World's first coal power plant with CCS

Vattenfall takes the plunge at Schwarze Pumpe

The world's first pilot plant for the capture of carbon dioxide in a coal-fired power station has commenced operations at the eastern German power station Schwarze Pumpe.

by Stefan Schroeter

When the weather is good, the lignite-fired power station Schwarze Pumpe in Lusatia in eastern Germany can be seen from a long way off. The two gigantic cooling towers of the large power station, which has a capacity of 1,600 MW, throw out thick white clouds of steam into the clear blue sky. These clouds contain large amounts of carbon dioxide. The power station puffs 12 million tonnes of CO_2 a year into the air. Its owner Vattenfall Europe AG (VE) produces a total of 70 million tonnes of CO_2 per year. CO_2 is the last pollutant still produced in significant quantities by the eastern German lignite power stations built by VE towards the end of the 1990s. There has been no market-ready technology capable of separating and safely disposing of the CO_2. VE and its Swedish mother company, Vattenfall AB, expect it will take a long time to solve this problem. By 2050, they want their plants to be completely CO_2 neutral.

The economic viability of the oxy-fuel process is still questionable

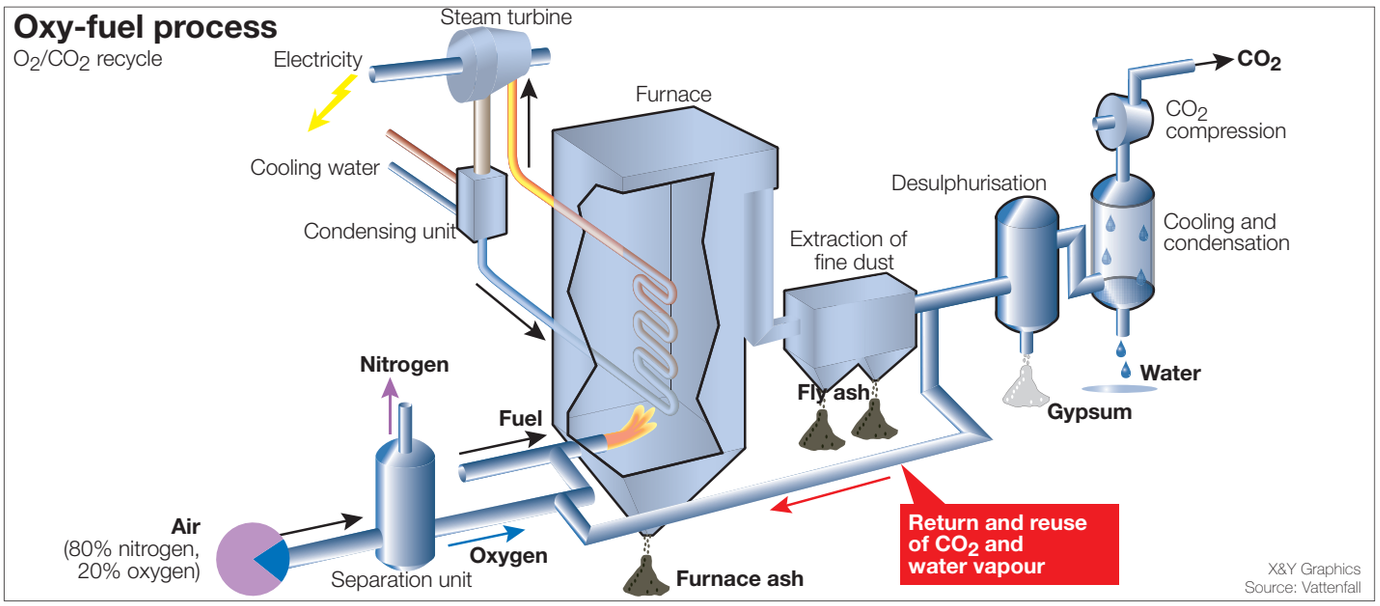
To achieve this they are relying heavily on a pilot unit that VE built over the last two years (at a cost of €70 million) right beside Schwarze Pumpe. According to the company, this is the world's first pilot plant at a coal-fired power station to use CO_2 capture. It has a thermal capacity of 30 MW and works with oxy-fuel technology. In this process, lignite is not burned using air from the surrounding environment as has typically been the case, but rather a mixture of pure oxygen and recycled flue gases is used. Following various stages of purification, the flue gases are converted into a highly concentrated CO_2 that can be liquefied, transported and stored in underground reservoirs.

99% captured

The opening of the plant has apparently been successful. 'Last Thursday at 4.50pm, our engineers have for the first time managed to capture carbon dioxide in this plant,' reported VE chairman Tuomo Hatakka at the commissioning on September 9. Hubertus Altmann, head of the engineering department, calculates that a 99% rate of capture was achieved.

In the coming months, Hatakka wants to make the whole chain of carbon capture and storage (CCS) operational. He plans to transport the 60,000 to 100,000 tonnes of CO_2 captured from Schwarze Pumpe by tanker truck to a gas storage depot 350 km away in the Altmark region. VE plans to bring its joint storage program with Gaz de France into operation in March 2009. There is also a joint agreement with Linde in which CO_2 will be used as an engineering gas. 'The pilot plant has been set up for a CO_2 purity of 99.7%,' says Reinhardt Hassa, chairman of VE Mining and Generation. 'This meets the quality requirements for engineering applications.' In industry, CO_2 is utilized as fertilizer, cooling agents and dry ice, as well as for cleaning purposes. It is also used in fire extinguishers. VE has put the cost of the pilot plant's five-year research trial at €20 to €30 million.

Between 2012 and 2015, the company intends to build a demonstration power plant using CO_2 capture with a capacity of 300 to 500 MW at the Jänschwalde power station, costing up to



The oxy-fuel process

Instead of being combusted with air, coal is fired into an environment of pure oxygen and recycled flue gas. A 75% share of the carbon dioxide produced is then fed back into the boiler during power plant operations. In subsequent treatment steps, the dust and sulphur compounds are removed from the flue gas stream as in conventional power plant operations. Finally, the remaining steam is condensed out, so that the flue gas, with approximately 98% CO_2 concentration, remains. The CO_2 is then liquefied on site or compressed so that it is suitable for transportation by tanker truck or via a pipeline.

€1 billion. The plans there are to use oxy-fuel technology in one boiler. In a second boiler, so-called post-combustion technology will be used. The Vattenfall Group is also planning two post-combustion projects in Denmark and Norway. By 2013, the Danish bituminous coal-fired power station Nordjyllandsvaerket will be upgraded with this technology. In northern Jutland, Vattenfall is investigating possibilities for CO_2 storage. In the Norwegian refinery Mongstad, Vattenfall is participating in a research project in which two different post-combustion technologies are being tested.

With oxy-fuel technology, VE anticipates being able to reduce the CO_2 emissions which occur during power production from over 900 to way below 100 grams per kilowatt hour. The downside is the high use of energy, which leads to a 10% loss in efficiency for a lignite-fired power station. Investment costs will also increase dramatically. But Altmann assumes that by 2020, the loss of efficiency will be counteracted through the use of efficiency-increasing measures such as lignite pre-drying and higher steam temperatures and pressures. By then, VE will be ready to use oxy-fuel at a large scale commercial power station. Altmann also sees possibilities for reducing the amount of energy used in the oxy-fuel process. 'We will be able to achieve efficiency rates of significantly more than 40% with the types of power plants that will come after the demonstration units.'

Economic viability

The economic viability of oxy-fuel is still questionable. The chairman of Vattenfall AB, Lars G Josefsson, estimates that CO_2 costs at the Jänschwalde demonstration unit will be between €80 and €90 per tonne. Because this is not economical, Vattenfall needs public funding. In a commercial power station that VE has planned for 2020, CO_2 costs are expected to be reduced to €30 to €35 per tonne. As far as the effect of CCS technology on power prices is concerned, Josefsson has made divergent statements. 'If CCS becomes too expensive, then we won't use it', he said. Later he conceded that the price of emissions certificates could also increase to enable the introduction of CCS, 'but in 10 years, there will be new technologies, and of course we'll be smarter with CCS technology. It will be a race.'

This race could lead to the white steam clouds over Schwarze Pumpe containing less CO_2 in the future. 'If the technology exists, and if it is economical and can be financed at market rates,' says Hassa, 'then the day will come when power plants with sufficient remaining operating life will be upgraded.' ■