Profiles

IEA CLEAN COAL CENTRE

No 12/14 November 2012

Coal-fired CCS demonstration plants, 2012

Coal is used to generate around 40% of the world's electricity and is expected to maintain its dominant share for the foreseeable future. The world's coal resources are considerable and spread widely and, at current rates of production, are sufficient to last for more than a century. Numerous studies have examined the outlook for global energy demand and concluded that despite efforts to diversify, some of the biggest economies will continue to depend heavily on coal for many decades to come. In many, coal is essential for the provision of an affordable and reliable electricity supply that underpins economic and social development. Although coal use has plateaued or declined in some of the older industrialised nations, its use continues to increase in the burgeoning economies of countries such as China and India, where it provides a secure source of energy.

An important element in coal's future will be the increasing deployment of Clean Coal Technologies (CCTs) and Carbon Capture and Storage (CCS); both are expected to play significant roles in helping create and maintain a sustainable global energy structure. Both will be major elements in maintaining coal's role as a fuel for power generation and industrial applications around the world, and will form an essential part of an overall strategy needed to achieve the carbon reductions required for stabilising atmospheric CO_2 concentrations.

In 2010, global greenhouse gas emissions reached an all-time high (30.6 Gt), a 5% increase over the previously highest level of 29.3 Gt reached in 2008. Emissions came from all major fossil fuels (44% from coal, 36% from oil, and 20% from natural gas). There is therefore a huge challenge to reduce CO_2 emissions produced by the use of these fuels. At the moment, the goal of limiting global temperature rise to no more than 2ºC is looking less attainable, although the greater deployment of CCTs and CCS would certainly contribute towards achieving this.

This report reviews development activities focused on the eventual large-scale deployment of carbon capture systems on coal-fired power plants. It provides an update of the most promising coal-based CO_2 capture projects at significant scale under development around the world. The latest data being produced from larger-scale (predominantly larger pilot-/demonstration-scale) projects is summarised, and an attempt made to determine where gaps in the knowledge remain and how technology developers aim to fill such gaps. However, issues of commercial confidentiality have meant that, in some cases, information in the public domain is limited, therefore it has only been possible to identify overarching aspirational goals rather than to report on detailed individual research plans and proposals. Where appropriate, relevant data generated from smaller-scale testing is noted, especially where this is feeding directly into ongoing programmes aimed at developing further or scaling-up a particular technology. Where available, learning experiences and operational data being generated by these projects is noted. Technology Readiness Levels (TRLs) of individual projects have been used to provide an indication of technology scale and maturity.

There are three main CO_2 capture technology streams currently being developed and tested; these comprise pre- and post-combustion capture, and systems based on oxyfuel technology. Each category encompasses a number of different alternatives or sub-categories, reflecting the differing approaches being taken forward by individual technology developers and utilities. The report concentrates mainly on these three approaches, namely pre-combustion chemical capture from IGCC-derived syngas, post-combustion chemical capture using amines, amino acids or ammonia, and variants of oxyfuel combustion. Issues and technologies associated with CO_2 transport and storage are not addressed in detail as they fall largely outside the scope of this report.

At present, both pre- and post-combustion capture technologies are commercially available and are used widely for purifying gas streams in a variety of industrial processes. For instance, post-combustion capture using solvents has long been used for various applications. However, such capture processes were not designed specifically for application to large coal-fired power stations. Consequently, the necessary equipment may be sizable, steam demand high, and contaminants in the flue gas may affect the effectiveness of the capture process. However, post-combustion capture is viewed as having the greatest near-term potential for reducing CO_2 emissions, as potentially, it could be retrofitted to many existing coal-

IEA Clean Coal Centre is a collaborative project of member countries of the International Energy Agency (IEA) to provide information about and analysis of coal technology, supply and use. IEA Clean Coal Centre has contracting parties and sponsors from: Australia, Austria, Brazil, Canada, China, Denmark, the European Commission, Germany India, Italy, Japan, Republic of South Korea, the Netherlands, New Zealand, Poland, Russia, South Africa, Sweden, Thailand, the UK and the USA.

Tampa Electric's 320 MW IGCC power plant in Florida, USA. The plant will host the Warm Gas Cleanup and CCS Demonstration Project. It should be operational by 2015 (photograph courtesy of TECO)

fired power plants. Many possible technology variants and options are being followed and major development programmes are under way in Europe, North America, and the Asia-Pacific region. Oxy-combustion capture is still under development and is not currently a commercial proposition, although recent developments have helped push the technology much further forward. The advantages and limitations of each of the three main technologies are discussed in the report, along with plans for their continued development and demonstration, predominantly in large-scale power plant applications.

Potentially, all three carbon capture approaches are capable of high CO_2 capture efficiencies, typically about 90%. However, for each, the major drawbacks associated with current processes are their high cost and substantial operational energy requirements. A considerable proportion of the ongoing and planned research and development is dedicated firmly to reducing process costs and associated energy penalties. Even with an aggressive development schedule, the general consensus is that (assuming their effectiveness is confirmed) the three main approaches to CO_2 capture are unlikely to become commercially available for large-scale deployment on coal-fired power plants for some time. Most technology roadmaps anticipate that CO_2 capture will be available for commercial deployment on power plants by 2020 or later.

A major issue with all forms of CO_2 capture system is both capital and operating cost. However, based on previous experience with the introduction of other forms of environmental control technology on coal-fired plants, associated costs tend to reduce over time. For instance, after an initial rise during the early commercialisation period, the cost of post-combustion SO_2 and NOx control systems declined by 50% or more after about two decades of deployment. It is therefore considered that once these CO_2 capture technologies become deployed widely, a similar downward trend might be expected.

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:

Coal-fired CCS demonstration plants, 2012
Stephen Mills
CCC/207, ISBN 978-92-9029-527-3,
114 pp, October 2012, £255*/£85†/£42.50‡

* non-member countries
† member countries
‡ educational establishments within member countries

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