Cutting CO2 emissions with innovative technology

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The objective of SOLVit is to develop improved chemicals and processes for post-combustion CO2 capture systems.

Researchers are testing a variety of technological solutions in the battle to reduce CO2 emissions. On this technological front, there is room for not just one but many winners

The projects showing greatest promise include everything from large-scale demonstration facilities to research on use of tiny nanoparticles.

Sound solutions for carbon capture and storage (CCS) are a key component in a carbon-neutral society. In Norway, public authorities and the R&D sector have pooled their resources in the search for effective solutions.

he Norwegian state-owned enterprise Gassnova and the Research Council of Norway have jointly established the Norwegian Research Programme for Accelerating the Commercialisation of Carbon Capture and Storage by Financial Stimulation of Research Development and Demonstration (CLIMIT) to promote and provide funding for CSS-related projects. The Research Council administers the R&D portion of the CLIMIT programme.

Reining in costs

"One major challenge for efficient CO2 management is that the processes involved are energy-intensive and require large investments upfront. We are looking to remedy this with ground-breaking solutions," says Special Adviser Åse Slagtern of the Research Council. "For CO2 capture to be efficient for industry and power plants, costs will have to be cut dramatically."

The CLIMIT work programme has been revised and will be applied from the beginning of 2013. The programme is placing a stronger emphasis on developing next-generation technologies and innovative solutions within every type of CO2 capture technology. The solutions are being designed to reduce long-term costs and gain the upper hand on current technical and financial uncertainties.

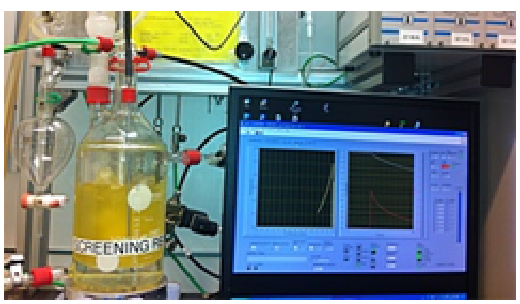
Supporting innovative projects

"We must be even stronger in innovation," asserts Ms Slagtern, citing the following six examples of current projects with the potential to make a real difference in developing efficient CO2 management. Their technologies range from using nanoparticles to capture CO2, to large-scale testing of solvents.

SOLVit: Research on CO2 capture using solvents on a large scale and wide scope in multiple countries

Using conventional amines to capture large emissions of industrial CO2 is highly energy-intensive. One of Europe's largest research projects for CO2 capture has been tackling this challenge. The objective of the eight-year project "Solvents for the next generation of post combustion CO2 capture systems (SOLVit – Phase 2)" is to develop improved chemicals and processes for post-combustion CO2 capture systems.

After four years, the SOLVit project has already cut energy requirements by 35 per cent, and its target of a 50-per-cent reduction is within range. The project is headed by Aker Clean Carbon (ACC), and the project receives funding from the research foundation SINTEF and the Norwegian University of Science and Technology (NTNU). Other partners are the German energy company EnBW AG and the energy multinational E.ON.



NanoCO2: researchers at SINTEF Materials and Chemistry are using multifunctional nanoparticles for higher-efficiency CO2 capture.

ZEG: Pilot facility for producing electricity and hydrogen with zero emissions will be ready in 2013

The process under development in the Zero Emission Gas (ZEG) project has a very high energy efficiency potential. The target is to utilise over 80 per cent of the energy stored in natural gas. What makes this pilot facility different is that it produces both electricity and hydrogen while capturing CO2. One advantage of the ZEG process is that it integrates CO2 capture, in contrast to pre- and post-combustion CO2 capture systems.

The project is set to make the leap from laboratory scale to a 50-kW pilot facility being constructed in Lillestrøm, Norway, in conjunction with the Norwegian Hydrogen Highway (HyNor). The pilot facility is slated to be ready by the end of 2013. The project is headed by the Institute for Energy Technology (IFE) and there are two partners: the technology company Prototech and the technology research institute Christian Michelsen Research.

Chemical Looping Combustion (CLC): Test rig under construction in Trondheim for refining the process

Chemical Looping Combustion (CLC) is a promising alternative for producing energy while capturing CO2. A chemical looping system consists of two reactors. In one, coal or natural gas is combusted along with a metal oxide which is reduced to its metal. In the other reactor, the metal is converted back to its metal oxide state. Using the metallic oxygen carrier in this way, the combustion gas (fuel plus air) is split into three parts: nitrogen is separated out early in the combustion process, while the steam condenses, and the gas by-product is virtually pure CO2.

Researchers at SINTEF Energy Research have calculated a 51-per-cent efficiency potential for a coal-fired cogeneration power plant using CLC. This is several percentage points above the efficiency of a plant using conventional CO2 capture. The project is scheduled to run through 2013.

Palladium membrane: Super-thin, patent-pending membrane that separates hydrogen to be tested large-scale

Based on efficient production of hydrogen from natural gas, power plants can be designed to separate out CO2 before combustion and energy production. The hydrocarbons can be divided into pure hydrogen and pure CO2. The CO2 is then stored or transported away, while the hydrogen is combusted in the gas turbines to produce electricity. The challenge lies in separating out the hydrogen as efficiently as possible.

Researchers at SINTEF Materials and Chemistry have developed a unique method capable of producing large sheets of very thin, flawless membranes made of a palladium alloy. With a thickness of just 2-3 microns, the membrane allows only hydrogen atoms to permeate.

DualCO2: Studying what happens when molten-phase membranes separate CO2

Developers of CO2 capture systems have long dreamt of membranes permeable only to CO2. The University of Oslo and SINTEF are now developing a dual-phase membrane, with a molten-carbonate phase that transports CO2 from one side of the membrane to the other, and a solid yet porous ceramic phase that supports the molten phase. This type of membrane may in principle be used both to capture CO2 from flue gas in post-combustion systems and to extract CO2 in pre-combustion systems.

In the project "Dual phase membranes for CO_2 separation in power generation (DualCO2)", the University of Oslo is testing the characteristics in a membrane cell constructed by SINTEF. Trials have shown good conductivity of carbonate ions, but also some transport of other ions. The project is in an early phase. LECIME (France) and Argonne National Laboratory (USA) are international partners and advisers.

NanoCO2: Nanoparticles enhanced with amines to raise efficiency of CO2 capture systems

A conventional post-combustion system using amines must treat large volumes of chemicals and water, first to capture CO_2 and then to release it. Attaching the amines to nanoparticles speeds up CO_2 capture and, equally important, requires less energy to release the CO_2 again.

For higher-efficiency CO_2 capture, researchers at SINTEF Materials and Chemistry are now using multifunctional nanoparticles – a new class of hybrid materials well suited to such processes and with many applications in nanotechnology.

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