Technologies for lower-emission electricity

Linde is actively involved in development of the three main processes used to capture carbon dioxide at coal-fired power plants and in research into CO2 injection.

Pre-combustion capture

Pre-combustion capture, or integrated gasification combined cycle (IGCC) technology, is an upstream process for gasifying coal in combined cycle power plants (also known as gas and steam power plants). IGCC technology first converts coal to a synthesis gas (syngas) inside a gasifier at high temperatures and under pressure. The syngas mainly comprises hydrogen (H) and carbon monoxide (CO).
A water-gas shift reaction is then used to create carbon dioxide and additional hydrogen. The carbon dioxide can then be scrubbed, and the hydrogen burnt in the gas turbine. IGCC technology without CO capture has been used in power plants since the 1980s.
IGCC increases plant efficiency levels compared with other CO capture technologies. It is also a versatile process enabling different feedstocks (such as biomass or waste) to be used instead of coal. And the resulting syngas can be used to manufacture fuels such as methanol.
See Corporate Responsibility at www.linde.com for information on our research projects.

Post-combustion capture

Post-combustion capture uses chemicals to separate the carbon dioxide in conventional coal-fired power plants following desulphurisation of the flue gas. It is the only method suitable for retrofitting existing power plants and therefore particularly valuable. Widespread penetration of new power plants with integrated CO capture will take several more decades due to lengthy investment cycles – 40 years being the norm. We have already launched a pilot facility for this process, known as CO scrubbing, in collaboration with BASF and RWE. The facility will be located at the lignite power plant in Niederaußem (North Rhine-Westphalia, Germany).
The energy group Vattenfall Europe is planning to retrofit a power station in Jänschwalde, Germany, with post-combustion capture technology, thus establishing a CO -free, lignite-powered pilot facility. Our Engineering Division is producing a feasibility study for this project.

Oxy-fuel combustion

In the oxy-fuel process, coal is combusted in an atmosphere consisting of pure oxygen and CO . This means the resultant flue gas is not diluted by nitrogen from the air, but primarily consists of CO and water vapour.
This vapour is easily condensable, leaving a highly concentrated CO stream. The CO can then be compressed and transferred to storage. The energy group Vattenfall decided to build on this technology and thus went on stream with a 30-megawatt pilot oxy-fuel facility on the site of the Schwarze Pumpe lignite power plant in Brandenburg, Germany. Vattenfall intends to create a demo plant showcasing oxy-fuel technology in Jänschwalde, Germany.

Carbon capture and storage (CSS)

We do not yet have a mature solution for the disposal of CO captured from combustion gases. One method currently on trial is sequestration, i.e. CO storage below the ground or seabed. The gas can be stored in crude oil or natural gas reservoirs, saline aquifers or coal seams.
This is part of the carbon capture and storage (CCS) process chain, which extends all the way from CO separation to final disposal, making an important contribution to a more sustainable energy chain. However, the CO sequestration step is still in the development stages. Under the umbrella of the CO SINK project, Linde is participating in investigations into technologies

capable of permanently pumping CO into plutonic rock. Linde is also involved in a further pilot project investigating the use of carbon dioxide to increase natural gas recovery rates (enhanced gas recovery, EGR).
See Corporate Responsibility at www.linde.com for more information.

CO recycling

It's a well-known fact that carbon dioxide helps plants grow. With this in mind, Dutch greenhouse operators previously used gas furnaces even in summer to increase plantation productivity with the CO -rich flue gas. The CO benefitted the plants, but it also added to global emissions.
So supported by Linde's Dutch subsidiary, Hoek Loos, two engineers from the Netherlands launched OCAP ("Organic CO for Assimilation by Plants"), a project to supply greenhouses with CO from a nearby refinery instead. A bright idea that is a win-win for everyone – the diverted CO from the crude oil refinery no longer escapes into the atmosphere as a greenhouse gas, and the plants in the real greenhouses grow faster.