carbon capture journal

July / August 2008 Issue 4

CO2 injection begins at Ketzin - first onshore storage in Europe

Global CO2 Summit - IEA calls for CCS push

How to win the PR war on CCS

SaskPower seeks partners for Boundary Dam project

How ready is 'capture ready'?

The HTC Solution to carbon emissions

Surface Deformation Monitoring for CCS

UK government announces CCS competition shortlist

Purenergy CCS™

Pre-engineered Modular CO2 Capture System by HTC Purenergy

'The world's first Pre-engineered Modular Design™ post-combustion CO2 capture system, customized to site requirements of regional and global electricity producers, industrial processors and other CO2 emitters.'

HTC's Purenergy CCS™ CO2 Capture System offers a 'world first' economically viable commercial scale CO2 capture system for industries seeking 'carbon clear solutions' in power generation, fossil fuels and industrial chemical processing, cement production and many other industrial applications.

The **Purenergy CCS™** CO2 Capture System is a fully validated and optimized product of HTC's demanding product development, technology aggregation and testing program, which for the **Purenergy CCS™** CO2 Capture System has been a multi-year collaboration of the International Test Center (ITC), the University of Regina, Canadian & International engineering groups, international engineering-procure-construct (EPC) companies and HTC Purenergy.

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Front cover: Opening the valves to start CO2 injection at Ketzin. (from left: Prof. Dr. Dr. h.c. Reinhardt Hüttl (GFZ-Executive Board), Bernd Lück (mayor of Ketzin), Dr. Klaus Freytag (President of the state institute for mining, geosciences and Natural Resources of the state of Brandenburg), Michael Richter (State Secretary in the ministry of economics of the State of Brandenburg, in the background) and Dr. Wolfgang Heidug (General Manager CO2 Policy, Shell International und founder of the project CO2SINK). See pg. 25 (Photo: ©GFZ)

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Contents

Global CO2 Summit - IEA calls for CCS push

The IEA will release its annual World Energy Outlook in November, we got a preview of some of the conclusions concerning the 'new world energy order', and a call for a push for CCS especially in India and China, at the Global CO2 Summit in London, 12-13 June

Dr Fatih Birol, Chief Economist, International Energy Agency (IEA)

"This meeting is a very important one for me because I think it is the first time I am going to tell you what we are aiming to do in the world energy outlook 2008 report [which will be] published in November on the climate change side and also some of the key messages we are going to give next month in Hokkaido [Japan July 7-9]."

"I would also like to add that energy and climate change are we believe very much interwoven. More than two thirds of the greenhouse gas emission are to do with the activities of energy production, transportation and consumption."

"So the decision we are going to take on the energy sector will have direct implications on climate change and vice versa."

The new world energy order

"Prices are high, abnormally high, and this is one of the symptoms, I believe, of a new world energy order. So I will try to tell you what the new world energy order is, and then what are the implications of this new order for climate change."

"The new world energy order means the actors we have seen up to now which are determining the game of energy are slowly leaving the scene and we are seeing new actors with their own roles and their own regulations and this determines the energy picture."

"On the demand side China and India are transforming our energy markets by the sheer size of their economic growth and populations and the OECD countries are leaving the scene slowly as the big demand centres."

"The fact that China and India and other countries are driving demand has implications for the global energy scene."

"On the supply side in the last 20-25 years the big international oil companies were responsible for bringing a lot of oil to the markets, but we see the bulk of those companies are having difficulties to have access to new reserves and we expect that the growth to international oil supply will have to come mostly from the national oil companies and this will have implications on the global oil markets."

"This picture I call the new world energy order."

"We have to do everything viable to push renewable technologies. The bulk of the growth is coming from coal, oil we believe will grow mainly from growth in India and China and from the transportation sector."

"Gas is also growing according to our expectations, but the growth in gas is a bit lower than we previously estimated mainly because of high prices induced by high oil prices. Whereas in oil we don't have many alternatives in terms of oil substitution, in gas, especially in electricity generation, we have alternatives so the high gas prices may tail off in the future."

"Nuclear generation will be more or less the same if the talks about nuclear power everywhere in the world is not translated into actual projects. Hydro, biomass and other renewables are growing but growing from a relatively low range."

"This picture, we think, is not a good one; it will end up with two major strategic challenges: increasing risks of energy insecurity, and growing threats in terms of climate change."

"We all know today that China is the largest CO2 emitter in the world and will overtake the US. By 2010 China will be the largest energy user in the world, again overtaking the US. Almost half of the growth in global energy demand will come from China and India. Every third dollar we are going to have to invest in energy generation worldwide will go to China and India."

"Our message in Hokkaido to the world leaders will be, if you are serious about climate change, if you really want to do something, consider to give a big push to CCS especially in China and India"

He talked about how the new energy order has its own rules and highlighted this in terms of the oil market. In 1973-5 oil prices rose and as response global oil demand declined around 2%. In 199-81 oil prices again

"We are living with a new world energy order" - Dr Fatih Birol, Chief Economist, IEA
Image: © OECD/IEA, 2008

spiked and demand fell by 7%. In 2004-6 oil prices increased but demand rose by 3%.

"This is a bizarre situation that needs explaining. There are two points: in the last two or three years more than 80% of the growth in oil demand came from China, Middle East and India, and in 2008 we expect almost all the growth coming from these regions."

"Also there are significant subsidies in these three regions of around $70 billion which filter the effect of the increase in international energy prices."

" We may expect strong demand to continue over the next years."

"In the past IOCs have been able to replace reserves during periods of high prices, but this is no longer the case. This means that these companies are having something of an identity crisis and are trying to find new business strategies enhancing their portfolio."

"In terms of reserves the NOCs have more than 70% of oil reserves and in terms of production 50% and the production growth needs to come from NOCs in the future."

"NOCs have more responsibilities than just making a profit, he said; they may have social responsibilities to their home countries. This will have implications for the global market, as it may not be in their interests to increase oil production even if global

demand dictates it."

"So in the oil picture we will see demand driven by the new players and supply will have to increase by the NOCs; this is the first part of the new energy order."

"Although all countries, with some exceptions, agree on the need for action, they don't agree about who is responsible for what, and this is the major problem we need to solve up to Copenhagen at the end of 2009."

"So we should look at the cumulative emissions, which show that the bulk of emissions since the start of the industrial revolution come from OECD countries. But looking at the future, Chinese emissions will grow so strongly that Chinese cumulative emission since 1900 will catch up with OECD emissions."

"So there will be three countries which are key, China, US and India. These countries are responsible for more than 50% of global emissions. Without these countries on board we have no chance whatsoever to solve the climate change problem. We are hopeful that the US position next year will be clearer."

Timing and urgency

"There is one issue I want to highlight which is the timing and the urgency. China will build in the next 8 years 800GW of capacity, 90% of which will be coal fired. This is equal to European build since the end of the second world war. Once they are built they will be operational for 60 years."

"One of the issues we will highlight in the November report is that OECD countries have an opportunity to move towards cleaner energy, as there is a large amount of retirement among power plants, half of which are coal fired."

"Even if all 27 countries in the EU achieve the stated objective of 20% CO2 reductions by 2020, then the cumulative emissions reduction for those 15 years to 2020 only equal 70% of one year of India and China emissions."

"So in perspective in the absence of China and India those efforts may not be successful."

What needs to be done?

"In order for us to reach emission targets to stabilise temperatures at a 2 degrees increase we need to reach emissions levels of 23Gt by 2030, down from 27Gt today. It is theoretically possible, but I will tell you what needs to be done and you can decide how feasible it is."

"First global carbon emissions need to peak earlier than ten years from now and come down. Second, on the demand side, global energy efficiency needs to improve 2.7% per year; in the last years it was less than 1% so we need to triple our efforts in energy efficiency."

"Third, in the electricity generation sector, 80 power plants which will be built up to 2012 have to be carbon free, either renewables, nuclear or fossil fuels with carbon capture and storage. We have made the assumption of a third for each sector."

"This would mean, for example, building 30 nuclear power plants per year worldwide, today we are building about 1.5. We have to increase wind by 50GW per year, last year it was about 20GW. We have to build about 40 fossil fuel plants with CCS, this is also a big challenge – these will be built mainly in China and India."

CCS

"Unfortunately there is a contradiction between the targets countries are talking about and their activities. CCS is one of the key technologies we will be pushing at the G8 summit. We need to bring the costs down, the key to that is of course research and development."

"However, when you look at the numbers, even though the leaders are talking about reducing CO2 by 50%, what they have reduced 50% in the last 20 years is the money they put in energy research and development."

"So there is a contradiction between what the targets are and where you put the money to reach those targets."

"From the technology angle we are still on the demonstration stage; in terms of regulation we have lots of questions in terms of having a regulatory framework for CCS lots of difficulties there; in terms of economics we know it will be very costly in the absence of a carbon price to go for a coal fired power plant with CCS."

"The positive side: there is greater recognition of what the world will look like in 20-30 years if fossil fuels continue to be par of our energy mix and CCS will have to be part of the solution."

"There was a meeting in Rome bringing oil producers and consumers together; it was one of the very few areas where there was a common understanding and underlined in the communiqué that CCS is a technology that needs to be pushed strongly."

"We are going to suggest that CCS becomes part of the clean development mechanism and we will see what comes of that."

Can reduction be achieved without CCS?

"The answer is definitely yes, but the questions what reductions and how much reductions. If we can push the efficiency button, renewables and nuclear, with the policies that are under consideration but not yet implemented, and there are countries which have not mandatory but voluntary targets."

"If those targets are reached, without major technology advances and without CCS, by 2030 we can expect a temperature increase of around 3 degrees [550ppm scenario]. So yes without CCS we can make substantial reductions, but if we want to go to a sustainable future we need CCS."

Implementation is very slow, is cap and trade good enough to drive the market?

"I believe the cap and trade system is a definitely a very important one, but it may not be an attractive option for many key players, China India and others. So our main task in Copenhagen is to provide a framework to get all these countries together; perhaps cap and trade could be a part of it. In the IEA work schedule to 2008 we are going to propose a hybrid framework so we can move, otherwise implementation is very very slow."

"We are also going to look at the supply aspect; looking at hundreds of fields worldwide on a field by field basis looking at how much oil could come onto the market in the years to come and in what conditions."

"We see two major problems, one is the significant decline rates, especially in non OPEC areas; and two there are some problems in terms of investments coming in a timely manner in the upstream sector on the production side."

"Therefore our work will highlight the challenges we are going to see and how the oil markets are going to evolve and what are the implications of our new look at the oil markets for our governments and everybody; we will tell you in November when the book comes out."

Conclusions

"There are three areas we have to push very strongly: efficiency; renewables particularly wind and hydro and biomass; and nuclear in those countries where it is accepted."

"CCS can play a very key role, our message in Hokkaido will be to the world leaders, if you are serious about climate change, if you really want to do something, consider to give a big push to CCS especially in China and India, support in financial terms and technology terms, and if or not you do this will your litmus test to how serious you are with tackling climate change."

From a talk given at the Global CO2 Summit in London on 12th June 2008
www.thecwcgroup.com

SaskPower seeks partners for CCS project - revises CCS plans in Saskatchewan

Saskatchewan Power Corporation intends in July to issue a request for proposals soliciting partners for its lignite-fuelled Boundary Dam integrated carbon capture and sequestration (ICCS) project

By our North America correspondent Stephen Salaff

www.saskpower.com/cleancoal

SaskPower's clean coal project manager Max Ball outlined what the company is looking for "For our Boundary Dam ICCS, we are inviting proposals from industry for post-combustion technology aimed at improved control and evaluation of project CO2 volumes."

"Within our former 2006-2007 CCS development at nearby Shand station in Estevan, southeastern Saskatchewan, we embodied pre-combustion "oxyfuel" methods to abet CO2 separation, and optimised our design around the station's electrical system, but ultimately we could not strike deals to market all CO2 intended for co-production," Ball continued.

"We now consider ourselves better positioned to obtain much-needed CO2 value. In fact, our former Shand design provides the technical and business understanding needed to develop and commercialise our current Boundary Dam ICCS project."

Ball listed the process equipment and services required for Boundary Dam in his May 8 presentation to the US Department of Energy's Seventh Annual Conference on Carbon Capture and Sequestration, Pittsburgh. "Vendor and technology for the CO2 system; detailed CO2 system design; process equipment supply contractors; and construction contractors," are needed, he said.

Regina Leader-Post headlined on May 27, "SaskPower's clean coal project lacks money from oil industry," reporting remarks by Ball's deputy manager at a Saskatchewan Mining Week breakfast meeting. "Oil industry buy-in is essential to the project… We don't think the Boundary Dam CCS project is economical right now unless we can receive some value for the CCS created for enhanced oil recovery."

Leader-Post commented that CO2 volumes planned for the former Shand CCS exceeded EOR demand, "further escalating the cost" of the predecessor project.

Ball elaborated, "Another key distinction between Boundary Dam and our former concept is today's planned smaller-scale retrofit of an existing station versus our former 'new-build' planning. We are now readying flexibly at smaller-scale to match project CO2 flow rates to CO2 market needs."

The sharp turn away from oxyfuel in SaskPower's new ICCS concept belies the spectacular claims in the utility's 2007 annual report, which gushed twice at distinct locations, "In 2007, SaskPower became the first utility in the world to complete a workable design for a large scale near-zero emission pulverized coal plant."

Ball justified in part, "The contractors and experts within our former Shand CCS effort knew no other equally advanced, commercially ready CCS designs."

Ball continued, "We call our design 'workable' because it embodied fuel and lifecycle cost assessments and all needed specifications for construction of our demonstration plant, and was supported by ample commercial contracts and offers for equipment. Our engineering work included a vast array of system design elements, process diagrams and project standards, and a full thermodynamic model."

In my opinion, SaskPower failed to assemble a database of large scale near-zero emissions pulverised coal plants and did not survey and rank for comparison counterpart utility CCS demonstrations.

Government support

SaskPower's February 27 Boundary Dam announcement was issued within minutes or hours of supporting Government of Canada pledges in Ottawa's 2008 budget statement.

For seasoned, contrasting commentary on SaskPower's perplexing start-stop CCS process, I contacted the Regina parliamentary opposition caucus.

"The background to Saskatchewan's CCS initiative indicates that we can surely find a deliberate, practical path to realise this promising environmental innovation," declared Lorne Calvert, an ordained Protestant minister and Saskatchewan's New Democratic Premier from February 2001-November 2007 and currently leader of the official opposition.

In the 1992-1998 NDP government, Calvert carried several portfolios including minister of health and minister for SaskPower.

The NDP is Saskatchewan's social democratic party. According to Canadian Encyclopedia, the NDP has governed provincially in most years since 1944, when they formed the first socialist government in North America.

"We now consider ourselves better positioned to obtain much-needed CO2 value." - Max Ball, SaskPower's clean coal project manager

Regional social democratic and social gospel initiatives have strongly influenced Canada, including their introduction of publicly-insured health care under Weyburn, a Saskatchewan-based ordained Protestant minister, and parliamentarian Tommy Douglas, designated in a 2004 Canadian Broadcasting Corporation opinion poll as "the greatest Canadian of all time."

The NDP of Canada has become a national "Kyoto Plus" advocate. With the May 4 passage of federal NDP leader Jack Layton's private member's bill "The Climate Change Accountability Act," Canada's House of Commons became an early proponent internationally of science-based targets for reducing greenhouse gas emissions by 80 percent from 1990 levels by 2050.

Canada's current minority Conservative Party government is much closer to the Saskatchewan Party, which won election in November 2007, than to the NDP.

Federal funding

Calvert visited Washington, New York and Paris in 2006 to promote Saskatchewan's hydrocarbon industry and to recruit science partners for CCS development at SaskPower.

US DOE co-funded SaskPower's CO2 monitoring and verification program in the Weyburn-Midale oilfield. Regina's Petroleum Technology Research Centre managed this program under the International Energy

Agency.

On 14 February 2006, Calvert and his industry and resources minister highlighted to Vice President Dick Cheney Saskatchewan's key role as a secure and reliable energy supplier to the United States. They stressed Saskatchewan's estimated 19 billion barrels of heavy oil, and welcomed US investment in new technologies to stimulate recovery of this resource.

Calvert claims that SaskPower today needs far firmer Boundary Dam project funding.

"We mistrust the federal Government's $240 million commitment for Boundary Dam. We believe this money is tied to unspecified actions Ottawa expects from Saskatchewan," said Calvert.

On April 2, Saskatchewan NDP Critic for the Crown Investments Corporation and SaskPower Kim Trew asked the Saskatchewan Party to illuminate federal Boundary Dam CCS project financing, "Where is the due diligence on this file? Where is the memorandum of understanding?," needled Trew.

Nuclear uncertainties

Calvert attributes CCS uncertainties at SaskPower partly to the utility's long-silent preparations for a publicly-controversial choice of nuclear electricity supply.

Canadian Broadcasting Corporation rumoured on May 9, "SaskPower nuclear reactor report stirs up northern debate," citing a shadowy "consultants report prepared for SaskPower and obtained by the CBC."

The Saskatchewan Party government's minister for the Crown Investments Corporation Ken Chevaldayoff told CBC's reporter, "the government will be working with the private sector."

Just as Ball persistently affirms the viability and merits of coal-based CO2 injection into nearby oilfields of southeastern Saskatchewan within a uranium resource province, Calvert also advocates for hydrocarbon energy and jobs in a heterogeneous party.

The former NDP deputy premier Duane Lingenfelter, in his subsequent capacity as vice president at Calgary-Alberta based petroleum firm Nexen Canada Ltd. began a campaign in 2005 for a Candu nuclear reactor in Saskatchewan.

Saskatoon Star-Phoenix reported on 26 October 2005 that Lingenfelter won qualified support from the leaders of the Saskatchewan Party and Saskatchewan Liberal Party.

The years-long internal arguments for nuclear electricity at SaskPower, which surfaced in their 2006 annual report (CCJ 3, p 7) peaked on June 17, with a Saskatoon communiqué from Bruce Power, a leading Canadian nuclear industry operator, partly owned by uranium miner Cameco Corporation of Saskatoon.

On June 27, Canadian Nuclear Safety Commission announced a forthcoming public hearing on Cameco's application to amend the construction license of its troubled Cigar Lake uranium mine in northern Saskatchewan.

Bruce Power's CEO appeared publicly on June 17 with Chevaldayoff and Lyle Stewart, Regina's Minister of Enterprise and Innovation. Stewart claimed, "Saskatchewan needs clean, affordable and reliable power to meet the future needs of a growing province. We would like to welcome Bruce Power to our province and look forward to the results of the 'Saskatchewan 2020' feasibility study, which we hope will lead to the creation of a nuclear option for our province."

"We mistrust the federal Government's $240 million commitment for Boundary Dam" - Lorne Calvert, former Saskatchewan Premier

NDP critic for Enterprise and Innovation Frank Quennell, attacked, "Without conducting any review of their own and after having promised to conduct such a review … the government has decided that they want a nuclear reactor and they want a privately owned nuclear reactor."

Calvert summarised to CCJ, "We believe that any steps toward nuclear technology introduction should be publicly debated. Saskatchewan cannot successfully implement two major new electricity-generation technologies simultaneously."

The HTC Solution to carbon emissions

Canadian company HTC Purenergy has developed a complete modular carbon management system that enables carbon dioxide to be captured, stored and transported to oil fields for enhanced oil recovery (EOR) and to other storage locations for sequestration

Jeff Allison, Senior Vice President, HTC Purenergy

It is getting so that you can't go a single day without watching, reading or hearing about global warming and climate change. The debate about this issue is becoming somewhat academic, in terms of its impact on industry.

As governments become convinced that there is an issue, and that the public mood favours action, new public policy becomes almost inevitable.

In Britain, policy will be based on the report by Sir Nicholas Stern, former chief economist at the World Bank, who warned of a $3.68[USD] trillion potential cost if greenhouse gases are not sharply curtailed. He refers to the shift to a "low carbon global economy" accomplished through taxation, regulation of emissions, and carbon emission trading. The report has been endorsed and accepted by U.K. government, who are now receiving guidance from none other than global warming crusader Al Gore.

With a Democrat-controlled Congress in Washington, and Britain leading the charge for emission reductions in the E.U., new regulation limiting emissions seem a matter of if not when. Companies that own, operate, and build large industrial plants, and especially coal-fired power plants, will be facing increasing pressure to sharply curtail CO2 emissions.

About HTC Purenergy

A Canadian company – HTC Purenergy has developed a complete carbon management system that enables carbon dioxide to be captured, stored and transported to oil fields for enhanced oil recovery (EOR) and to other storage locations for sequestration. When enhanced oil recovery is involved, economic returns can be made from CO2 at a cost per ton that makes CO2 capture and EOR an economic reality.

The U.S. Department of Energy has estimated that the potential for incremental oil production in the U.S. from EOR is 43 billion barrels. The current reported proven

CO2 capture process – technical description

1. The CO2 source flue gas from the emitter plant is transferred through the duct to the CCS Purenergy Plant. Prior to entering the plant, the flue gas is cooled to optimize the abruption process.
2. To enhance the movement of the flue-gas into the absorber tower, a blower is located in the flue gas duct.
3. The blower pushes the flue-gas into the bottom of the absorption tower and upward through the tower packing material. The solvent mixture of water, amines and other chemicals cascade down through the tower and typically absorbs 85-90% of the flue gas.
4. Once captured by the solvent the CO2 is transferred from the absorber to the top of the stripper tower, where the solvent is heated to enhance the release of CO2. The solvent containing the absorbed CO2 cascades down the stripper column through the packing material as steam and released CO2 flows upwards.
5. The CO2 is directed to the dehydration and compression stages and on to pipeline transportation.
6. The solvent flows from the bottom of the stripper to the re-boiler (heat-exchanger) where the solvent is cooled and the heat from this exchange is transferred to the steam to be used again in the stripper tower CO2 de-sorption process. The heat to operate the system is from an external source. (Normally emitter plant steam or a stand-alone steam system).
7. The "CO2-Lean" solvent solution leaves the boiler and is recycled back to the absorber tower, where it once again absorbs CO2.

reserves in the United States are just 28 billion barrels. So enhanced oil recovery is like discovering America's oil fields all over again. At just $47 (USD) dollars per barrel the potential oil to be recovered would be worth over two trillion dollars.

The market for Clean Coal Technology

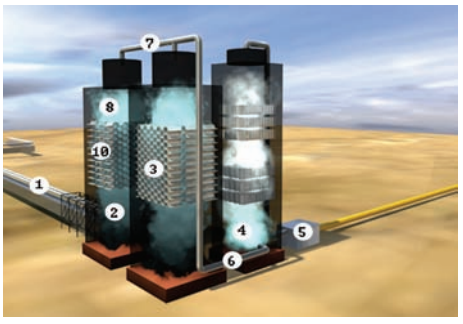
In the United States, coal-fired electrical generating plants account for over half (about 52%) of all of the electricity being generated today. In China, over 80% of electricity is generated by burning coal.

There is no crisis of supply or concern about reserves when it comes to coal. The U.S. is estimated to have a 250-300 year supply at current consumption rates. It is minable and secure within American borders, and the locations of reserves are well known.

Energy forecasters are now saying that by 2012, over 800 new coal-fired generating plants will come online in the United States, China, and India alone.

This would produce an estimated 2.7 billion tons of new CO2, an issue that needs to be dealt with. This newly produced CO2, however, has the potential of being a new commodity source that can be used and sequestered in enhanced oil recovery projects.

CO2 Capture



The world's first pre-engineered, modular design, CO2 capture system, factory built by HTC Purenergy. The system is truck transportable and is pre-built to site requirements of regional and global electricity producers, industrial processors and other large CO2 emitters.

The carbon dioxide that is generated in the combustion of coal can be captured from the flue gases that normally escape from smoke stacks and become greenhouse gases in our atmosphere.

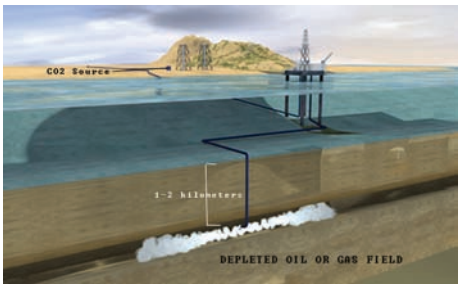
The Greenhouse Gas Technology Centre at the University of Regina is home to the International Test Centre (ITC) for CO2, as well as HTC Purenergy's product development center. This group is well known for their CO2 capture expertise and carbon management abilities.

Engineers at the centre have been developing new and best practices in carbon capture and sequestration for over a decade. Inside the ITC CO2 capture research centre is a natural gas turbine flue gas CO2 capture demonstration pilot plant, and a short distance away in Estevan Saskatchewan, a coal fired flue gas pre-commercial scale demonstration plant.

The combination of laboratory-controlled technology development and field-tested CO2 capture at a working plant is unique in the world, and gives the group an in depth knowledge of the CO2 capture process.

CO2 Sequestration

If the objective is simply to remove and dispose of the CO2, it can next be sequestered



CO2 sequestration in offshore saline aquifers or abandoned natural gas or oil fields

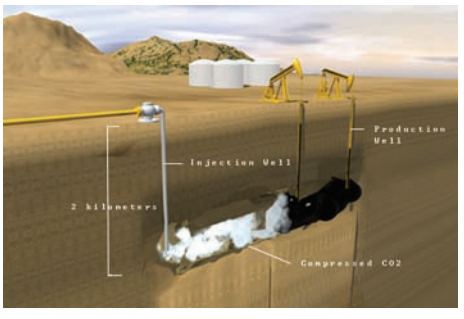
in deep underground geological formations including the spaces left by depleted oil and natural gas wells, naturally occurring saline aquifers, or in unmineable coal beds.
All of these formations are proven stable, in strictly controlled projects such as the offshore Sleipner field in Norway and the enhanced oil recovery fields in Weyburn, Canada.

Governments are just beginning to consider or implement limitations on CO2 emissions from large industrial emitters such as power plants.

Norway has applied a $50USD carbon tax. The governments of Australia and Canada are also providing matching grants to industry to encourage development of carbon dioxide reduction technologies.

So the world has begun to commoditise CO2, both as a corporate liability, and potentially as an asset for those companies that decide to react to their governments CO2 mitigation programs.

Enhanced Oil Recovery – CO2 as a profit centre?



When is CO2 really worth something measurable? When it is tied to another commodity - crude oil.

The cost to either retrofit a coal burning plant or build a new one with clean coal technology is substantial, and rising with material and labour costs. Seen as only a capital cost, this must be accounted for by raising the price of the power generated.

In a de-regulated electricity market, the potential price increases require consumer consensus. Therefore to improve the

Return on Investment of clean coal technology, the bridging solution is all about EOR.

EOR is a practice that has grown with the decline in conventional new oil reserves and the increase in the world price. These factors have caused oil producing companies to become very interested in so-called "mature" oil fields that had ceased to be economical to tap using conventional production technology.

The experience gained in the EOR fields to date in Canada suggests that injecting one ton of carbon dioxide will increase production by five to seven barrels of incremental additional oil. So at costs of capture of $25-40USD per tonne, CO2 usage for EOR becomes an investment, not just a cost.

Putting it all together

HTC is a public company founded with the objective of finding markets for its acquired and newly developed energy technologies, created and refined at the Greenhouse Gas Technology Centre in Regina.

The core of HTC's product offering is a proprietary suite of technologies which it has aggregated from different sources world-wide.

Among them is a CO2 modeling, design and simulation process it calls the HTC CCS Feed Engine, which essentially allows HTC to design the most efficient method of capturing CO2 for the customer, using their existing plant facilities.

In addition, it holds intellectual property rights to a number of product lines including designer solvents, packing materials and process flow designs that make the CO2 capture process more energy efficient.

Recently the company launched the world's first modular, pre-engineered CO2 Capture System, called the "Purenergy CCS™ CO2 Capture System"

The Purenergy CCS™ CO2 Capture System is a stand alone system that will capture CO2 from the flue gas exhaust of power plants, oil and gas processing facilities and large industrial emitters. The captured CO2 will be used for CO2 enhanced oil recovery or be stored geologically.

The Purenergy CCS™ CO2 Capture System is pre-engineered, pre-built and modularly constructed by HTC's strategic partners Pinnacle Industrial Services of Regina and NuVision Industries of Carseland Alberta Canada using technologies developed and validated for over 12 years at the University of Regina.

The system is capable of capturing up to 2,500 tons per day of CO2, and because of its modular design, will be able to be manufactured, shipped and erected at the emitter sight at a much lower cost than other systems that have to be custom built on site. If additional volumes of CO2 are required at a later point in time, then additional modules can be added.

HTC will feature a new Thermal Kinetics Optimization TKO™ process as a part of the Purenergy CCS™ CO2 Capture System.

The TKO process improves the capture process through heat recovery, thermal balancing and optimised process flow.

The primary advantage of this newly patented system is that it directly reduces the largest single cost of CO2 capture – the use of power plant steam – to a ratio of below 1 unit steam required to 1 unit CO2 captured.

"The new TKO process has shown to reduce steam consumption by up to 30%, which is a significant breakthrough in driving down the cost of CO2 capture compared to existing commercial technologies," said Lionel Kambeitz, HTC's Chairman & CEO.

"The Purenergy CCS™ CO2 Capture System is a stand alone system that will capture CO2 from the flue gas exhaust of power plants, oil and gas processing facilities and large industrial emitters."

"This new Capture System enhancement will make HTC's Purenergy CCS™ CO2 Capture System a world leader in energy efficiency and simplicity of design," he said.

HTC's EOR engineers also have access to the knowledge gained from the largest enhanced oil recovery project in the world using man made CO2, the Encana oil field near Weyburn, Saskatchewan.

Carbon dioxide has been injected into that field since 2001, resulting in the resurrection of what was once considered a nearly expired reserve that has been pumping oil since 1954.

HTC's "Team CO2" worked on the original design of the Weyburn project, as well as jointly developing the protocols that are currently being used world-wide for CO2 enhanced oil recovery.

Out of their EOR work, Team CO2 is helping to develop the CO2 sequestration risk assessment protocols that are currently being used by many groups.

Asked to comment on their current product offering, Lionel Kambeitz, HTC CEO, said, "We have pulled together the science of CO2 capture, the science of EOR and with the recent announcement of the University of Regina being named as the new Home of the 'Global Performance Assessment Centre' (GPAC), HTC will be able to offer a complete suite of CO2 capture, enhanced oil recovery, sequestration and risk assessment solutions. That's an exciting product offering that is not currently available from many companies in the world today."

Moving forward

Jeff Allison and Lionel Kambeitz are passionate, not just about the environmental significance of CO2 capture technology (a 700 MW clean coal power capture system would remove approximately as much CO2 from the air as taking about one and half to two million cars off the road), but also about the strong business case for combining CO2 capture with enhanced oil recovery.

"Commercial solutions are the catalyst to problem recognition and remedial action, " said Kambeitz, who came to the world of carbon solutions from an environmental entrepreneurial background.

"We believe we can translate this technology into a very profitable reality, and positively impact global warming at the same time."

The company is currently providing CO2 capture and sequestration engineering to large emitters, and has worked with a number of large EPC utility contractors who see the necessity of a defined carbon management strategy for new build carbon generating projects.

"We are doing business with companies who have decided that reducing emissions will be part of their strategic operating plan," said Kambeitz. "I'm exploring the potential for new partnerships, both as carbon management product providers and in terms of potential project development partners"

About the company

HTC is a public company traded on Canada's Canadian Venture Exchange with offices in Canada, Australia, and the United States.

Additional information on the company is available on their website at:

www.htcenergy.com

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How to win the PR war on CCS

Supporters of carbon capture and storage need to adopt American-style campaigning tactics to end the current stalemate over funding

By Geoff Beattie, Managing Director of Cohn & Wolfe Global Consultancy

The commercial is unmistakeably American, designed to tug at the heartstrings. An old couple wave from their porch; a female farmer tends her cattle; a group of industrial workers laugh and joke with each other at the end of the day.

It looks like an advert for a major retail brand or a bank that prides itself on having a human face. In fact, it's neither of those.

This thirty-second spot, currently running on all of the America's major networks, is designed to make viewers think again about a subject which has become hugely unpopular and unattractive: coal.

This expensive advertising campaign is being funded by an organisation called 'Americaspower.org', which in turn is supported by the American Coalition for Clean Coal Electricity (ACCCE).

The ACCCE is clearly determined to persuade large numbers of consumers that 'clean coal' is the solution to current concerns over energy security, cost (both of those issues have a much higher profile in the US than they do in Europe) AND global warming. And what do they mean by 'clean coal'? The commercial's honey-toned voiceover builds to this crescendo:

"We have to continue to advance new clean coal technologies to further reduce emissions, including the eventual capture and storage of CO2."

Mass appeal?

So there we have it: the first serious attempt to use mass communication techniques to educate millions of consumers about carbon capture and storage.

For those hooked by the television ad, there is much more information available on the Americaspower.org website, including news on various new CCS initiatives now underway in many US states.

Why bother? CCS is an issue currently pre-occupying some of the best minds in engineering, the energy business, and national government. But what's the point of trying to explain it to a mass consumer audience, which has a limited attention span for complex science?

The answer is reasonably simple: the ACCCE understands that it's going to be very difficult for the coal industry to maintain its 'licence to operate' in a carbon constrained world without CCS becoming an integral part of its business in the future.

But it's by no means certain that American (or European) society will welcome CCS with open arms.

This is a technology which is unproven on a large scale, and has many technical issues to address.

Once those are overcome, there will be legitimate questions of health and safety raised by environmental and grassroots citizen activist groups, which could be blown up considerably by the media.

And then there is the potential cost. Under any known scenario, CCS is going to be massively expensive to implement.

"The uncomfortable truth for European supporters of CCS is that they are not winning the propaganda battle which is necessary to secure significant public funding."

The coal industry would like the taxpayer to pick up a large part of the bill through large public subsidies for CCS. The alternative would be large rises in energy bills, which would probably be even more unpopular.

Battle for hearts and minds

The ACCCE has grasped a critical point. The debate over the viability of carbon capture and storage as a viable carbon abatement technology cannot be confined to the elites of academia, engineering, industry and government – all endlessly scratching their heads over the finer points of scientific and economic detail.

This is a battle for the hearts and minds of society at large. Without a serious attempt to explain CCS to millions of voters/consumers – and gain their support – it is very hard to see how the political will can be mustered to make CCS a reality.

If you think this is overly pessimistic, look at what's happened to the CCS debate in Europe in the first half of 2008. It's not good news.

"There is a compelling need for an intelligent, creative, public education campaign " - Geoff Beattie, Managing Director, Cohn & Wolfe Global Consultancy

The uncomfortable truth for European supporters of CCS is that they are not winning the propaganda battle which is necessary to secure significant public funding.

The way forward

Michael Jacobs, a senior UK government adviser on the environment, made headlines in April when he expressed public doubts about the EU's goal of having 12 CCS demonstration projects across Europe by 2015, and that there needed to be an 'incentive mechanism' in place to make it happen.

A successful 'incentive mechanism' would inevitably involve pumping billions of Euros in public money into CCS, not the 'tens of millions' which the British government is prepared to invest in its sole demonstration project.

Recent analysis from investment bank Climate Change Capital showed that each demonstration will need one BILLION Euros in capital expenditure, and that funding would have to come from the EU, because 'no single member state will deliver'.

At this moment in time, it's not clear that there is a way forward on CCS in Europe. In this stand-off between national governments and the EU over who pays for CCS, there is at least one clearly identifiable loser: the utilities who want to participate in these demonstration projects and make carbon capture and storage a commercial reality, especially for new coal-fired plants.

Taking the lead

Consequently, it's my view that Europe's leading utilities need to take the lead and consider the more populist approach of the ACCCE (and other US energy groups) if they are to make any progress on this vital issue.

There is a compelling need for an intelligent, creative, public education campaign which informs the public about the technology, provides factual reassurances over safety issues, and highlights the potential for making very deep cuts in carbon emissions.

If the British public (for example) can get their heads around the fact that there is enough geological capacity in the North Sea to store the UK's total CO2 emissions for many years to come, supporters of CCS might be able to persuade people that this is one solution which is 'absolutely critical', to quote Michael Jacobs again.

Branding

Creating a successful public campaign for carbon capture and storage is a challenging task, even for the best brand strategists. On the most basic level, it would be starting from a near-zero awareness base.

The evidence so far is that there is almost no understanding of – far less support for – CCS, either in the UK or the rest of Europe. Given the complexity of the technology, it will require a highly creative approach to explain how CO2 can be captured at power plants and buried safely in underground aquifers or old oil and gas fields.

'Safely' is the key word. As I said earlier, it's by no means certain that greater awareness of CCS will lead to widespread support.

New technologies tend to be subject to media scares of one kind or another. Think of the 'brain cancer' headlines which plagued the mobile phone industry a few years ago.

In the same way that local activists campaign against new cellular masts, it's easy to envisage alarm being whipped up over the transportation of CO2 through new pipelines, from power stations to storage points which might be hundreds of miles away.

It would be better to educate the media at local and national level now on CCS safety issues than wait for a pipeline planning application in a built-up area to generate scare stories which might spiral out of control.

Winning support

The campaign also needs to win the support of leading environmental groups, many of which are largely hesitant on CCS - preferring to concentrate on truly 'clean' technologies like wind or solar power.

Some, like Greenpeace, are actively hostile, labelling CCS a 'false solution'. The views of these popular activists have the potential to swing the public debate one way or the other.

"In this stand-off between national governments and the EU over who pays for CCS, there is at least one clearly identifiable loser: the utilities who want to participate in these demonstration projects and make carbon capture and storage a commercial reality, especially for new coal-fired plants." - Geoff Beattie, Managing Director, Cohn & Wolfe Global Consultancy

"The evidence so far is that there is almost no understanding of – far less support for – CCS, either in the UK or the rest of Europe."

Then there is the rapidly emerging power of digital media and social networks to influence large numbers of people. Why does a leading oil and gas company like Shell have a page on the social networking site, Facebook?

Because it understands that, if it wants to educate millions of younger consumers on complex energy issues, Facebook is one of the best places to do it.

Chevron Texaco has won plaudits for its digital game 'Energyville', which uses an entertaining, interactive format to increase understanding of the implications – scientific and economic – of different energy choices.

This kind of activity is probably very far from the minds of utility bosses who are keen to promote carbon capture and storage – but it shouldn't be!

A clear message

Most industry experts would agree that it's very hard to see how we can address both of our big energy challenges – securing new supplies, often from coal-fired stations, and making drastic cuts in greenhouse gas emissions – without carbon capture and storage being an integral part of our future energy mix.

The problem is that, unless CCS supporters, including our major utilities, start making the case for it loudly and clearly to the people of Europe, it's equally hard to see how it's ever going to become a reality.

About the author

Cohn & Wolfe is a global public relations agency serving key markets round the world. Part of the WPP group, Cohn & Wolfe works with some of the world's best known brands in the energy sector and beyond.

Last year, the agency launched an international Sustainability Practice, to service the growing markets in 'green branding', corporate sustainability and alternative energy.

Geoff Beattie is the MD of Cohn & Wolfe Global Consultancy, and heads up the agency's Sustainability Practice.

A former ITV journalist, Geoff has worked with a series of blue chip clients since moving into corporate communications a decade ago. Among those have been Nokia, Nortel Networks and Shell.

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How ready is 'capture ready'?

The renewed interest in investing in coal-fired power plants creates a dilemma for Government. Building new unabated fossil-fuelled power plants creates a risk of carbon lock-in, unless the plants can be guaranteed to be complemented with carbon capture and storage systems as soon as the technology becomes available

Dr Nils Markusson, Research Associate, School of Geosciences, Edinburgh University

The regulatory challenge, if new build of fossil plants is to go ahead, is to steer power plant investments towards de-carbonisation as far as possible.

Regulation

Two regulatory strategies are currently being discussed: emission limits and capture ready requirements. This article is based on a report from the Scottish Centre for Carbon Storage, focussing on capture readiness as a regulatory option.

The basic notion here is that preparations are made today to avoid a situation where it is impossible or prohibitively expensive to add a CCS system to a power plant tomorrow.

Capture readiness as a regulatory requirement has been included in the recently proposed EU regulatory framework for carbon capture and storage.

It has also been used in the UK over the last few years in permits granted to building new gas fuelled plants, but without much specification of what capture readiness really means, and it has not been applied in a uniform manner.

There is clearly a need to investigate what capture readiness can and should mean as a regulatory requirement. The Government is planning a consultation on capture readiness this year.

Regulating technology that has not been fully developed is never easy. If you regulate too early, there is too much uncertainty involved and the properties of the ready-to-use technology can not be predicted.

Regulations then risk being quickly outdated, and as a worst case counter-productive.

On the other hand, if you regulate too late, when the technology is already on the market, there is a risk that it has become entrenched - locked-in - and that it is then very difficult to change.

This is especially a risk for infrastructure technologies like power generation, where the technological components have co-evolved with the organisations, networks and institutions of the overall technological system.

Avoiding lock-in

It is therefore worth scrutinising proposals about standards for capture ready power plants to avoid locking us in to more unabated power plants, whilst keeping in mind the uncertainty inherent in trying to predict the future development of the technology.

Existing proposals for a capture readiness standard often require very little changes to be made. Typically, only to make sure that there is enough space on the site to build a capture plant, and enough space in the power plant to add the pipes between it and the capture plant. This is insufficient in several ways.

Reports show that when considering future retrofitting of capture plant, all aspects of the design of power plants are potentially affected. This includes all layout, all equipment, and even the choice of the basic conversion technology.

> **"Capture readiness is most often understood as affecting only the power plant, but a capture ready power plant without sufficient preparations for transport and storage, is pointless."**

A comprehensive study of the design options is therefore required. Also, adding new technology raises issues about the skills and expertise of power plant staff, and this shows the need also for organisational preparations.

Capture readiness is most often understood as affecting only the power plant, but a capture ready power plant without sufficient preparations for transport and storage, is pointless.

"The biggest challenge for regulators is perhaps to ensure that future retrofitting actually takes place." - Dr Nils Markusson, School of Geosciences, Edinburgh University

Preparations for transport and storage can include identification of routes for transport and sites for storage, securing planning permissions and ownership.

It is also a challenge to prepare for system integration. This is a technical matter, in terms of matching flow rates of the gas and availabilities of the assets involved, etc., but also a matter of planning for the coordination of the different actors that would have to be involved to manage the different parts of the overall system.

From the utility's point of view, capture readiness thus includes not just space on the site and layout in the plant.

Capture readiness is a comprehensive set of technical and organisational choices, regarding the power and capture plants, the downstream transport and storage components as well as system integration.

Making it happen

The biggest challenge for regulators is perhaps to ensure that future retrofitting actually takes place.

The history of the introduction of flue gas desulphurisation shows that it takes considerable political will and clout to impose abatement technology on the power indus-

try.

There is a considerable risk of granting permits to power plants today, but that CCS retrofitting plans get delayed or shelved later on.

"Current capture readiness requirements in gas plant permits are much too vague, and not very robust, especially regarding the forcing of future retrofitting."

The earliest full-chain, full-scale demonstrations planned may be operational as early as 2012. Retrofitting of CR plant could be mandated within three years of that date.

A robust capture readiness regulation could include a condition about revoking operating permits if CCS is not operational within this time frame. This would show a commitment from Government to ensure future CCS retrofitting.

Current capture readiness requirements in gas plant permits are much too vague, and not very robust, especially regarding the forcing of future retrofitting.

It is hoped that the impeding consultation will highlight these problems.

A basic problem of basing regulation on a technical standard will always remain however. As indicated above, specifying what capture readiness means can be complicated, especially as the technology is not yet mature.

This may put the regulator at a disadvantage vis-à-vis the utilities and developers who are likely to always know more about the technologies involved.

An emissions limit may have the advantage of requiring less technical specification and so be easier to implement. At the end of the day, either option will require a strong political will.

Further reading

How ready is 'capture ready'? - Preparing the UK power sector for carbon capture and storage, Markusson, N. and Haszeldine, S., 2008, Scottish Centre for Carbon Storage, independent report prepared for the WWF UK.

Evading Capture - Is the UK ready for Carbon Capture and Storage?, WWF UK, 2008.

Six Thousand Feet Under: burying the carbon problem, Policy Exchange, 2008.

CO2 capture ready plants, IEA GHG, 2007/4.

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New interactive database of CCS sites around the world

The Scottish Centre for Carbon Storage has developed a free interactive resource for researchers, industry and all interested in CCS which locates proposed CCS sites worldwide and details basic project information

Locating accurate and updated information on CCS sites is a time consuming and frequently frustrating exercise. Indeed, there can be conflicting information, company websites are out of date or adequate information simply does not exist in the public sphere.

In response, The Scottish Centre for Carbon Storage (SCCS) has developed an interactive, easy to use database for industry and individuals interested in the emerging CCS market. All full-chain and pilot project sites have been researched and are geographically located on a google map.

This google map is in place of a traditional database, and users can simply open the SCCS website and browse the interactive map. The website gives an easily accessible overview of planned and on-going projects around the world.

The site also gives more detailed information about specific projects. Users are able to locate a site, zoom in and obtain the name, location, company name(s), general project description, separation technology, injection amount and proposed start date.

The user can also click on relevant web links and instantly be connected to further websites about the particular project. The website can thus also serve as a starting point for the gathering of more detailed information about specific projects.

This site is designed as a resource for the emerging CCS industry and we invite industry to locate their relevant site on the google map and feed information into the SCCS, for inclusion on the map as their project progresses.

This map has already had a great deal of interest from industry and we are expecting this to grow.

This database is a product of funding from the Scottish Funding Council, and later in 2008 SCCS will also be launching a searchable database presented in a more traditional format.

Both these formats are designed to be easy to use and, more importantly, both these databases will be provided as a free resource.

The Scottish Centre for Carbon Storage Research is a partnership between the University of Edinburgh, Heriot-Watt University and the British Geological Survey. It is a UK centre of research excellence that combines world-class expertise in petroleum and hydrocarbon geoscience based on geology, geophysics, geo-engineering and subsurface fluid flow.

The aim of SCCS is to undertake primary and secondary research along the CCS chain and develop methods, processes, evaluation and de-risking technologies for carbon storage, to reduce CO2 in the atmosphere.

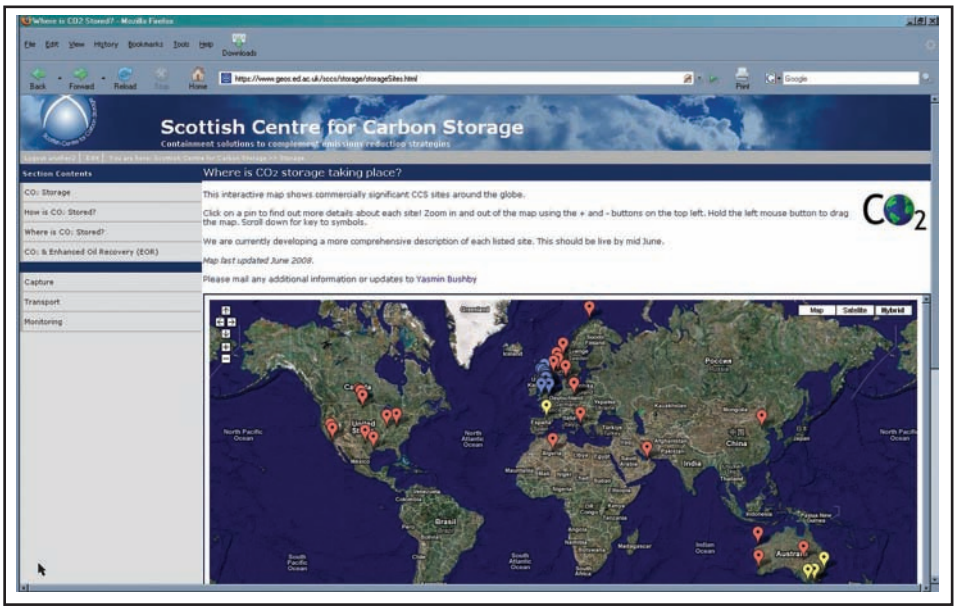

Figure 1 - Home page world view of all sites

Further information

For further information or to provide updates please visit:

www.geos.ed.ac.uk/sccs

or contact:

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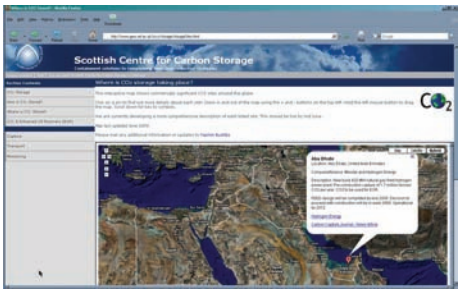


Figure 2 - Zoom in to regional locality

Fig 3. Access basic project information and link to the relevant website.

Carbon capture projects - leading news

DOE moves ahead with restructured FutureGen program - seeks to invest up to $1.3 billion

www.doe.gov

The U.S. Department of Energy (DOE) has released a Funding Opportunity Announcement (FOA) to solicit public support on the demonstration of multiple commercial-scale IGCC or other clean coal power plants with CCS.

The FOA outlines DOE's estimated investment, which would be set out in cooperative agreements or technology investment agreements awarded to commercial partners, and would range from $100 million - $600 million per project.

It also outlines the planned scope of the project, evaluation criteria, terms and conditions, and cost sharing requirements for public-private cooperation under FutureGen.

The DOE says its restructured approach, announced on January 30, 2008, aims to accelerate the near-term deployment of advanced clean coal technology by equipping new IGCC or other clean coal commercial power plants that generate at least 300 megawatts of power with CCS technology.

It also claims that the new approach of funding multiple projects is expected to at least double the amount of CO2 sequestered compared to the concept announced in 2003.

A draft FOA was released to provide an opportunity for public review and comment which closed on May 21, 2008. Input from interested parties was considered in the development of the final solicitation, which DOE releases on June 24, with selection of projects targeted for December 2008.

Subject to compliance with the National Environmental Policy Act, the draft FOA envisions commercial operation of IGCC or other clean coal power plants equipped with CCS technology to begin as soon as the plants are commissioned by December 31, 2015.

DOE anticipates $290 million during FY 2009 will be available for initial project selections under the FOA and anticipates an additional $1.01 billion in subsequent years.

DOE's draft FOA also requires that at least 50 percent of the energy output of the project's energy conversion system must be used to produce electricity; the project must produce at least 300 megawatts gross electricity output; and the project must be located in the United States.

In addition, the projects must be designed to achieve a goal of approximately 90 percent capture of carbon content in the syngas or flue gas and must achieve a minimum capture rate of 81 percent.

Projects must also remove at least 90 percent of the mercury emissions based on mercury content of the coal, at least 99 percent of the sulfur emissions based on sulfur content of the coal, and reduce nitrogen oxide and particulate emissions to very low levels.

To ensure safe and permanent sequestration, DOE requires a number of monitoring and verification performance requirements for FutureGen projects, including quantifying and assessing CO2 capture, transport, and storage aspects for the duration of a 3-5 year demonstration of a least one million metric tons of CO2 injected per year in a saline formation; monitoring the plume of injected CO2 for a minimum of two years after cessation of the injection demonstration, with the results of the monitoring reported to DOE; and developing information necessary to estimate costs of future CO2 management systems.

IEA releases Energy Technology Perspectives 2008

www.iea.org

The second edition of the IEA publication responds to the G8 call on the IEA for guidance on how to achieve a clean, clever and competitive energy future.

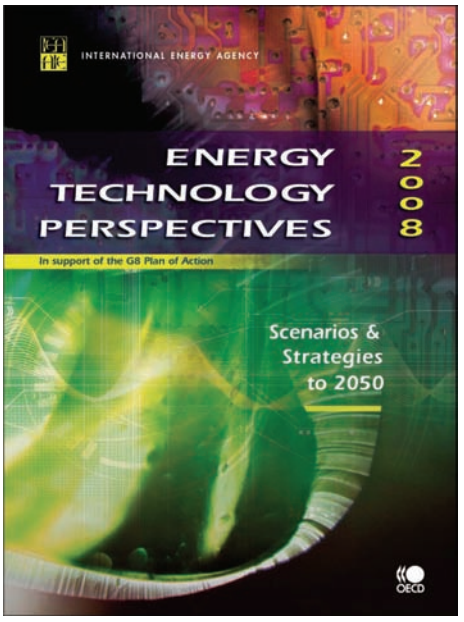
The document is built around three sets of global energy technology scenarios. These are a Baseline (business-as-usual Scenario), a range of ACT (Accelerated Technology) Scenarios showing how CO2 emissions could be brought back to current levels by 2050, and a set of BLUE Scenarios outlining how they could be reduced to 50% below current levels.

ETP 2008 also contains global roadmaps showing how each of 17 key advanced energy technologies would need to be developed and deployed to deliver the ACT or the BLUE outcomes.

The IEA says its analysis demonstrates that a more sustainable energy future is within our reach, and that technology is the key. Increased energy efficiency, CO2 capture and storage, renewables, and nuclear power will all be important, it says.

"We must act now if we are to unlock the potential of current and emerging technologies and reduce the dependency on fossil fuels with its consequent effects on energy security and the environment."

The BLUE Scenarios would need a virtual decarbonisation of the power sector.



IEA Energy Technology Perspectives 2008 - order the second edition online

Given the growing demand for electricity, this would mean that on average per year 35 coal and 20 gas-fired power plants would have to be fitted with CCS technology, between 2010 and 2050 at a cost of USD 1.5 billion each.

UK government announces CCS competition shortlist

www.berr.gov.uk

BP Alternative Energy International Limited, EON UK Plc, Peel Power Limited and Scottish Power Generation Limited were selected from nine contenders based on their responses to the pre-qualification questionnaire.

Discussions in the next phase of the competition between the Government and the four bidders will cover technical, commercial, contractual and financial issues.

"The progress we are making with the CCS demonstration competition and on developing a sound legislative and regulatory framework will help to deliver our ambition to see CCS ready for commercial deployment by 2020," said Energy Secretary John Hutton.

The government said the demonstration project continues to be on course to be operational by 2014.

The government has also published a consultation document - "Towards Carbon Capture and Storage" - that sets out the Government's view on CCS as a 'high potential' carbon abatement technology and asks for views on what more can be done to promote,

develop and deploy CCS in the UK, EU and globally.

The document, which will have a 12 week consultation period, outlines the proposed EU CCS Directive and invites consultation on:

• the principle of carbon capture readiness

• the regulation of CO2 storage

The consultation seeks views on the definition of carbon capture readiness (CCR) proposed in the EU draft Directive, including:

• what CCR means and to which combustion plants it should apply

• whether CCR should be addressed by developers when designing new combustion plant and be taken into account by the regulatory authorities when deciding whether or not to consent to such plant

• how any such requirement would be incorporated into the consenting process under section 36 of the Electricity Act 1989 in England and Wales

The Government said it will continue to process power station applications under Section 36 of the Electricity Act 1989. The applicants for the only coal-fired application, E.ON for Kingsnorth, have requested a decision be deferred until the consultation is complete.

Dr Jeff Chapman, Chief Executive of the Carbon Capture and Storage Association (CCSA), said he welcomed the Government's consultation and the announcement of a short list in the competition for the UK's first commercial scale CCS project.

However he said more projects were need and urged the government to work to ensure that there is a tranche of CCS demonstration plants in operation by 2013-2015, "which means sanctioning investment in these plants within the next year," he said.

Victoria government commits $127.4 million to CCS

www.vic.gov.au

Premier John Brumby of the State of Victoria in Australia announced a $110 million fund to establish new large-scale, pre-commercial CCS demonstration projects.

The Premier also committed $12.2 million to create Clean Coal Victoria in the Latrobe Valley, an organisation which aims to maximise the value of Victoria's brown coal resources.

A further $5.2 million will go towards investigating carbon storage sites in the Gippsland basin to better understand carbon storage potential through research and modelling of the region's geology.

The CCS demonstration project is part of the Brumby Government's second generation Energy Technology Innovation Strategy (ETIS) and will take the Government's total clean coal investment to over $244 million since 2002.

The aim of these investments is to assist power stations such as Loy Yang at Traralgon to reduce and ultimately eliminate their greenhouse gas emissions.

The additional $110 million builds on previous clean coal announcements for projects such as the Latrobe Valley Post Combustion Project being launched today at Loy Yang.

The Latrobe Valley Post Combustion Project was a joint collaboration between Loy Yang Power, International Power Hazelwood, government and researchers from the CO2CRC (including Monash and Melbourne Universities) and the CSIRO.

Minister for Energy and Resources, Peter Batchelor said the clean coal projects would involve working in partnership with industry and the Commonwealth to demonstrate carbon capture and storage technologies from power plants on an industrial scale.

"The first ETIS initiative attracted over $1.2 billion in investment and we would expect this next commitment to do even better in securing the future of the Latrobe Valley, including attracting significant overseas investment," he said.

Mr Batchelor said Clean Coal Victoria would be based in the Latrobe Valley and would focus on identifying future coal resources, planning for long-term brown coal use and rehabilitation.

Doosan Babcock launches £11M Scottish clean energy centre

Doosan Babcock has initiated a project to create an industry-leading Research and Development programme in Renfrew, Scotland.

Doosan Babcock facility in Renfrew with (Left to Right) Mike Farley, Doosan Babcock, Richard Dennis, Doosan Babcock, Jim Mather, MSP, Iain Millar, Doosan Babcock

The project is supported by an £11M R&D grant awarded by Scottish Enterprise to research clean energy technologies including power station boilers and associated environmental control technologies.

The centre will initially create over 100 jobs, and is projected to grow to 200 staff over the next few years.

The research supported by the R&D grant will develop innovative technologies to meet the global need for cleaner and more efficient power generation. Specific areas covered include:

- Supercritical and ultra supercritical boilers
- Environmental control technologies including carbon capture
- Advanced materials and fuels
- Asset management of power plant
- Exploratory research on novel technologies for future products

Lena Wilson, Chief Operating Officer of Scottish Enterprise, commented, "Doosan Babcock's research activity will play a vital role in developing leading technologies that will place Scotland at the forefront in this important sector and further consolidate the company's international operations in Scotland."

Policy Exchange says UK 'missing CCS opportunity'

www.policyexchange.org.uk

Think tank Policy Exchange argues that the UK is in a unique position to lead the world in developing CCS, but the reluctance shown by the current Government in backing the fledgling industry financially has seen our notional advantage slip.

The report suggests that with a proper incentive system the UK can not only go a long way towards solving its own emissions problems but also provide practical assistance to those in the developing world.

The UK is in an excellent position to develop a CCS industry, the report says, with world leading experts, an established engineering base and a selection of potential storage sites.

UK industries could build several clean gas and coal power plants, not just a single demonstration project, if some of the new income from the sale of carbon credits was used to subsidise the first developments of a new generation of cleaner power plants.

The UK Government should also ensure a new generation of fossil fuel power stations will be built ready to retrofit CCS when the technology becomes commercially viable. However, attempts to define how stations could be built ready to retrofit have been non-existent or clumsy, the report says.

"Without adequate safeguards there is a real danger that the UK will not be ready for CCS when it comes and we shall be locked into another generation of high emissions."

Policy Exchange proposes emissions standards on all new power stations that would eliminate coal without CCS and gradually tighten to ensure all power stations are fitted with CCS by 2020.

The report also suggests commercial incentives could be achieved by giving the carbon saved via CCS a carbon price of the same level given to other low carbon sources of energy, such as wind.

This could be done by any of three methods: 1) creating a Decarbonised Renewable Obligation Certificate band granting CCS the same level of support as onshore wind or offshore wind; 2) introducing a feed-in tariff to provide a guaranteed higher price for clean CCS electricity; 3) using the EU Emission Trading Scheme allowances to reward CO2 stored.

"Without such price support, the Development and Deployment of CCS in the UK is not commercially viable, and cannot exist in the UK electricity market system."

Joint author of the report, Professor Stuart Haszeldine of the University of Edinburgh, said, "The climate message is clear: the UK and the World cannot continue to burn fossil fuels and release CO2. Either we can stop burning, or we can fit CCS; neither is happening."

"CCS is planned to become part of a multi-billion pound world market. Now is the time to be practical: to encourage and join up these new businesses in the UK. But the industry is currently way ahead of Government."

"An electricity market is needed which enables this new industry to see a fair price for decarbonised electricity, take risks, grow rapidly, and build not one, but a suite of clean power plants in the UK."

"If Government takes heed and acts now we can ensure that CCS does not become just another missed UK opportunity. The UK was first to industrialise and now can be first to decarbonise."

Vattenfall to build CCS demonstration plant in Jänschwalde

www.vattenfall.com/ccs

Vattenfall will build a demonstration plant for CCS at one of the 500 MW blocks of the conventional lignite power plant Jänschwalde in the State of Brandenburg, Germany.

The plant will be in full-scale operation no later than 2015, the company said.

The Jänschwalde lignite power plant consists of six 500 MW blocks. For the demonstration plant, one of the blocks, consisting of two boilers, will be equipped with CCS.

One boiler will be newly built with Oxy-fuel technology; another will be retrofitted with post-combustion technology.

Vattenfall's Schwarze Pumpe 30 MW Oxy-fuel pilot plant will be opened summer 2008. The company said a demonstration plant on an industrial scale was the consistent next step.

Vattenfall's Jänschwalde lignite power plant in the State of Brandenburg, Germany

Vattenfall is cooperating with Gaz de France Production and Exploration in order to test a technology for storing the captured CO2 in a depleted natural gas field in the Altmark.

WRI report says CCS needs 'major policy intervention'

www.wri.org

A World Resources Institute (WRI) analysis of the challenges that investors would face when deploying CCS technologies says that until government policies support large-scale demonstrations it is unlikely that CCS will be able to fulfill its potential in combating climate change.

The WRI report is called "Capturing King Coal: Deploying Carbon Capture and Storage Systems in the U.S. at Scale".

Using CCS technologies to inject CO2 from coal combustion into underground formations will require solutions to a host of technical, regulatory and financial challenges, according to the analysis.

"Unless we can put a price on carbon and push these new technologies into the market with additional incentives CCS won't arrive in time," said Dr. Jonathan Pershing, director of WRI's climate, energy and pollution program.

"We need to deploy the technology as quickly as possible - and that in turn means paying for large scale demonstrations and infrastructure, and creating a regulatory environment that provides public confidence in the safety and environmental integrity of the technology."

The report points to the need for rapid progress in the technological, regulatory, financial and policy fronts for CCS to become a solution to climate change.

Unique financial and investment challenges will also have to be overcome in order to create a CCS infrastructure in the U.S., says the report. In addition to the large capital investment that will be required, a more immediate concern is that construction firms, already facing rising costs, may be reluctant to extend performance guarantees to coal plants built with untested technology.

WRI is also working on the regulatory front by developing a set of guidelines for CCS to be released 3Q 2008. This effort is taking place in the context of rapid changes in the policy arena, WRI says, as the U.S. EPA has initiated a process to develop regulations governing the underground injection of CO2 for sequestration.

The WRI guideline project provides a transparent forum for communication of best practices and regulatory recommendations for carbon capture, CO2 transportation and underground sequestration among a wide range of stakeholders.

Japanese companies partner for CCS research

www.tepco.co.jp

24 Japanese power and energy-related companies have jointly launched a research company to develop carbon capture and storage technologies.

The 24 companies, who will each invest 3 million yen in the new firm, include Tokyo Electric Power, Electric Power Development Co., and Japan's other regional power utilities and seven oil-related companies, such as Nippon Oil Corp., as well as civil engineering firms, steelmakers and chemicals firms.

The new company, Japan CCS Co., said that it is hoping to win research projects from the Japanese Ministry of Economy, Trade and Industry and to select candidate locations for implementations of CCS technologies by the March end of this fiscal year.

It also said it aims to launch large-scale experiments as early as possible.

The Japanese government is targeting an annual reduction of 100 million tons in carbon dioxide emissions through CCS technologies by 2020.

The new firm aims to combine the CCS technologies of the participating companies to overcome technological difficulties for commercialisation.

Policy, company and regulation news

UK launch for Mitsubishi Power Systems Europe

www.mhi.co.jp

Mitsubishi Power Systems Europe (MPSE) has launched its European Headquarters in London to expand its presence in Europe, North Africa and the Gulf.

MPSE, the European subsidiary of Mitsubishi Heavy Industries (MHI), is due to sign two long term service agreements for the maintenance of Gas Turbine Combined Cycle plants in Kent and Hull.

The company says it has created the office in order to tap into fast growing demand for power generation equipment to support both new build plants and improvements to existing plants across the UK and continental Europe, in both conventional and renewable power generation.

The company will focus on securing contracts to support construction of new thermal power generation plants. It will also provide ongoing management and maintenance services and promote expansion of the renewable energy business, which includes wind turbines and photovoltaic power generation systems.

MPSE is also providing marketing, project management and post-construction maintenance services as part of major MHI contracts in the Netherlands and Turkey.

EESTECH and Santos partner on CCS

www.eestechinc.com

EESTECH and HTC Purenergy have entered into an agreement with Santos to explore business opportunities for CCS and enhanced oil recovery using CO2 from its gas fields.

EESTECH owns the exclusive Asia-Pacific rights to the HTC Purenergy Carbon Capture system, which was developed over the past fifteen years at the International Test Centre for Carbon Capture at the University of Regina, Saskatchewan, Canada.

The system can capture up to 1000 tonnes of CO2 per day from the flue gas stream of coal and gas fired power stations and can be retrofitted to existing plant.

Santos will look to use the CO2 for its enhanced oil recovery activities in the Cooper Basin.

It will also complement current development activities focusing on the Moomba Carbon Storage Project which has the long-term objective of establishing a large-scale carbon storage hub at Moomba, which could eventually store up to 20 million tonnes of carbon dioxide per year and 1 billion tonnes over the life of the project.

GE and Schlumberger work together on IGCC CCS

www.ge.com/energy

www.slb.com

GE Energy has signed a carbon sequestration alliance agreement with Schlumberger Carbon Services to accelerate the use of IGCC technology.

GE said the agreement will help both companies to offer customers a cost effective solution that will provide a complete answer for IGCC with CCS that can be readily implemented under the proper regulatory framework.

GE's IGCC technology will be partnered with Schlumberger's services for assessing, selecting and qualifying potential geological carbon storage sites.

GE said clear regulations and policies are needed for large-scale implementation. It said it can offer IGCC plants with CCS from the beginning or designed to be retrofitted when clear policy and regulations create an appropriate environment.

Its involvement with IGCC includes supplying a gas turbine for Cool Water, the first IGCC demonstration project, which came on line in 1984. Its IGCC technology also has operated at the TECO Polk I station in Florida for more than 12 years.

The company currently offers commercial scale IGCC plant designs that offer emissions approaching those of advanced natural gas combined cycle performance for SOx, NOx and Particulate Matter.

Several utilities in the eastern U.S., including Duke Energy, AEP and Tenaska, are currently working on proposed IGCC projects using GE's technology.

Spectra Energy, NETL collaborate on CCS in Canada

www.undeerc.org

www.spectraenergy.com

U.S. Senator Byron Dorgan, the U.S. Department of Energy National Energy Technology Laboratory (NETL), Spectra Energy Transmission, and the Energy & Environmental Research Center (EERC) are collaborating on a large-scale CCS project near Spectra Energy's existing Fort Nelson natural gas plant in northeastern British Columbia, Canada.

The project is in its initial feasibility phase with initial injections are scheduled to begin in late 2011. It is part of EERC's Plains CO2 Reduction (PCOR) Partnership.

It aims to determine whether deep underground saline reservoirs are appropriate for CCS. Tests and analysis will evaluate geological, technical, and economic feasibility of using the technology to manage greenhouse gases.

This demonstration is one of two projects the PCOR Partnership will lead in its Phase III efforts (during 2007–2017).

The PCOR Partnership also includes the British Columbia (BC) provincial government, which has directly contributed a $3.4 million grant toward the project as previously announced.

The EERC is working with PCOR Partnership members, including NETL, Spectra Energy, and BC, to expedite the deployment of CO2 sequestration technologies in the region.

Spectra Energy will drill two test wells to determine whether the surrounding geology is suitable for the permanent storage of CO2 and hydrogen sulfide (H2S).

These compounds are present in the raw natural gas produced in the area and removed during processing at the company's Fort Nelson gas plant.

If proven feasible, the EERC will design and implement a monitoring program for the injection phase of the project to ensure the safety of the environment.

Spectra Energy says it has been using CCS technology for more than a decade. Currently, four of Spectra Energy's gas processing facilities in British Columbia and four in Alberta are equipped with CCS technology. Together, these facilities remove about 200,000 tonnes of greenhouse gases from the atmosphere each year.

Deutsche Bank revises carbon price forecast

www.db.com

Deutsche Bank has forecast a 2008 EU Emission Allowance (EUA) price of €40 per tonne, up from €35.

The price is based on Deutsche Bank's long term gas and coal price estimates, and is the EUA price required to ensure the successful acceleration of the CCS programme, it said.

The research is authored by Mark C Lewis, Managing Director of Global Carbon Research at Deutsche Bank, who stated that the new price forecast reflects a need for 60GW of Combined Cycle Gas Turbine CCGT capacity by 2020.

Deutsche Bank believes that insufficient fuel switching capacity across the EU currently means the required level of internal abatement within the ETS cannot be achieved at a price of below €40/t over phase

2 and that therefore installations will need to a use a disproportionately large share of their total allowed carbon credits over 2008-1012, thus giving themselves time to build the new capacity reserves to enable greater fuel switching over 2013-20.

Lewis, however, also warns of potential price spikes during phase 2, "Because borrowing from future periods is not allowed, there is a non trivial risk of a significant spike in EUA price towards the end of phase 2. Prices of €100/t or more are possible," he said.

FutureGen Mattoon site would have funding under Obama

www.jg-tc.com

The Journal Gazette reports that U.S. Senator Dick Durbin of Illinois said federal money could be available for the FutureGen project under the next administration, and that Barack Obama would support the original Mattoon site.

John McCain has not said whether he supports further funding or the Illinois site.

Some Members of Congress have recently called for the release of documents relating the decision to scrap the project and have talked about issuing subpoenas if the authorities are not more cooperative.

Tories support mandatory CCS for coal-fired power stations

www.conservatives.com

David Cameron, leader of the UK Conservative Party, announced that he would support an emissions performance standard that would mean the carbon emissions rate of all electricity generated in the UK could not be any higher than that generated in a modern gas plant.

He also pledged that a Conservative Government would take money from the auctioned EU Emissions Trading Scheme credits and use it to fund at least three CCS demonstration projects over the next five to ten years.

However the Association of Electricity Producers (AEP) said that the plan would be impossible for the electricity producers to implement.

"The clear commitment for funding CCS demonstration projects is welcome, but making CCS mandatory before it has been demonstrated successfully is the wrong approach," said David Porter, Chief Executive of the Association of Electricity Producers.

"Developing a regulatory framework and the infrastructure for capturing and storing carbon will take time. Meanwhile, coal-fired power stations still have a significant role to play in maintaining security of electricity supply," he said.

The Tories will also set up a panel of experts to advise on how to move matters forward and make Britain one of the world's test-beds for CCS. "We could be global pioneers in both pre- and post-combustion technologies and export our expertise worldwide," said Mr Cameron.

"By funding three demonstration projects, we could have the beginning of a CCS pipeline system which future British - and European - companies could plug into," he said. "And by sending out the clearest market signal yet to UK power developers that their product must be clean, we can propel further innovation within our energy sector. So harnessing the power of markets and innovation by giving businesses a secure framework for investment."

"There is much in the Conservatives' statement that the electricity generating industry can agree with", said Mr Porter. "The industry is committed to responding to the challenge of climate change and pioneering innovative technologies. Small-scale generation, wave and tidal as well as nuclear and carbon capture and storage – CCS – all have a role to play in our future energy mix. We are pleased that the Conservatives recognise this."

IEA CCS regulators' network - first meeting

To help inform the development of legal and regulatory frameworks for CCS, on 13-14 May, 2008, the International Energy Agency (IEA) launched the International CCS Regulators' Network together with the Carbon Sequestration Leadership Forum (CSLF) and University College London (UCL)

www.iea.org
www.ucl.ac.uk/cclp

The Network will meet regularly to provide updates and exchange views on specific legal, regulatory, and policy issues associated with the expansion of CCS worldwide.

Day One

The IEA's Executive Director Mr. Nobuo Tanaka opened the workshop by explaining global energy and environmental challenges with an urgent call to action.

Citing the IEA's analysis from its recently released Energy Technology Perspectives 2008 publication, Mr. Tanaka called attention to the need for an energy revolution to achieve climate change stabilisation goals.

Fig. 1 highlights the rapid growth in the use of a portfolio of energy technologies that will be required to achieve international climate goals by 2050.

Mr. Tanaka also stressed the important role that CCS must play in any future climate change mitigation scenario, saying that the IEA expects it to deliver 20% of emissions reductions by 2050.

Day Two

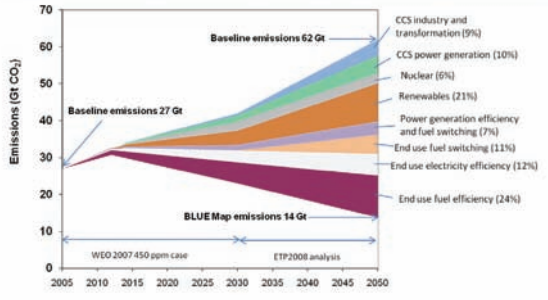
Day Two was devoted to a series of three panels exploring legal issues and developments in more detail.

The first panel explored the relationship between CCS and GHG regulatory efforts, and included a detailed technical presentation on CO2 monitoring and site selection technologies and methods, followed by discussions of proposed incentive and mandatory schemes in the United States and some thoughts about legal issues from a law firm's perspective.

Panel two included presentations on property rights issues associated with CO2 storage, with a particular focus on the peculiarities of the United States property law.

Finally, the third panel includes CO2 transportation issues and long-term liability models and current status in this important area.

Figure 1. A New Energy Revolution: Cutting Energy-Related CO_2 Emissions



The mix of technologies needed to reduce CO2 emissions to achieve stabilisation at 2 degrees
Source: Energy Technology Perspectives, OECD/IEA, Paris (2008)

Brainstorming Session

The final session was chaired by IEA's Tom

Kerr and UCL's Ian Havercroft. They explained that the goals for the session were to evaluate the value of the CCS Regulators' Network, and to decide future priorities and activities.

They also laid out a proposed list of activities for the coming year, including enhancing the UCL website to include up-to-date legal developments and analysis, a series of web conferences that go much deeper on specific legal/regulatory topics, documentation of case studies and another Network meeting sometime in 2009.

The following summary captures the main points of discussion during the brainstorming that followed.

• The Network is filling an important gap by focusing on detailed technical/regulatory issues that benefit from increased international collaboration. The IEA should not dilute this focus by including broader CCS issues like tracking demonstration projects or surveying public opinions about CCS.

• The legal and regulatory challenges faced by regions, countries and even sub-national jurisdictions are not uniform and a "one size fits all" approach will fail to account for differences in political traditions, regulatory regimes, surface and subsurface rights, and socio-economic development.

• The major hurdle for CCS is locating adequate leadership and financing for the first round of up to 20 demonstration projects by 2020. While this is critical, it should be done outside of the Network. Tom Kerr assured that the IEA will call attention to this urgent need with its G8 Recommendations in July as well as through a possible "CCS Summit" later this year.

• The Network should be expanded to include new members, most importantly government representatives from rapidly growing regions like China, India, Russia and other emerging economies to help them think through the needs and models for CCS policy and regulation. A representative from India asked for assistance in presenting appropriate policies to the government.

• The IEA GHG, and the Carbon Sequestration Leadership Forum (CSLF), another meeting co-sponsor, are already operating international networks that share technical information, best practices, and demonstration project developments. It was felt that this Network should not duplicate these efforts, and instead should attempt to liaise with other existing initiatives and leverage these resources where possible.

• In terms of specific topics for future web conferences, site selection methodologies, CO2 transport and storage health & safety issues, liability frameworks, particularly for the long-term and formal public consultation methods and tools (as opposed to public opinion taking) were raised. Some of these areas are being covered by IEAGHG (as mentioned above), and the close cooperation between IEAGHG's more technical programme and this network's regulatory programme should ensure that work is not duplicated and information is shared and used most efficiently.

• Some felt that the IEA and/or UCL should create an "E-room" on their websites to allow posting of questions and answers and other discussion around specific points.

• There was some discussion about the need to harmonize international guidelines, e.g., for monitoring & verification of CO2 retention at storage sites. Some felt the IEA and the Network should strive to achieve harmonization and best practices; others felt that this was an impossible task and would limit the Network's effectiveness. The IEA will attempt to capture case studies and document them rather than to focus primarily on best practices or harmonization.

Next Steps

The IEA will continue to communicate with the full Network, including those who attended the launch meeting and several others who have asked to be included in future web conferences and events.

Within the next month, the IEA will send a proposed calendar of events and begin soliciting speakers and participants. Network members are also strongly encouraged to engage their counterparts in their own networks to participate where appropriate; the Network will only be as strong as its members.

For more information about the Regulators' Network or the IEA's CCS work generally, please contact:

Thomas Kerr
thomas.kerr@iea.org
or visit the IEA website at:
iea.org/Textbase/subject-queries/ccs_legal.asp

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- The Canadian province of Saskatchewan has shifted policy from carbon capture and storage to nuclear power, according to our North American correspondents Stephen Salaff and Mazin Saba. >>more
Hillary Clinton - would fund 10 CCS large projects
- If elected as US president, Hillary Clinton would "put immediate funding towards 10 large-scale carbon capture and storage projects."... >>more
Australia moves on CCS
- Professor Ross Garnault, an economist who is drawing up a climate change strategy for the new Australian government, has said that coal fired power has no future in Australia without CCS... >>more
Peabody Energy joins China's 'GreenGen' project
- Peabody Energy has became the only non-Chinese equity partner in GreenGen, the first near-zero emissions coal-fueled power plant with carbon capture and storage under development in China. >>more
AEA appointed to manage Chinese CCS program
- AEA Technology, a leading environment and energy consultancy, has been appointed to run the first 18-month phase of the UK-China Near Zero Emissions Coal (NZEC) initiative. >>more
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Capture Technology

Sargas and Fortum complete CO2 capture test

www.sargas.no
www.fortum.com

Scandinavian power group Fortum and Norwegian clean energy company Sargas have published the final result of their work on a experimental pilot project for capturing CO2 from coal power production at the Värtaverket plant in Stockholm.

Sargas' Värtaverket plant in Stockholm

The result of the experiment gave an average capture rate of over 95 per cent. The results confirm that a functional cleansing technique is now available to be taken into use, said the company.

Sargas' Ultra Low Emissions technology was tested between November 2007 and February 2008, in cooperation with Fortum and others, including the Swedish Royal Institute of Technology (KTH), Massachusetts Institute of Technology (MIT) and Siemens.

The Institute for Energy Technology (IFE) at Kjeller assisted with the control of methods and results.

A scaled-down capture component was built at Værtan, beside one of the plant's large coal-fired boilers. Exhaust gas was then ducted under pressure from the boiler into a cleansing column, which used similar technology to that used worldwide in applications that include ammonia production.

This pressurised solution consistently captured over 95 per cent of the CO2 content of the exhaust gas for the whole test period.

Atlantic Hydrogen tests carbon removal technology

www.atlantichydrogen.com

Atlantic Hydrogen Inc. (AHI) has initiated a new project to design and build a CarbonSaver demonstration plant to produce hydrogen-enriched natural gas (HENG) while reducing CO2 emissions.

CarbonSaver technology involves subjecting natural gas to an electrical charge, causing the carbon and the hydrogen molecules to split.

The hydrogen is then mixed back with natural gas to produce HENG with around 20% hydrogen, reducing CO2 emissions when it is burned, while the carbon is removed as a solid.

The CarbonSaver Demonstration Project, which will be located in Fredericton, New Brunswick, is expected to take three years to complete, starting in the summer of 2008.

It will involve building a plant capable of generating HENG at volumes greater than 1,000 cubic metres per hour and at pressures between 50 and 150 psi.

The company has secured financing from the EnCana Environmental Innovation Fund and the New Brunswick Climate Change Action Fund. The combined funding from these two sources will account for roughly half of the total project costs. The company is working on funding from other sources that, if successful, would lead to an expanded scope of the project.

Basin Electric and Powerspan complete feasibility study

www.basinelectric.com
www.powerspan.com

A feasibility study for adding a carbon capture unit at Basin Electric's Antelope Valley Station (AVS) has been completed, and the study results were very positive, said the company.

Basin Electric's Antelope Valley Station

The demonstration project would capture about one million tons of CO2 from a 120-megawatt slipstream from Unit 1 at AVS. The captured carbon dioxide would then be fed into an existing CO2 compression and pipeline system owned by Dakota Gasification Company (DGC), which has been in operation since 2000.

The next step is a FEED (Front-End Engineering and Design), with construction of the CO2 capture system scheduled to move forward late 2009, with an aim to be operational in 2012.

Powerspan's CO2 capture process, called ECO2, is a post-combustion, regenerative process, which uses an ammonia-based solution to capture CO2 from the flue gas of a power plant.

Once the CO2 is captured, the ammonia-based solution is regenerated to release CO2 and ammonia. The ammonia is recovered and sent back to the scrubbing process.

Ron Harper, Basin Electric CEO and general manager, stressed the need for the federal government to support the demonstration project.

"We're looking at a price tag of $200-$300 million for this project. If we're going to revolutionise the way coal is used in the future, it's imperative that the federal government help meet this challenge and share in the risk."

Carbon Sciences in joint research project with Finnish university

www.carbonsciences.com

Carbon Sciences, the developer of a technology to transform CO2 into useful products, has signed a joint research agreement with Abo University, Finland.

Professor Ron Zevenhoven, Abo University, Finland

The research team at Abo University, led by Professor Ron Zevenhoven, is a leader in carbon transformation research.

Carbon transformation, or carbon mineralisation, is a process in which CO2 is combined with rock minerals to produce a solid carbonate. Due to the unique geology of Finland, underground sequestration of CO2 is not an economically viable option. Therefore, an important option for CO2 mitigation in Finland is carbon transformation.

Carbon Sciences is developing a proprietary process to transform CO2 emissions into a high value chemical compound, PCC, currently used in the manufacture of paper, pharmaceuticals and plastics. The company says that the process will be carbon neutral, use less energy and result in a lower cost product than existing methods of production.

Surface Deformation Monitoring (SDM) Advantage for CCS MMV Activities

As pilot injections ramp up to a million tons a year or more, we have to start thinking about how we can cost effectively monitor very large projects for the long term

Glenn R. McColpin, Director of Business Development, Long Term Monitoring, Pinnacle Technologies

Over the past few years there have been a number of small scale CCS pilot projects globally.

Million ton per year injections have been largely limited to commercial projects like Statoil's Sleipner and BP's InSallah. In reality the larger commercial projects may be injecting only a fraction of the CO2 that will be generated from large coal fired power plants.

I have seen numbers as high as 5-7 million tons a year quoted for projects on the drawing board.

As you start to consider the enormity of the storage issue and the length of time that these projects must be monitored, it becomes apparent that some of the MMV techniques used in the early pilot phases for site characterization will just not be cost effective when scaled up.

Many of these techniques are also not going to provide timely alerts if there is a leakage situation.

For those reasons, it may be wise to consider Surface Deformation Monitoring (SDM) techniques which have the ability to offer near-real-time results and a very low cost per square mile.

What is Surface Deformation Monitoring (SDM)?

SDM is the process of measuring ground dilation and/or subsidence caused by the injection or extraction of fluids and gases.

Common measurement techniques include the use of tiltmeters, Differential GPS (DGPS) and Interferometric Synthetic Aperture Radar (InSAR).

As applied to Carbon Capture and Storage (CCS) activities, SDM can be used to monitor the extent of the CO2 plume, fracture development that can affect caprock integrity and fluid movement out of zone.

These techniques have been used for more than a decade to monitor oil & gas activities, drill cutting and waste water injections, steam floods and other injection activities.

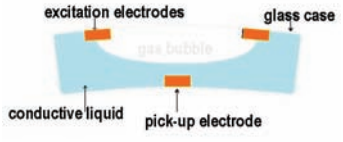

Figure 1 – Electrolytic tilt sensor

Technologies Described

A tiltmeter is basically a highly sensitive carpenter's level. The essence of the sensor is a glass vial partially filled with conductive fluid.

Electrodes penetrate the vial which measure resistance. As the fluid moves in the vial due to a tilt in the earth's crust, the resistance changes across the electrodes and those readings are converted to a tilt measurement.

These instruments are capable of measuring movements down to 1 nanoradian. That's the equivalent of lifting one end of a beam from New York to San Francisco ¼ of an inch and being able to measure the angle that's created.

Earth tides caused by the gravitational pull of the Sun and moon on the earth's crust are large signals for these instruments. Figure 2 illustrates the tool sensitivity by showing two earthquakes on different continents picked up by tilt instruments in Texas.

Tiltmeters can be deployed in wellbores where they are used to measure fracture height downhole or in surface arrays where they are used to map fluid fronts and fracture azimuth.

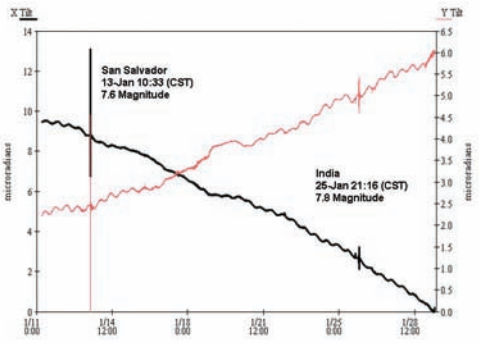

Figure 2 – Tilt sensitivity showing earthquakes on two continents

The readings are normally taken every few minutes and data from a surface array is processed and run through a geomechanical inversion model to estimate what reservoir level activity must have caused that particular surface deformation.

One great characteristic of tilt is that the shallower the fluid injection, the larger the signal. This allows tiltmeters to quickly identify out of zone fluid migration.

The second SDM technology that I'll describe is InSAR. In a previous Carbon Capture Journal article, Mark Raistrick commented that MMV tools will need to have

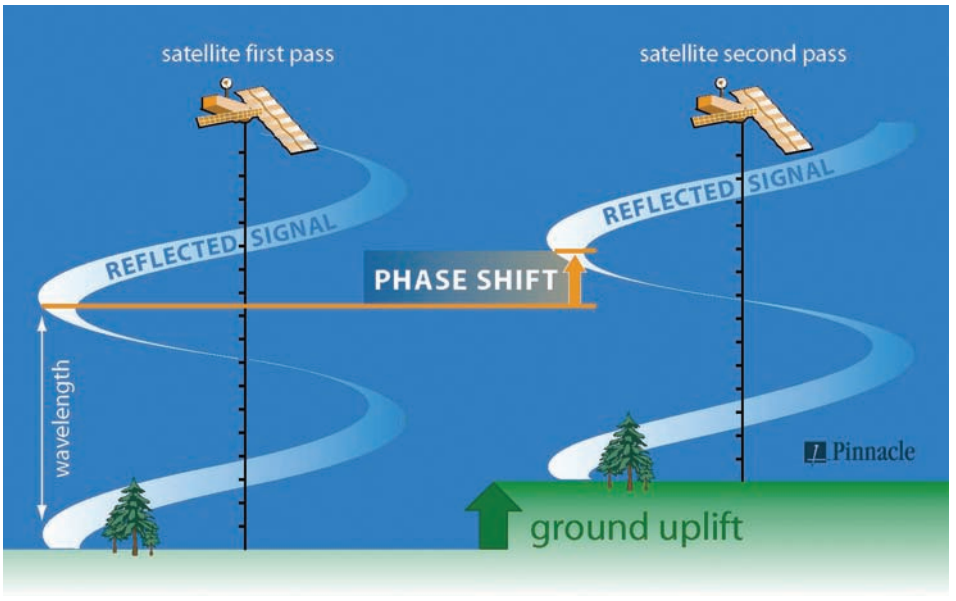

Figure 3 – InSAR phase shift observation method

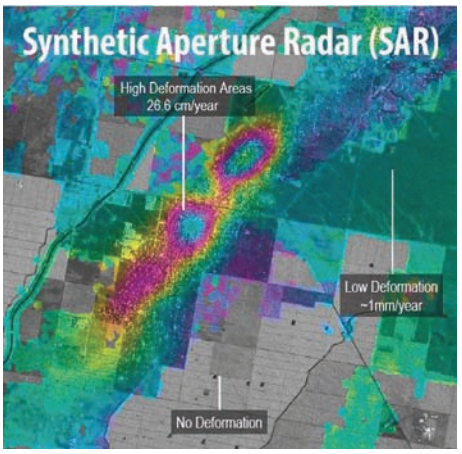

Figure 4 – InSAR scene over thermal recovery field showing areas of high, medium and low movement

"as wide an area of coverage as possible to detect previously unidentified migration pathways in the storage complex and beyond".

InSAR is a satellite based radar method which can provide mm resolution of ground deformation over thousands of square miles for a few thousand dollars a month. This is your gross surveillance technology.

InSAR works by taking readings at regular intervals (usually 24-35 days) and comparing the radar return from one scene to another. (Figure 3)

Differences from scene to scene are usually represented as colored bands with each band indicating an additional mm of movement. (Figure 4)

InSAR works best in areas with consistent radar reflections. In areas of high vegetation or earthwork, simple sheet metal point reflectors can be installed which posses a much larger signal to noise ratio than the surrounding vegetation.

One deficiency of InSAR is that it's a slant range measurement in which X,Y and Z motion is not directly measured but integration with Global Positioning System (GPS) measurements can resolve this issue.

Differential GPS (DGPS) employs two or more GPS receivers. Usually one is placed in the area of expected movement and a remote station is placed where you expect little movement.

By using two stations, atmospheric variations can be backed out resulting in 1-2mm resolution of X,Y and Z motion.

By placing some DGPS units in a CCS project area, their results can be used to correct InSAR results and make a more accurate picture.

DGPS can also be used as a ground truth anchor for tiltmeter measurements. DGPS measurements are also realtime.

What happens when you inject 5 million tons of CO2?

Figure 5 is a table showing the effect of injecting various volumes of CO2 at different depths. The modeling used was a simple Okada homogeneous half space model.

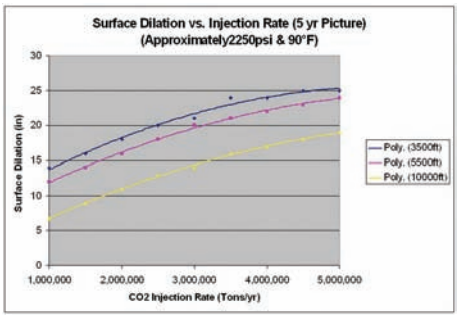

Figure 5 - the effect of injecting various volumes of CO2 at different depths

If you look at the 5 million ton/yr scenario you have 19 inches of dilation after 5 years at 10,000ft and 25 inches with a 3500ft injection. This type of movement is easily measured with SDM technologies.

There has been extensive use of these technologies in US and Canadian steam flood projects where the dilation is even greater due to the additional thermal effects. Some operators even rely on these technologies to provide intra-day results which are then used to optimize their steaming programs.

What is the best mix of technologies?

Every CCS project will be different. Some will be EOR focused where the reservoir has been analyzed for decades while others may target virgin reservoirs with no seismic, logs or pressure data.

Some will be onshore and near infrastructure while others will be offshore. I see a critical need to apply enough technology to characterize how CO2 will act in a reservoir in the initial stages of the project but once the characteristics are defined, I see no need to spend more than is absolutely necessary to achieve our monitoring goals.

In the series of diagrams below I have illustrated how a CCS project could be monitored using a layered SDM approach. I am assuming that the up front reservoir characterization is complete and we are focusing on monitoring for the next 25 years.

In Figure 6 we have the pre-injection state where you would start collecting InSAR scenes in order to capture the baseline for the immediate site area as well as the surrounding region.

In Figure 7, based on the injection depth and rates and surface conditions, we pick an SDM technology mix that meets our

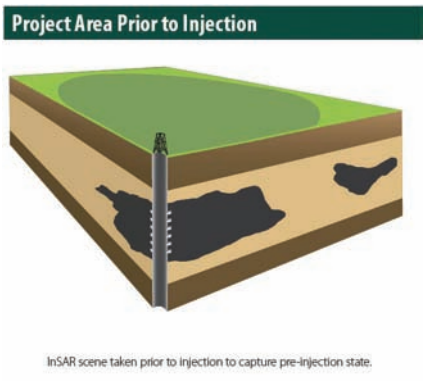

Figure 6 – Pre injection baseline monitoring

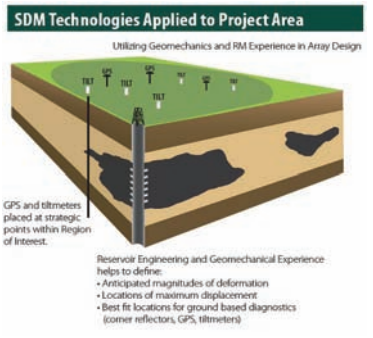

Figure 7 – SDM technology design

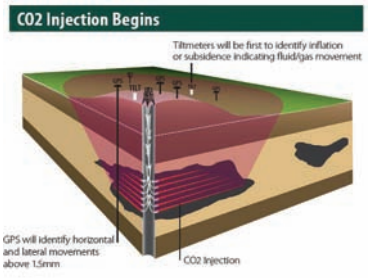

Figure 8 – CO2 injection causing surface dilation

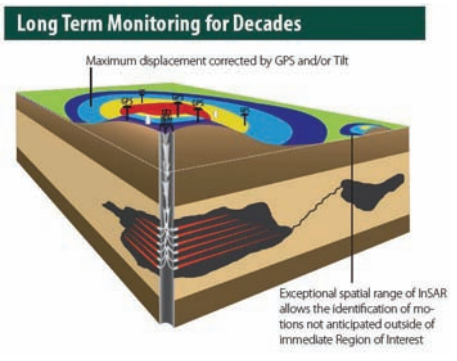

Figure 9 – InSAR picking up leak that it outside of project area

MMV goals for resolution, accuracy and periodicity. This could include identifying whether InSAR point reflectors are needed, how many tiltmeters are required to properly image an area of interest and an assessment of how many GPS stations would be required to give us the data quality that we specify.

"Surface Deformation Monitoring has the potential to image large volumes of rock at a relatively low cost" - Glenn R. McColpin, Director of Business Development, Pinnacle Technologies

Figure 8 represents what would happen one the injection begins. Tiltmeters being the most sensitive instruments will see the surface dilation first. DGPS and InSAR will be the next to pick up movement that exceeds 1mm.

Figure 9 illustrates that the exceptional spatial coverage in InSAR can pick up anomalies outside the immediate area of interest. Such areas could be instrumented with additional tiltmeters or a portion of the initial array could be relocated as the plume expands.

SDM offshore?

While InSAR and GPS are suitable for terrestrial deployment as far as CCS is concerned, tiltmeters can and have been deployed in ocean settings.

An array of ocean bottom instruments could be deployed to monitor seafloor dilation and run through the same modeling process as land based SDM. This technique, although unproven, could be more cost effective than offshore 4D seismic monitoring.

Conclusions

The hard truth is that any money that is spent on CCS activities will end up on people's utility bills. In order for CCS to take off and be accepted globally, we will need to keep a tight reign on cost in every aspect of a CCS project.

Surface Deformation Monitoring has the potential to image large volumes of rock at a relatively low cost with near real-time leakage identification.

The key to success is understanding the circumstances under which SDM makes technical and economic sense so that the right technologies can be applied to each project.

Further reading

Du, J., Wolhart, S., Brissenden, S., McGiliivray, P., Davis, E., Roadarmel, W., Wright, C. (2005) *Mapping Fluid Flow in a Reservoir using Tiltmeter Based Surface Deformation Measurements*, SPE 96897 presented at the 2005 SPE Annual Technical Conference, Dallas, TX Oct. 9-12

Deformation Monitoring Through Multi-Platform Integration, LENC, Lisbon 2008 May 12-15

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Wright, C., Davis, E., Minner, W., Ward, J., Weijers, L., and Scheel, E. (1998). *Surface Tiltmeter Fracture Mapping Resches New Depths – 10,000 Feet, and Beyond*, SPE 39919, presented at the SPE Rocky Mountain Regional/ Low-Permeability Symposium and Exhibition, Denver CO, 5-8 April.

Transport and storage news

Shell commits to Saskatchewan storage project

www.shell.com

Shell Canada has committed to be a co-sponsor of the final phase of the IEA GHG Weyburn–Midale CO2 monitoring and storage project at the Petroleum Technology Research Centre (PTRC) in Regina, Canada.

Great Plains Synfuels Plant (left) and where CO2 emerges at Weyburn 200 miles away (right)

The project is the largest CO2 enhanced oil recovery (EOR) project on land and researches the geological storage of CO2 at the sites of the commercial EOR operations by EnCana Corporation (Weyburn) and Apache Canada Ltd. (Midale) in Saskatchewan, Western Canada.

The final phase of the project, which Shell has committed to co-sponsor, will include work on site characterisation, monitoring and verification, wellbore integrity and risk assessment.

"What makes the Weyburn-Midale CO2 Project a win-win project for Shell and other industry partners is the potential to store a man-made greenhouse gas in a natural hydrocarbon container, while realizing the economic benefits of increased oil recovery thanks to the CO2," said Ray Knudsen, Project Director of the Weyburn-Midale CO2 Project.

A key end deliverable for this final phase is also to compile a Best Practices Manual to guide all aspects of future CO2 storage projects. This Best Practices Manual will address both technical and policy considerations for successful implementation.

The project will also look at regulatory issues concerning the long-term nature of storage, public communication and outreach, and the means to foster widespread use of CCS through aspects to support the business environment.

The Project is supported by an international collaboration of governments, research institutes and industry. Government sponsors include: Natural Resources Canada, the United States Department of Energy, Saskatchewan Energy and Resources, and the Alberta government through the Alberta Energy Research Institute.

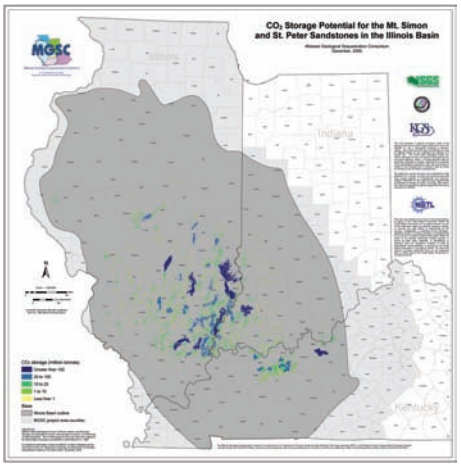
Corporate sponsors currently include: Apache Canada Ltd., Aramco Services

Company, Chevron, EnCana Corporation, OMV Austria Exploration & Production GmbH, Research Institute of Innovative Technology for the Earth (RITE, Japan), Saskatchewan Power Corporation, Schlumberger Carbon Services and Shell Canada Limited.

DOE awards $126.6 million for two further sequestration projects

www.doe.gov

The U.S. Department of Energy (DOE) has awarded $126.6 million to the West Coast Regional Carbon Sequestration Partnership (WESTCARB) and the Midwest Regional Carbon Sequestration Partnership (MRCSP) for the Department's fifth and sixth large-scale carbon sequestration projects.



CO2 storage in the Mount Simon Sandstone in the Midwest region

The new projects will demonstrate the entire CO2 injection process, pre-injection characterisation, injection process monitoring, and post-injection monitoring for large scale injections of one million tons or more to test the ability of different geologic settings to permanently store CO2.

DOE plans to invest $126.6 million in the two projects over the next 10 years, while the industry partners will provide $56.6 million in cost-shared funds to make these projects a success.

In the first stages of the projects, researchers will characterise the selected sites, then over the first 24 months they will complete the modelling, monitoring, and infrastructure improvements needed before CO2 can be injected in partnership with industry.

This will establish a baseline for future monitoring after CO2 injection begins. Each project will then inject one million tons or more of CO2 into a regionally significant storage formation. After injection, investigators will monitor and model the fate of the CO2 to determine the effectiveness of the storage reservoir.

Midwest Regional Carbon Sequestration Partnership (MRCSP). The MRCSP, led by Battelle Memorial Laboratories, will demonstrate CO2 storage in the Mount Simon Sandstone. This geologic formation stretches from Kentucky through Ohio and has the potential to store more than 100 years of CO2 emissions from major point sources in the region.

In addition to the DOE funding, MRCSP members will contribute nearly $32 million as cost share for the Phase III project, bringing the total value to just under $93 million.

The new research will be implemented over a 10-year period and builds on the previous two phases that started in 2003.

A focal point of the Phase III project is to demonstrate permanent storage of carbon dioxide in deep geologic formations at a scale much larger than the MRCSP field validation tests underway across the region as part of the current Phase II effort.

The project intends to inject approximately one million tons of CO2 over a four-year period. The CO2 will be obtained from an ethanol production facility located in Greenville, Ohio that is owned by The Andersons Marathon Ethanol, a joint venture between The Andersons and Marathon Petroleum Company.

The CO2 would be injected into the Mount Simon Sandstone, which is more than 3,000 feet beneath the surface in the area around the injection site.

The Mount Simon Sandstone stretches across much of the Midwest region and has the potential to store more than 100 years of CO2 emissions from major point sources in the region.

The purpose of the project is to validate that the injection and storage of CO2 can be done safely, permanently, and economically.

An IGCC power plant, to be located near Edwardsport, Indiana, is an optional additional source of CO2 for the third phase of the project. The power plant is currently being developed by Duke Energy.

Total Project Cost: $92,846,271 DOE Share: $61,096,271 Partner Share: $31,750,000

West Coast Regional Carbon Sequestration Partnership (WESTCARB). The WESTCARB Partnership, led by the California Energy Commission, will conduct a geologic CO2 storage project in the San Joaquin Basin in Central California.

The project will inject 1 million tons of CO2 over 4 years into deep (7,000+ feet) geologic formations below a 50-megawatt, zero-emission power plant in Kimberlina, CA.

The Clean Energy Systems plant uses natural or synthesis gas in an oxyfuel system to produce a relatively pure stream of CO2. This CO2 will be compressed and injected into one of a number of potential storage formations below the surface of the plant. WESTCARB will develop, operate, and close the injection site as well as monitor the fate of the injected CO2.

Total Project Cost: $90,594,099 DOE Share: $65,606,584 Partner Share: $24,987,515

IEA Web Conference on CCS: CO2 Transport, Health and Safety Issues

The second activity of the International CCS Regulators' Network is a series of web conferences on specific legal and regulatory issues relating to CCS.

First meeting of the IEA CCS regulators' network. Image: © OECD/IEA, 2008

As web conferences, attendees will participate from their own offices – listening to presenters speak and following powerpoint presentations via a designated internet site, through which questions may also be asked of the presenter.

The first such conference, which will focus on transport, health and safety issues, will be held from 3:00 pm to 4:30 pm Paris time on **10 July 2008**.

The draft programme for this event is as follows:

Host: Mr. Tom Kerr, International Energy Agency

Moderator: Ms. Rosemary Whitbread, Health & Safety Executive of the United Kingdom

Presenter: Mr. Arthur van Dalen , Government of Netherlands

Presenter: Ms. Joy Kadnar, United States Department of Transportation

Presenter: Mr. Shu Lee, Alberta Provincial Government, Canada

There is no participation charge for this conference, but places are limited and registration is essential. The conferencing system will require participants to have access to a computer with sound and internet access, and in some instances to have access to a telephone.

Empire District Electric Company in carbon storage pilot

www.empiredistrict.com

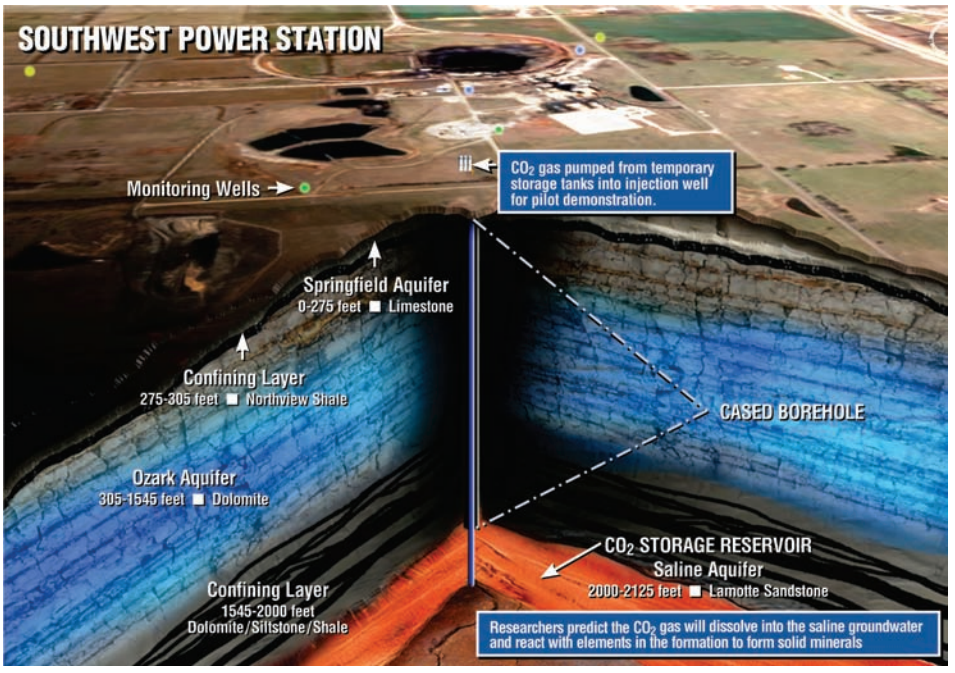
The Empire District Electric Company, based in Missouri, will participate in the Missouri Carbon Sequestration Project, a joint pilot project to evaluate the feasibility of local carbon sequestration.

In addition to Empire, partners in the project include City Utilities (CU), Ameren UE, Associated Electric Cooperative, Aquila, and Kansas City Power and Light. Research partners include Missouri State University, Missouri University of Science and Technology, and the Missouri Department of Natural Resources.

Missouri Senator Christopher S. "Kit" Bond announced that $2.46 million in federal funding has been secured to assist with the Missouri Carbon Sequestration Project. The utility funding partners will provide twenty percent matching funds totalling $590,587, or approximately $98,400 each.

The pilot project will be conducted at CU's Southwest Power Station site in Springfield in southwest Missouri and will involve drilling, coring, and characterisation of the site.

If results prove favorable, injection of CO2 at a depth of approximately 2,000 feet will take place, followed by long-term monitoring and evaluation, which is expected to last two years.



City Utilities' Southwest Power Station site in Springfield in southwest Missouri showing CO2 storage potential

Scottish regional CCS study begins

www.geos.ed.ac.uk/sccs

The Scottish Centre for Carbon Storage has started work on a Scottish CCS Joint Study.

It will evaluate CO2 sources, offshore hydrocarbon reservoir and saline formations sinks within Scottish waters, volumes of potential storage sites and timing of availability, potential for Enhanced Oil Recovery (EOR), the options for CO2 transport and economic models for CO2 storage.

The Scottish Government and ten commercial organisations, with operational interests in Scotland, are funding the project: BG Group; ConocoPhillips (U.K.) Limited; Doosan Babcock; Hydrogen Energy International Limited; INEOS; Marathon Oil; Scottish and Southern Energy; ScottishPower; Shell U.K. Limited; Wood Mackenzie. A report will be published during spring 2009.

The SCCS, established in 2005 with funding from The Scottish Funding Council, is a partnership between the British Geological Survey, Heriot-Watt University and The University of Edinburgh.

The centre combines world-class expertise based on petroleum and hydrocarbon geoscience in 3D regional and field scale geological modelling, geophysics, geo-engineering and subsurface fluid flow.

Contact: Stuart Simmons, Scottish Centre for Carbon Storage
stuart.simmons@ed.ac.uk

Shell, Qatar Petroleum and Imperial College research carbonate reservoirs

www.qstp.org.qa
www.imperial.ac.uk

Shell, Qatar Science & Technology Park (QSTP) and Imperial College London will collaborate on research into further understanding carbonate reservoirs, which constitute the vast majority of hydrocarbon reservoirs across the Middle East, and CO2 storage.

At a ceremony at Imperial College London, Qatar's Deputy Premier and Minister of Energy and Industry, His Excellency Abdullah Bin Hamad Al-Attiyah, Ms. Linda Cook, Executive Director of Royal Dutch Shell, Dr Tidu Maini, Executive Chairman of Qatar Science & Technology Park (QSTP), and Sir Roy Anderson, Rector Elect of Imperial College London launched the joint research collaboration.

Funded jointly by Qatar Petroleum, the Qatar Science & Technology Park, and Shell, who will contribute together up to $70 million over a 10-year period, this collaboration aims to provide the foundation for new CO2 storage technologies that can be applied in Qatar, elsewhere in the Middle East and beyond.

This collaboration forms part of a technology partnership between Qatar Petroleum and Shell, within the Qatar Science & Technology Park, that involves select academic partners from around the world, the first of which being Imperial College.

It also builds on the on-going Grand Challenge Programme agreed between Shell and Imperial in 2006.

The agreement will see Imperial's Departments of Chemical Engineering, and Earth Science and Engineering recruit a number of new academic staff, 20 PhD students and 20 postdoctoral researchers to push forward research in the UK and in Qatar.

It will also provide critical expertise for Qatar and Shell as they seek to develop hydrocarbon resources in a sustainable way.

Researchers involved in this collaboration will characterise carbonate reservoirs in detail and develop computer modelling and simulations to establish an in-depth knowledge of rock structures and the way fluids like oil, water, and natural gas and CO2 move within them.

This will improve understanding of how these rocks trap gas and fluids. With this knowledge, researchers will be able to propose new CO2 management plans and processes, and identify suitable carbonate rock formations to potentially store CO2 emitted from power stations, the group said.

Germany begins CO2 storage at Ketzin

The GFZ (German Research Centre for Geosciences) has begun pumping CO2 underground for the first time in Europe as part of an EU project called CO2SINK

Under the management of the German Research Center for Geosciences (GFZ) in Potsdam, in cooperation with 18 partners from nine countries, the injection into and storage of CO2 in deep, saltwater-filled, porous rocks will be examined for the first time in Europe.

The project aims to store up to 60,000 tons of CO2 in a saline aquifer at a depth of more than 600m during the next 2 years. An injection well and two observation wells have been successfully drilled to depths of 800m.

The project involves intensive monitoring of the injected CO2 using a broad range of geophysical and geochemical techniques, the development and benchmarking of numerical models, and the definition of risk-assessment strategies. These steps will all help to evaluate the reservoir's stability and integrity.

The Ketzin gas storage site was selected for CO2SINK for several reasons including:

• The site offers a geological structure favourable for CO2 storage

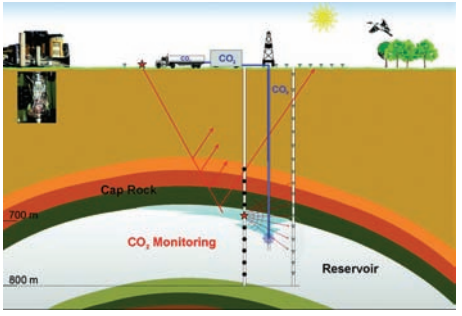
• The existing surface infrastructure reduces the need for new developments

• The local political community strongly supports the project, and permitting authorities have been involved in project definition.

• The test site is close to a metropolitan area, providing an opportunity to develop a European showcase for onshore CO2 storage.

The project will be looking at several issues, not least of which is the risk of leakage either through the overlying rock seals or from the upward migration of gas along artificial pathways such as the metal casing of injection/observation boreholes.

It will also look at how CO2 migrates within the reservoir and the rate at which CO2 dissolves in salt water or reacts with indigenous minerals.



Sketch of the location in Ketzin (Brandenburg): underground structure, injection well for CO2 storage and 2 monitoring wells (Image: ©GFZ)

This will lead to a better understanding of the fate of the CO2 and make it possible to develop a more accurate risk assessment for the long-term application of CO2 storage in built up areas.

Yorkshire bids to reduce UK carbon emissions

A new report led by Yorkshire Forward and some of the UK's largest energy and industrial companies shows how a unique CCS network could be developed for the region

www.yorkshire-forward.com

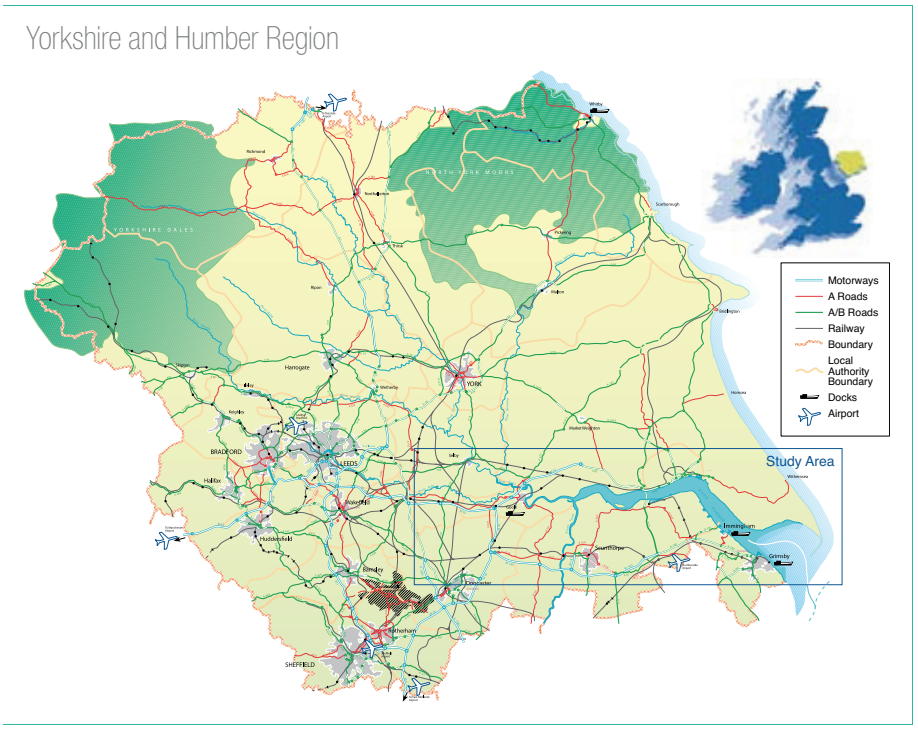
The study shows how a network could evolve using existing and new infrastructure in the region to connect major producers of carbon emissions. Costs for the network are predicted to be in excess of £2 billion and would take 20 years to develop fully.

Contributors included Corus, Scottish and Southern Energy, Powerfuel Power Ltd , BP, ConocoPhillips, E.ON UK and Drax Power Ltd and AMEC.

Yorkshire and Humber is home to some of the country's largest power plants. The region has a unique opportunity to become a UK and global leader in tackling climate change, says Yorkshire Forward.

Up to 60 million tonnes of the carbon emissions produced each year by burning fossil fuels could be liquefied then pumped out to depleted gas fields under the North Sea.

Head of Sustainable Development at Yorkshire Forward, Mike Smith, believes that Yorkshire and Humber's unique geography and experience of dealing with the environmental impacts of burning fossil fuels makes the region an ideal candidate location to develop CCS.



The Yorkshire and Humber region used for the study

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