

# CCS – THE FIRST STEP TOWARDS CLEAN COAL POWER

Carbon Capture and Storage (CCS) – involving the capture and storage of carbon dioxide from fossil-fuel combustion – is emerging as one of the most important energy technologies for the future. With the inauguration of its pilot CCS plant at Schwarze Pumpe, Germany, Vattenfall has further established its reputation as a world leader in this area.

Climate change caused by emissions of carbon dioxide and other greenhouse gases is one of the greatest environmental challenges of our time.

The world's energy needs are expected to rise, and most of this increase will be met with fossil fuels. Even within the EU27 countries, use of fossil fuels is expected to increase. According to the International Energy Agency (IEA), 51% of electricity generation in the EU27 countries will still be based on fossil fuels in 2030, compared with slightly more than 55% in 2006. This means that the use of fossil fuels will be increasing, since total electricity generation will be at a higher level in 2030 than in 2006.

From this perspective, the capture and storage of the carbon dioxide produced from fossil fuel combustion is a vital instrument for reducing climate impact. The potential is great; however, the technology must be scaled up and costs lowered to enable a commercial debut by 2020.

## Vattenfall's CCS project started in 2001

As one of Europe's largest electricity producers, Vattenfall is also one of the largest emitters of carbon dioxide. Vattenfall thus has a major obligation to reduce environmentally affecting emissions from its electricity and heat production. Toward this end, since 2001 Vattenfall has been conducting a large-scale Carbon Capture and Storage (CCS) project. Vattenfall has earmarked more than SEK 11 billion for development of CCS technology by 2013.

Vattenfall is working to develop safe, cost-effective and feasible CCS technologies in the aim of achieving substantial reductions in CO<sub>2</sub> emissions. The aim is to have a fully developed commercial concept ready by 2020.

## From pilot project to demonstration plants

The pilot plant at Schwarze Pumpe, Germany, for testing the so-called oxyfuel technology (see page 17), is an important

milestone in Vattenfall's CCS technological development and is an investment worth EUR 70 million. The 30 MW plant – the first of its kind in the world – was inaugurated on 9 September 2008 (read more on page 19).

The next step will be to build demonstration power plants that are large enough to be able to evaluate the commercial prospects. Plans and pre-studies are currently being conducted in various parts of the Vattenfall Group.

## Nordjyllandsværket

In Vedsted, in northern Denmark, Vattenfall is looking into opportunities to store carbon dioxide in a geological formation at a depth of 1–2 km underground. In connection with this, block 3 at the Nordjyllandsværket facility is currently being fitted with a full-scale plant for capturing carbon dioxide using post-combustion technology (see page 17). After combustion, the liquefied carbon dioxide will be transported from the power plant to the storage site via a pipeline. If a positive result is obtained from the geological surveys, an investment decision may be made in 2010. In such case, a 300 MW CCS demonstration plant could be in operation at Nordjyllandsværket by 2013.

## Jänschwalde

Vattenfall is also studying the prospects of building a 500 MW CCS demonstration plant in Germany. In Jänschwalde, Vattenfall has a lignite-fired power plant comprising six blocks. A pre-study is currently looking into the possibility of rebuilding one of these units. The plan is to build a new oxyfuel boiler (see page 17) and retrofit one of the two existing boilers with postcombustion equipment. This double-demo project can be realised by 2015 at the earliest.

## Here's how CCS technology works



CCS technology consists of three parts: capture, transport and storage of carbon dioxide. Each part relies on various technological solutions.

### Capture

The principle of CCS is to capture carbon dioxide after combustion and compress it into liquid form for further transport and permanent storage in bedrock. Today there are three main methods of capturing carbon dioxide:

**Oxyfuel** – the fuel is pre-burned in pure oxygen and recirculated flue gases. Carbon dioxide is the only residual product.

**Postcombustion** – the flue gases are scrubbed after conventional combustion, leaving a purer form of carbon dioxide.

**Precombustion** – carbon is separated from the fuel through gasification, and the resulting hydrogen gas (H<sub>2</sub>) is burned.

The challenges for all three concepts include reducing the higher need of fuel required by the separation process, and the higher investment cost.

### Transport

A large-scale CCS system must have capacity to handle carbon dioxide from several power plants. A single coal-fired plant with a capacity of 1,600 MW produces about 10 million tonnes of CO<sub>2</sub> per year. Transport via pipeline or by ship are the most suitable alternatives for moving large volumes of liquefied carbon dioxide.

### Storage

Carbon dioxide exists in a natural state in underground geological formations around the world, where it is trapped in the same type of geological formations of sedimentary rock as those in which oil and natural gas are found. The idea is that geological storage will resemble these natural carbon dioxide deposits. Three storage forms are of interest:

**Existing oil and gas fields** where carbon dioxide can be injected to increase the volume of oil and gas extracted. The oil industry has extensive experience with this technique.

**Depleted oil and gas fields** that have shown an ability to sequester oil and gas for millions of years.

**Saltwater aquifers** – the same formations as above, but which have not held oil or gas and can be found at a minimum of 800 metres underground.

Vattenfall is currently working on locating and evaluating suitable storage sites. Studies indicate that there is more storage capacity in Europe than what is needed to store all of the carbon dioxide that is produced from existing coal-fired power plants.