for bituminous coals with an F-class gas turbine. The highest reported efficiency for an IGCC is 41.8% HHV basis (Shell gasifier powering an F-class turbine, fuelled with Pittsburgh coal).
- Good environmental characteristics on a par with the best existing PC plants. The plant's high thermal efficiency means that emissions of CO_2 are low per unit of generated power. In addition, emissions of SOx, NOx and particulates are reduced by the requirement to deep clean the syngas before firing in the gas turbine.
- Reduced water consumption. IGCC uses less water because 60% of its power is derived from an air-based Brayton cycle, reducing the heat load on the steam turbine condenser

Illustrative roadmap for developing India's power sector, 2007-17



Integrated gasification combined cycle without CO_2 capture – major component systems

to only 40% of that of an equivalently rated pulverised coal fired plant. Additionally, through the direct desulphurisation of the gas, IGCC does not require a large flue gas desulphurisation unit which consumes large amounts of water, thereby reducing water consumption in comparison with a conventional pulverised coal fired power plant. Further gains in reducing water use can be achieved when CCS is incorporated into the plant.

A simplified version of a coal-fuelled IGCC cycle is shown in the figure above. Gas cleaning is typically undertaken by water scrubbing or the dry removal of solids, followed by hydrolysis of COS to H_2S, then scrubbing to remove H_2S. There are many possible plant configurations, because gasifier designs vary significantly and IGCC has a large number of process areas that can use different technologies. The deep cleaning needed to protect the gas turbine enables emissions of particulates and SO_2 to be very low. Totally dry gas clean-up at elevated temperatures ('hot gas clean-up') may eventually be applied, with advantages in efficiency, but it is not currently available for commercial IGCC.

There are three main types of coal gasifiers, namely; moving bed, fluidised bed and entrained flow. In a moving bed gasifier, the coal is fed through the top of the gasifier and the oxygen and steam from the bottom. The gases flow upwards through the bed of coal and the slag is withdrawn through the bottom. In a fluidised bed gasifier, the coal is gasified in a bed of heated particles suspended in flowing air. In an entrained flow gasifier, the pulverised coal and the gases flow concurrently at high speed. The three types differ in relation to the rank of coals they are most suited to, whether the ash conditions are dry or slagging, the size of the coal feed and the type of feed system, whether the oxidant is oxygen or air, how the slag is handled and the operating pressure, temperature and the exit gas temperature. Moving bed gasifiers are relatively insensitive to fluctuations in fuel, air or steam flow but they can produce large quantities of tar. Fluidised bed gasifiers are well suited to some forms of coal and use finer coal sizes than fixed bed systems. Entrained flow systems use very finely ground coal. Their low fuel inventories make the control of oxidant to fuel ratio very sensitive and their operating temperatures produce superior carbon conversions and the potential to use high temperature reject heat.

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

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† member countries
‡ educational establishments within member countries

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IEA CLEAN COAL CENTRE

Gemini House
10-18 Putney Hill
London SW15 6AA
United Kingdom

Tel: +44 (0)20 8780 2111
Fax: +44 (0)20 8780 1746
e-mail: mail@iea-coal.org
> Internet: www.iea-coal.org