

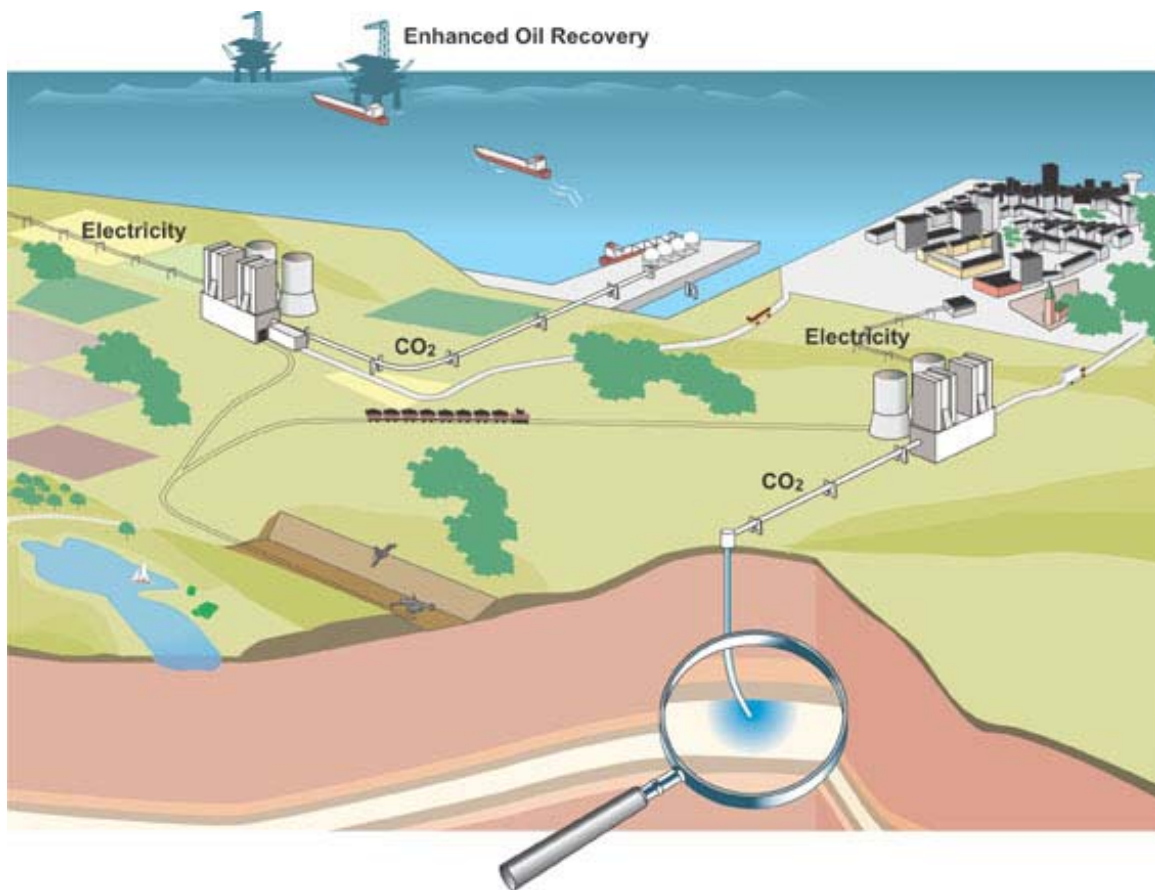
Vattenfall and CCS - Carbon Capture and Storage

What is CCS?

Carbon Capture and Storage - CCS - is the method of capturing carbon dioxide from flue gas, compressing it into liquid form and storing it deep underground in suitable geological formations.

The world is currently dependent on the use of fossil fuels for its energy supply. This will continue to be the case in the foreseeable future. The development of alternative energy sources will take time, but emissions from fossil fuels need to be drastically reduced already.

CCS is a plausible concept that can help achieve a sharp reduction of carbon dioxide emissions from fossil-fired power plants. It can support the transition to a long-term sustainable energy system and be one step on the way to fossil fuel independence.



CCS – a necessity to halt the greenhouse effect

Climate change, a result of emissions of carbon dioxide and other greenhouse gases, is the overriding environmental challenge of our time. Vattenfall uses fossil fuels in some plants and we therefore have a responsibility to reduce our carbon dioxide emissions. We also see it as our responsibility to take initiatives, to be a driver of development and lead the way for others.

CCS will enable us to reduce carbon dioxide emissions while continuing to use fossil fuels, something that will still be necessary for a long time to come. CCS will work as a temporary solution that buys us the time we need to develop a sustainable energy system in the future. We say that CCS is a way of “bridging to the future”.

We need CCS technology if we are to start reducing the ever-growing amount of carbon dioxide in the atmosphere and thereby counteracting the greenhouse effect.

Vattenfall’s view of CCS

Vattenfall has taken a leading position in the European development work on CCS. Our ambition is that the technology should become fully commercialised by 2020 and that the cost of capture and storage will be cut to €20 per tonne of captured CO₂. We believe that this goal is within our reach, but our assessment is that it will be enough to reach €25-30 for CCS to be commercially implemented by 2020.

Vattenfall is convinced that, sooner or later, CCS will become commercial and that it will be generally accepted as an intermediate means of tackling the threat of global climate change. CCS should be commercially introduced under the European ETS in competition with other low-carbon technology solutions.

Based on the knowledge that we have built up within our CCS project since it began in 2001, we are convinced that commercial CCS could be realised by 2020 with the necessary support from society – both in financial terms for demonstration and in political terms for the removal of formal obstacles. Without a strong, immediate and focused support, the commercial introduction of CCS will be delayed.

Vattenfall’s belief in CCS is independent of public funding. However, the magnitude and the rate of our continued efforts regarding CCS development are dependent on financial and general political support, as well as on general public acceptance. The stronger the support from the public, the stronger our own efforts will be.

We have announced our position regarding preferred funding in the EU to promote the realisation of a fleet of CCS demonstration plants – plants that are necessary for CCS to become commercial in Europe under the ETS by 2020.

We already know that the three parts of the CCS chain - capture, transport and storage – are viable and that they can be performed safely. In addition, we are convinced that the total CCS costs can be cut to the levels needed to make CCS commercial. Our view is that CCS is more than a fully-plausible solution to the climate change problems that stem from the greenhouse effect. It is an absolute necessity, and we welcome others to venture into CCS development in Europe and the rest of the world.

Vattenfall's CCS project

CCS is a part of the solution to the world's problems with increasing amounts of greenhouse gases in the atmosphere. Vattenfall has ventured into the development of CCS technologies in order to make it possible to take a large step towards reduced carbon dioxide emissions.

Since 2001, Vattenfall has been working on developing methods for capturing CO₂ from large coal-fired power plants and storing it underground. We work to develop safe, cost-efficient and viable technologies that can contribute to drastic reductions of CO₂-emissions. This work includes all parts of the chain – capture, transport and storage. Another important part of the project is to identify and assess the environmental impact that capture, transport and storage of CO₂ entails.

Capture

There are three main technology options for capturing the CO₂ produced in large power plants.

- Oxyfuel combustion, where CO₂ is practically the only product following combustion in almost pure oxygen and recycled flue gas, instead of air.
- Postcombustion, where CO₂ is washed from the flue gas after conventional combustion.
- Precombustion, where a gasification process removes the carbon from the fuel before the resulting hydrogen gas H₂ is combusted.

Transport

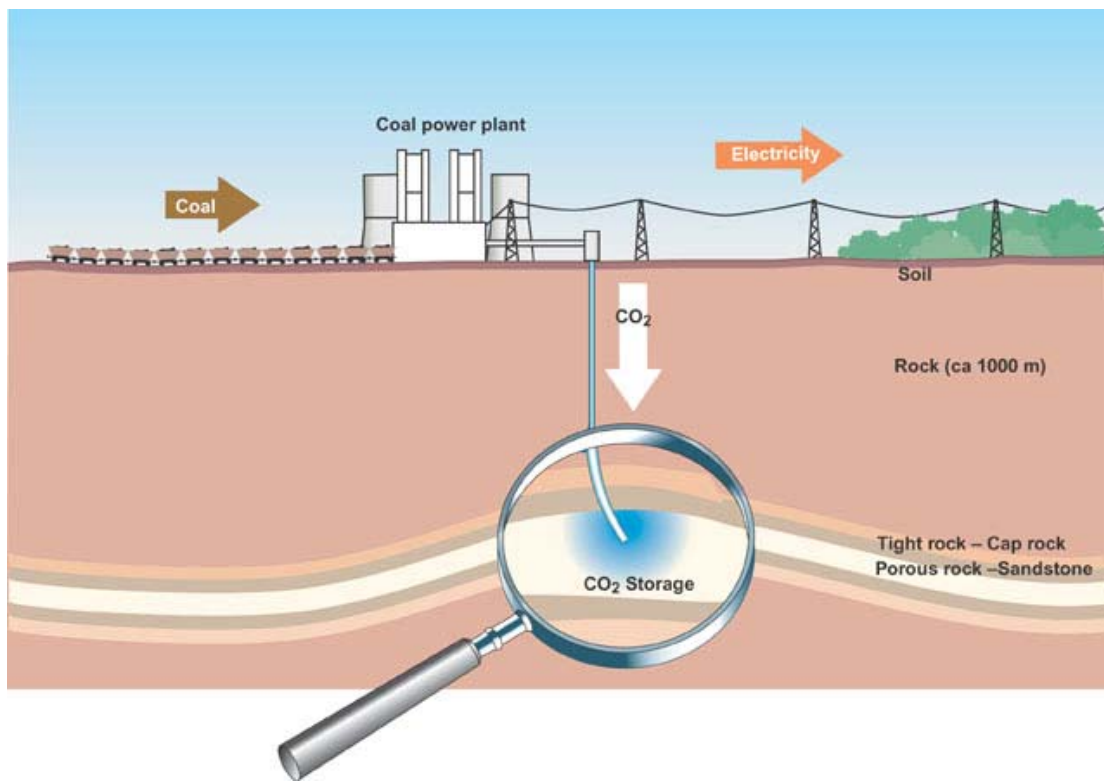
A functional infrastructure for transporting carbon dioxide is the key component that ties the capture at power plants together with storage at suitable sites. One single 1 600 MW lignite-fired power plant, like our power plant in Schwarze Pumpe, produces around 10 million tonnes of CO₂ each year. Transports through pipelines or by ship are the most suitable alternatives for such large amounts of CO₂.

Storage

In many parts of the world, natural carbon dioxide is found in geological formations where it has been trapped in sedimentary rock types in much the same way as oil and gas. The intention is to make the conditions for geological storage resemble the conditions in these natural CO₂ storage sites.

Depleted oil and gas fields have demonstrated an ability to hold oil and gas over millions of years. They have great potential to function as long-term storage sites for CO₂. Another alternative is to inject CO₂ into active oil and gas fields to enhance the recovery of oil and gas. There are also geological formations that are filled with salty water that can be suitable as storage sites. CO₂ partially dissolves in the water and can in some cases slowly react with minerals and form carbonates.

Regardless of the option that is selected, the storage site will be covered with an impermeable layer of rock, known as cap rock, that prevents leakage. When the storage site has been filled, it will be permanently sealed and put under constant surveillance.



Pilot plant in Schwarze Pumpe

In Schwarze Pumpe, Germany, we have built a pilot plant connected to one of our lignite-fired power plants. The purpose of the pilot plant is to validate and improve the technology relating to the Oxyfuel method of capturing CO₂. So far, this technology has only been tested on a smaller scale. During the summer of 2008, we have begun performing tests in Schwarze Pumpe. A wide range of tests will be performed at the pilot plant during a first test period of three years.

The concentrated carbon dioxide from the pilot plant will be injected for permanent storage in a gas field in Altmark in northern Germany.

Vattenfall's plans for demonstration plants

A demonstration plant is the link between the pilot plant and a fully-developed commercial concept. In the pilot plant, the technology itself and the process will be validated, whereas in a demonstration plant the commercial abilities of the technology will be proven. Initial studies for demonstration plants have already begun within the Vattenfall Group and two sites have been chosen so far.

In northern Denmark, we are investigating the possibility of storing CO₂ at the Vedsted structure, a geological reservoir between one and two kilometres below the Earth's surface. If the site proves suitable for CO₂ storage, the Nordjylland Power Station will be equipped with a full-scale unit for CO₂ capture using Postcombustion. The carbon dioxide will be transported through a pipeline across the 30 kilometres between the plant and the storage site. The CCS demonstration plant at Nordjylland Power Station could be ready and operational by 2013.

In Germany, we will turn the Jänschwalde power plant into a demonstration plant. Parts of the existing plant will be equipped with units for CO₂ capture and we are currently investigating the possibilities of implementing both Oxyfuel and Postcombustion technology at Jänschwalde. It has not yet been decided where the captured carbon dioxide is to be stored. This demonstration plant can be realised by the year 2015.

The goal of our CCS project

Our CCS project aims to provide commercially-available technology for the capture and storage of CO₂ by the year 2020. We believe in the CCS technology and consider 2020 to be a fully realistic goal. Our ambition is to be able to capture more than 95 % of the carbon dioxide in the emissions from power plants.

To reach our goals, the technology must gain acceptance from the general public. There is also a need for financial and political support and for a legal framework for CO₂ storage.

Contacts

More information on Vattenfall's CCS project can be found at www.vattenfall.com/ccs

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