carbon capture journal

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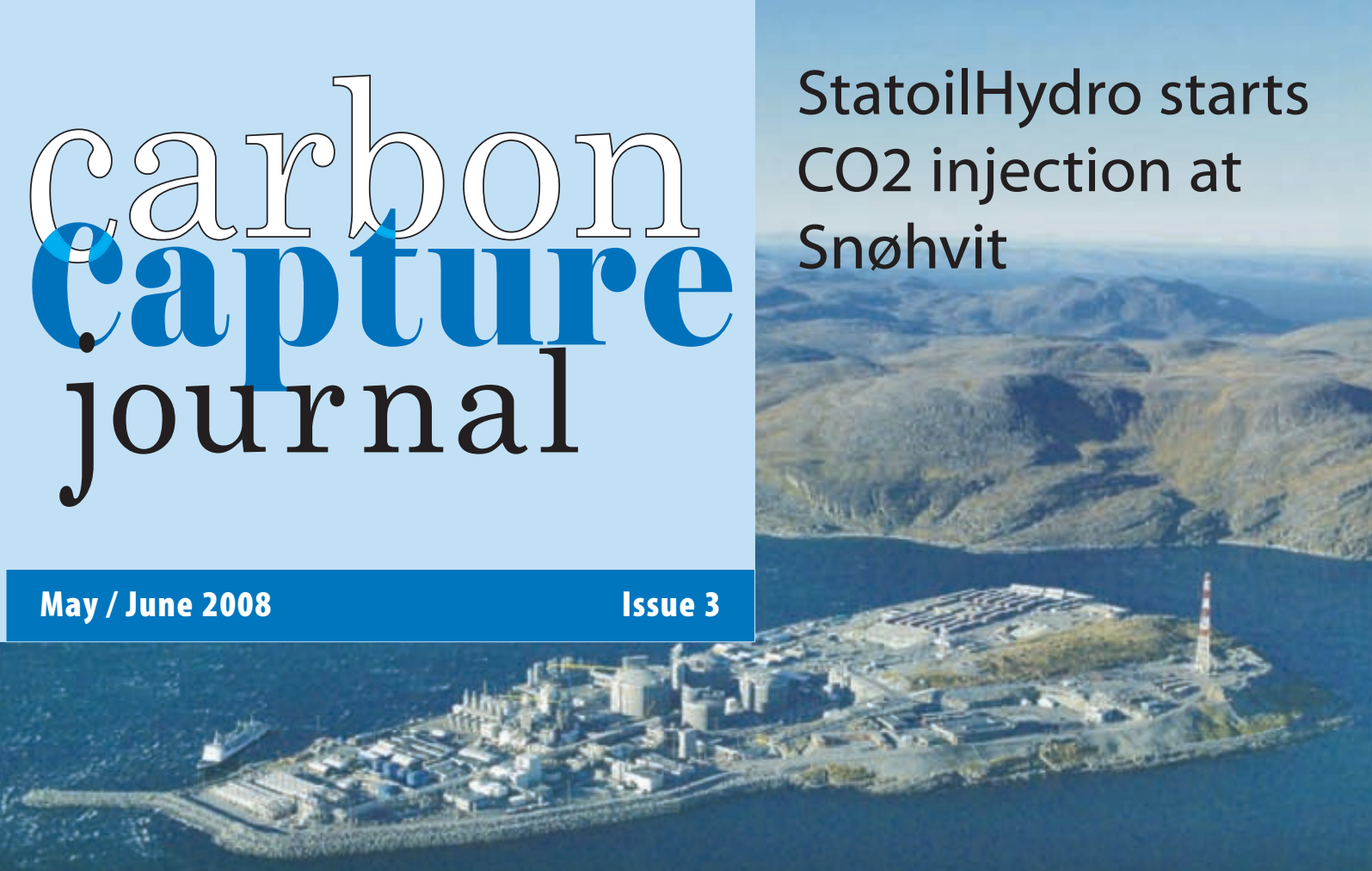


StatoilHydro starts CO2 injection at Snøhvit

Taming King Coal - the EU's new energy policy

SaskPower - CCS or nuclear?

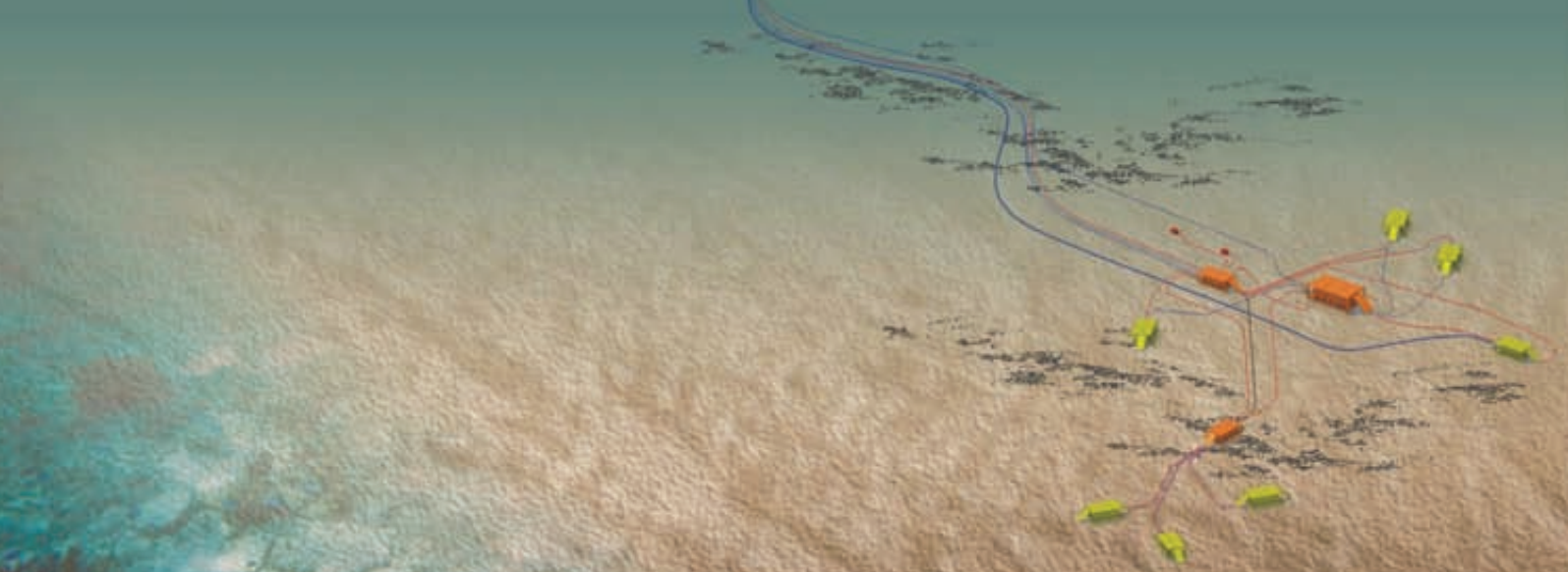
CO2CRC Otway project begins

IEA International CCS Regulators' Network

The Hatfield IGCC and post combustion demonstration project

Cracking the CCS nut - analysing the potential for CCS now

The Gorgon LNG project



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Front cover:

StatoilHydro begins CO2 injection at Snøhvit. The carbon injection systems at Melkøya are now online, pumping carbon dioxide to the Snøhvit field for storage. Image: Even Edland / StatoilHydro (See pg. 24)

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What does committed really mean?

Are the EU and the UK acting fast enough and where is the money coming from?

Keith Forward, Editor, Carbon Capture Journal

At the IHS Energy London Symposium on energy security and climate change, Lord Stern of Brentford, author of the Stern Report, gave some dire warnings based on the most recent climate change data, but was optimistic about the current international trend

"I would now argue that I badly underestimated the extent of the problem," he said. "But I am now more optimistic about getting international agreements than when the Stern Report was published one and a half years ago."

He said the problem "starts with people and ends with people".

"It is now clear that the IPCC badly underestimated the growth of emissions, how much greenhouse gases rise in relation to emissions, and how much the planet can absorb."

"There is also a greater temperature increase because of greenhouse gases than previously thought and the link with extreme climatic events is happening faster and having a more severe impact on human activity."

Is the EU doing enough?

The EU for now is putting its trust in market forces through the Emissions Trading Scheme (ETS) to encourage investment in developing commercial CCS technology. It has also proposed some form of legislation for mandatory CCS after 2020, and even some form of subsidy to take into account positive effects not captured by the market.

Analysts from Deutsche Bank predicted that the carbon price would stabilise at €35 / tonne CO2 as the market tightens up in Phase II of the ETS. This is in line with some estimates of the cost of CCS in the long term, but does not encourage first movers.

They also estimated that the total revenue from selling carbon credits in Phase III, which starts in 2013, would be around €61 billion, and could provide a major source of funding for CCS projects, but in the short term there has to be some other form of incentivisation to speed up deployment.

Robert Murray, Senior Associate with Booz Allen Hamilton said, "The timing and size of funding for CCS deployment needs to be more aggressive. Lack of funding and stakeholder agreement has already hurt the economics of some early projects. Incentives needed to stimulate CCS could be similar to those for renewables, such as feed-in tariffs."

The UK position

Michael Jacobs, a Senior Adviser to Prime Minister Gordon Brown, said that the UK Government was committed to supporting the first CCS power station. However he said the government's commitment to funding was only in the order of "tens of millions of pounds."

This is far less than the additional costs of adding carbon capture to a coal-fired power project, which are estimated at over £1 billion. Industry sources said that they were expecting something in the order of £300 million.

The Royal Society took the step of writing to the Secretary of State for the Department for Business, Enterprise & Regulatory Reform to urge the government to send a stronger signal by not allowing any new coal-fired power stations, such as Kingsnorth, to go ahead without a clear strategy and incentives for the development and deployment of CCS.

To do so "would send the wrong message about the UK's commitment to address climate change, both globally and to the energy sector," said President Lord Rees of Ludlow.

"A range of technology options exists that could demonstrate the viability of CCS and build confidence for its widespread deployment, but for industry to make any significant progress requires, greater policy and financial support and positive steps from government to reduce the investment risk," he continued.

"Requiring any new coal-fired power station, such as Kingsnorth, to include CCS will mean it will incur additional costs. At present the mechanisms and policies in place, including the EU Emissions Trading Scheme, do not appear to be robust enough to provide sufficient support for industry to risk investing in CCS, particularly when the costs of this new technology are uncertain."

So what does committed really mean?

CCS around the world

Last month, the Canadian federal government announced that oil sands developments and coal-fired power plants built after 2011 must be CCS ready, with the technology coming into use by 2018.

Alberta is the first region in North America to direct dedicated funding to implement CCS across industrial sectors and is pinning its hopes on the technology for a 70% reduction in emissions by 2050 – the bulk of those reductions coming from activities related to oil sands production.

"If the UK government fails to send a clear message China will be selling us the technology in 15 years."

A government industry council will provide a plan for the advancement and implementation of CCS in the province and there will be enhanced support for ongoing research and monitoring of CCS projects.

Meanwhile StatoilHydro has begun its second major CO2 storage project in Norway at Snøhvit where it will inject CO2 separated from natural gas back under the seabed, and the CO2CRC in Australia has begun the Otway project to study storage in depleted gas reservoirs, the first of its kind in the Southern Hemisphere.

A clear message

"The application of appropriate financing mechanisms, supported by a robust, long-term policy and legislative framework, could lead to investment by other parts of the industry, greatly increasing the learning and development of this vital technology," said Lord Rees.

"The benefits of having a full-scale coal-fired power station operating with CCS as soon as possible could be substantial, and extend far beyond their direct contribution to meeting UK emission targets. China and other developing economies that are reliant on coal are much more likely to make rapid progress to CCS deployment if the UK leads in this area," he continued.

The UK government has to work out how it can make industry confident enough to invest for the future so that UK companies can lead the way and take advantage of this huge market, otherwise China will be selling us the technology in 15 years.

Taming King Coal - the EU's energy policy

Europe has willed the end but not the means to deliver the CCS demonstration programme. Unless a way is found to rebuild momentum at EU level it is likely that companies will look to invest in other projects and other areas. In short, Europe has put itself between a rock and a hard place.

By Nick Mabey, Chief Executive, E3G

In March 2007 EU Heads of Government called for the deployment of technologies for the capture and storage of CO2 (CCS) in new European power plants by 2020, and welcomed the European Commission's intention to establish a mechanism to stimulate the construction and operation by 2015 of up to 12 CCS demonstration plants.

The EU is now in the process of adopting legislation providing for the geological storage of CO2.

So far, so good; but the current EU demonstration strategy will not produce CCS as a deployable large scale low carbon power option before 2020.

Europe's goals

Preserving European climate security means limiting global temperature rises to 2°C. Europe cannot meet this multilateral goal, or achieve internal energy security without aggressive EU leadership on CCS.

Global energy scenarios which stabilise greenhouse gas (GHG) concentrations around 450ppm CO2 equivalent – giving a 50% chance of remaining below 2°C – assume large scale deployment of CCS starting during the period 2015-20. Each year of delay, according to recent scenarios analysis by Shell, potentially raises the final stabilisation concentration by at least 1ppm.

Delay also risks lock-in to high emissions technologies. The next 25 years will see utilities in Europe build up to 850GW of new power stations, more than the US and nearly as many as China. Even if the EU meets its challenging renewable energy targets, over 75% of this investment will be in coal or gas fired power stations.

With gas prices high, and fears about dependence on Russian supplies rising, nearly 40GW of new coal power stations are planned by 2012 alone; mainly in Germany, Poland and Eastern Europe.

Unless these stations can be technically and economically retro-fitted with CCS, they risk having been inefficient investments – becoming costly stranded assets worth billions of Euros, or long term climate liabilities which reduce Europe's ability to transform into a low carbon economy.

Europe is the only major power seriously committed to delivering the 2°C target. The price of such leadership is that Europe needs to develop CCS technologies or the US, China and India will carry on investing in dirty coal and undermining European climate security.

When we recognise that developing CCS is not an option but a necessity, the question becomes "if not us, then who?"

Delivering CCS demonstration

No single European country can alone take on developing an effective demonstration programme on CCS.

While active industry and Member State support is critical for moving CCS forward, "bottom-up" activity is not currently delivering a comprehensive and accelerated demonstration programme.

> **"Even starting immediately, it will take a decade to define and begin delivering this infrastructure at the scale needed to make a real difference to European carbon dioxide emissions."**

A critical reason for this is that none of the countries or companies can on their own deliver a definitive assessment of CCS technologies and networks which would lead to market deployment. The resulting market failure leads to systematic underinvestment in CCS projects.

Producing high quality, comparable data to deliver an early resolution of many of the issues surrounding the technical and environmental feasibility of CCS, together with decisions on network investment inside a context of public acceptance, requires concerted EU action as a whole. And action must also be rapid.

Even starting immediately, it will take a decade to define and begin delivering this infrastructure at the scale needed to make a real difference to European carbon dioxide emissions.

Nick Mabey, Chief Executive, E3G

The current Commission proposals foresee policy intervention: "a focused R&D and demonstration effort can bring down costs of CCS by 50% between now and 2020, facilitating commercial deployment."

But to deliver this outcome, the Commission looks primarily to the EU Emissions Trading System (ETS), where "under the carbon market, CCS will be deployed if and when it is cost-effective".

This model will fail. From 2013 power plants face paying for 100% of their carbon permits, clearly creating stronger disincentives for building new coal plants. Even then, the carbon market cannot on its own deliver adequate investment in zero-carbon power to meet EU targets.

CCS is likely to require prices of at least €75-85 a tonne of CO2 to be competitive with unabated gas power in the next two decades.

If power station construction costs continue to escalate, the threshold price needed for CCS deployment will continue to increase, with estimates as high as €100-120 tonne CO2; a figure comparable with the cost of large scale offshore wind power and concentrated solar thermal power stations. Forward prices in the ETS are not currently providing these incentives.

Further, from 2009, if a strong global climate deal is concluded at Copenhagen, European emission trading prices will effectively be capped by the price of externally purchased permits which could cover up to 50% of the EU's effort beyond the 20% (or rather, Europe's multilateral 30%) target by 2020.

The price of these permits will be set

by the cost of decarbonisation in China and India, and is highly unlikely to reach levels necessary to deploy CCS.

In short, there is a fundamental tension between using international trading in the ETS to lower the cost of meeting the EU's targets, and expecting the ETS to send sufficient price signals to drive the low carbon power investment needed to reach the EU's 2050 objectives.

Supplementary policies – both European public funding and clearer regulation – are needed to shift EU investment patterns.

Market pull instruments

Already, some utilities argue that unless they continue to receive free ETS permits there will be a collapse in investment and Europe's lights will go out. The answer to this dilemma is to give the utilities the regulatory certainty they say they need.

Without the prospect of significant CCS deployment by 2020, even if the technology is proven, companies will have weak incentives to invest their own financial and technical resources in accelerating the improvement of risky CCS technology through demonstration programmes.

As with large scale renewable energy technologies, a regulatory approach could give effective market incentives for private investors.

This should take the form of either CCS as a mandatory requirement on new fossil fuelled plants from 2020 at the latest, or of an immediate carbon emission standard (tonnes CO2 per MWh generated) precluding the construction of unabated coal power.

Both rules should be technology neutral between CCS options, and between CCS and other low carbon power options. Unlike renewable energy there should be no obligation to build CCS power stations, but a requirement to fit CCS if a fossil fuel power station is being built.

Any regulation should be reviewed in 2014 based on the demonstration programme results, and revised if serious problems with CCS have arisen.

The current legislation on storage needs to include these provisions.

Market push

The current legislation also fails to provide guaranteed EU funding to deliver the demonstration plants.

The industry-led Zero Emissions Platform (ZEP) estimates the total incremental cost of the full CCS demonstration programme over its life time would be at least €6-10 billion.

Others have estimated €10-16 bn. Industry has reiterated to the Commission the need for significant public support if they are to make complementary investments in major CCS demonstration projects. The result is that there is currently little progress on moving forward many of the major planned demonstration projects.

Innovative proposals from ZEP to use part of the emission permit allocation in Phase III of the ETS have not yet found sufficient support among Member States to be implemented.

The Commission will review the potential for EU funding at the end of 2008. This exercise primarily will look toward the next 7-year EU budget period for 2014-2020, but the clock is ticking, and with political will an earlier funding stream could be unlocked from the current budget underspend.

In December 2007 the Member States rescued the Galileo satellite project using that year's Common Agricultural Policy underspend.

With the 20% (probably 30%) emissions reduction target looming, another existing EU project is now at risk of failure. It too could be funded. Agriculture underspend from 2008 alone was projected to be €7-8 bn – before rising food prices. This year's underspend could now top €10 bn.

Balancing risk and reward

While lack of market pull cannot be made up just by additional public funding to push development and demonstration activities, and while extensive experience shows that over-reliance on public funds will lead to cost-overruns and "white elephant" experimental projects, companies will not drive aggressively toward CCS commercialisation without a near-term market signal.

The European CCS demonstration strategy therefore must provide an acceptable balance of risk and reward for the private sector, and send very clear signals to investors over the future regulatory environment for fossil fuel power plants in Europe.

The current high levels of uncertainty are tending to disincentivise investment in new low carbon technology in favour of simple hedging strategies like moving to gas–fired generation.

There is a need for immediate European funding to support the initial capital costs for a priority programme of CCS demonstration projects which would give high European public value.

This programme should provide "first-mover rewards" by funding one example of each of the following: all major capture technologies; large scale CO2 storage and transport; demonstration in Central and Eastern Europe; CCS in the steel and cement industry; and CCS demonstration in major developing countries.

Member States should develop and part-fund these projects with industry. EU funding of around €250-500 million per annum for 2009-13 would kick start this process.

In return, all projects would operate under conditions of full transparency and comparability and potentially agree to conditions on technology cooperation.

Depending on market conditions and/or technological development the CCS demonstrations may cost less than anticipated. In this case it is important that there are no windfall profits to CCS developers. This safeguard could be achieved by including a clause on sharing profits above a reasonable rate of return, with a 100% profit claw back above a certain level.

Of course, the stronger the market pull signal, the more companies will be prepared to invest their own resources in demonstrating technologies, and the less public funding will be needed for the demonstration programme.

CCS ready assessment

Utilities and investors across Europe have yet to fully price future climate change policy into their investment models, and discussions show that there is scepticism that the EU has the political will to achieve its emissions targets.

A weak requirement in the storage legislation for technical "CCS ready assessment" of new plants confuses rather than helps to resolve this dilemma, and Europe is in danger in the next decade of building a stock of new nominally "CCS ready" coal power stations which cannot be economically retrofitted with the technology.

The worst case is that new plants are making minor changes in site layout allowing for a future CO2 capture facility, when they have no economically viable access to transport and credible storage facilities.

With high uncertainties regarding both transport and storage costs, as yet there is no clear business model for either. Will CO2 transport be allowed through common carrier pipelines, constructed with public funds and shared by many users?

Or will dedicated investment in transportation need to be included directly in project finances? Will CO2 storage compete with bulk gas storage, and be priced at variable rates? Or will storage be managed as a government concession with zero economic rent?

It is critical for the industry, for consumers and policy makers that investors and operators are aware of the full costs and uncertainties around fossil fuel investments.

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- **Sam Nader,** Director, Masdar Carbon, ABU DHABI FUTURE ENERGY COMPANY
- **Margaret Mogford,** Head, Climate Change Policy, BG GROUP
- **Dimitri Zenghelis,** Co-author, Stern Review, Office of Climate Change, UK GOVERNMENT
- **Jill Duggan,** Head of International Emissions Trading, DEFRA
- **Chris Leeds,** Head of Sales and Marketing, Carbon Markets, BARCLAYS CAPITAL
- **Dr AK (Tony) Booer,** SCHLUMBERGER
- **Dale Seymour,** Deputy Secretary - Energy, Resources and Major Projects, DEPARTMENT OF PRIMARY INDUSTRIES, STATE OF VICTORIA, AUSTRALIA

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Given the immaturity of this market it makes sense to require full technological, economic and financial readiness analysis, based on a set of agreed guidelines across Europe. The legislation could do this.

Here is a proposal. All new plants should be required to undertake a full economic, financial and technical review of CCS retrofitting as part of their permitting process.

Private investors in utilities should require similar analysis as due diligence for power plant financing. Guidelines for the analysis should be produced by the European Commission in consultation with member states and stakeholders.

This would also avoid any legal challenges against future regulation requiring CCS retrofitting.

Between a rock and a hard place

Europe has willed the end but not the means to deliver the CCS demonstration programme. Unless a way is found to rebuild momentum at EU level it is likely that companies will look to invest in other projects and other areas. In short, Europe has put itself between a rock and a hard place.

About E3G

E3G is an independent, non-profit European organisation operating in the public interest to accelerate the global transition to sustainable development. E3G works globally on a range of energy, environment, foreign policy and security issues, and sits on the Advisory Council of the European Technology Platform for Zero Emission Fossil Fuel Power Plants (ZEP). More information at: www.e3g.org

Saskpower clarifies CCS position

Ending protracted uncertainty on Saskatchewan Power Corporation's carbon capture development, the provincially-connected electric utility announced in Regina on February 27 a seven year, C$1.4 billion government-industry partnership that rebuilds and then repowers SaskPower's lignite-fuelled Boundary Dam generating station near Estevan in southeastern Saskatchewan.

By our North America correspondent Stephen Salaff

www.saskpower.com/cleancoal

SaskPower has allocated fully $758 million toward its CCS technology demonstration at Boundary Dam.

SaskPower applauded the February 26 federal government budget 2008 announcement awarding $240 million towards the project.

(Project finances have regrettably been misreported. Reuters apparently attributed the $240 million money to the Saskatchewan government. Regina's true $758 million project commitment vastly exceeds Ottawa's contribution.)

When fully operational in 2015, the $1.4 billion Boundary Dam demonstration might produce 100 megawatts of baseload power, while pipelining CO2 to nearby unidentified enhanced oil recovery operations.

Following previous CCS disclosure gaps, SaskPower now offers open and proactive communications.

According to SaskPower, abundant lignite near Estevan in southeastern Saskatchewan was a major factor at Boundary Dam, Canada's largest coal-burning station. Commissioned in 1960, Boundary Dam was named to acknowledge that its reservoir extends to Saskatchewan's USA boundary with North Dakota.

The SaskPower plan is to introduce CCS at Boundary Dam #3, extending that unit's life by 30 years. When fully operational in 2015, the 100 megawatt demonstration project would capture approximately 100 million tones of CO2 annually.

The Boundary Dam generating station near Estevan in southeastern Saskatchewan.

Private sector investment of approximately $400 million will be directed to the pipeline required to transport the captured CO2 to the oilfields and the infrastructure required in the EOR process.

The private sector investors, like the specific EOR operations, remain unnamed.

SaskPower's start-stop path to commercial CCS has been shaped by strategic priorities in Ottawa.

Following direct encouragement earlier this decade from Canada's Kyoto and CCS-champion Environment Minister Stephane Dion, SaskPower launched CCS planning.

At a high-profile Regina media event in October 2006, SaskPower introduced coalition partners for its desired lignite-fuelled CCS plant.

Air Liquide and Babcock & Wilcox enthusiastically joined the utility's C$20 million pre-commitment engineering study of construction parameters for a pulverized coal- fuelled unit to generate 300 MW (net) and capture 8000 tonnes per day of CO2.

SaskPower planned to market the captured CO2 to nearby southeastern Saskatchewan oilfield operators, including EnCana Corporation and Apache Canada

Ltd. for commercial EOR use.

SaskPower's project manager Max Ball told Modern Power Systems*: Extensive IEA GHG measurement, monitoring and verification in connection with US Department of Energy and other interests have verified that CO2 is effectively sequestered in the EOR operations of the Weyburn field.

In late November 2006, SaskPower announced the first deployment of its CCS technology as a planned addition to its Shand powerplant in Estevan. SaskPower anticipated further CCS deployment at nearby lignite-fuelled units.

Ball firmly forecasted a Shand go or no-go mid-2007 commitment decision.

Delivering the Canada Overview at the G8 Expert Workshop on Clean Coal Technologies, Leipzig, March 2007, renowned combustion scientist Ben Anthony of Natural Resources Canada, described SaskPower's Shand Project with oxyfuel combustion technology and 300 MW net output as the world's first near-zero emissions pulverized coal-fired powerplant fast-tracked for service by 2011.

As Ball's mid-2007 deadline approached, SaskPower began denying interviews with his team, and eventually cancelled the enterprise as premature (CCJ 1, p 12).

The 2007 Saskatchewan election campaign leading to the November 7 election of a new government in Regina under Saskatchewan Party Premier Brad Wall arguably contributed to CCS vacillation and uncertainties. Wall is closer politically to Canada's Conservative Prime Minister Stephen Harper than previous New Democratic Party Saskatchewan Premiers.

Ottawa has long vigorously promoted indigenous, natural uranium-fuelled Candu nuclear generators developed in the World War Two Manhattan Project at Chalk River Laboratories. Harper even staked his minority government on exceedingly controversial nuclear advocacy in December 2007, known here as the Chalk River reactor crisis.

Despite federal Cabinet insistence, every western Canadian province rejected Candu, until 2007 hints in Alberta and Saskatchewan.

Remarkably, however, federally subsidised Atomic Energy of Canada Limited, considerably more than two decades ago, achieved a September 1991 Memorandum of Understanding with SaskPower, under which each would contribute C$25 million to complete the design of AECL's Candu 3 (300-450 megawatt range) reactor, and determine the opportunities, timing and capability to store and/or dispose of nuclear fuel.

During the early 1990s, following the enormous 1986 Chernobyl nuclear disaster, AECL and competitor firms promoted small power reactors like Candu 3.

According to AECL representative Larry Christie, the MOU specified joint studies in the entire nuclear fuel cycle, including public education programs to help promote understanding of nuclear technology.

Prioritising low-cost, secure and reliable coal, Saskatchewan NDP Premier Roy Romanow, elected in October 1991, annulled the MOU in March 1992, tactically conceding Candu reconsideration in Regina roughly a decade later.

SaskPower's 2004 Annual Report excluded Candu from its 75-year supply forecast.

Still within Romanow's nuclear moratorium, SaskPower's 2005 Annual Report lionised Ball's CCS Generation Achievement.

However, uranium power entered SaskPower's 2006 Annual Report, which committed extensive research and analysis on future supply options including coal and nuclear.

The Star Phoenix of Saskatoon, Saskatchewan's northern metropolis and uranium center, affirmed on April 17 that clean coal and nuclear are the two options to dirty coal now being considered by our provincial government.

SaskPower revealed that its next annual report, expected by the provincial legislature on April 29, would clarify the CCS and Candu competition, and corresponding federal support for these rival options. This will be the subject of a future article.

Modern Power Systems, January 2007, p 4

Cracking the CCS nut

With the offshore industry likely to be at the heart of a future UK carbon capture and storage strategy, Martin Grant, Managing Director, Atkins identifies the key issues and looks at what steps can be taken to begin analysing the potential for CCS now.

Most battle-hardened offshore industry players could be forgiven for putting the issue of carbon capture and storage (CCS) to the bottom of their pile of concerns in 2008.

Sure, the government has recently announced its intention to fund a CCS demonstration project; but we seem a very long way from the moment when CCS is an economically viable undertaking which companies at different points in the value chain can regard as a commercial opportunity.

Quite understandably, therefore, most people are sitting on their hands until the government sorts out the large number of legal and economic hurdles which need to be overcome before CCS can become a major carbon abatement technology in the UK.

And yet, there is more and more evidence that offshore storage of CO2 will be the most viable solution for CCS. A report produced in 2007 by the Department for Business, Enterprise & Regulatory Reform (BERR) spelled out the scale of the opportunity and the enormous role which the offshore industry could play in the development of CCS[1].

First, there is the fact that oil and gas fields are 'prime potential sites' for CO2 storage because:

1. They have a proven seal which has retained high pressure fluids, in many cases for millions of years.

2. Over the course of conventional exploration and production, much knowledge has been accumulated about the geological and engineering characteristics of oil and gas fields.

3. There are the dual benefits of enhanced oil or gas recovery (EOR) – injecting CO2 into the rocks and extracting more core product. Indeed, the report sketches a scenario where a persistently high oil price could lead to significant expansion of EOR in the North Sea and create the potential for CO2 storage on a much bigger scale.

Second, there is substantial capacity in the North Sea, enough to handle the UK's CO2 emissions for many years. According to BERR's figures, the total gross capacity for geological storage of CO2 in the North Sea is 35.5 Gt CO2, which is broken down like this (Table 1):

Some of the oil and gas fields in this survey are already closed for production; others would close at some point in the decade ahead, while the rest could benefit from enhanced oil or gas recovery.

The remaining storage capacity - a significant proportion - comes from the saline aquifers under the UK and Norwegian North Sea; although the report authors admit it's largely guesswork because so little study has been carried out in this area.

Third, according to BERR, there is the compelling fact that we already have an extensive oil and gas pipeline network, which could potentially be re-used as part of a North Sea-based CO2 storage infrastructure, dramatically reducing the capital costs of any national Carbon Capture & Storage solution.

Elsewhere, more technical analysis recently has reinforced the case for looking very seriously at the North Sea as a major storage ground for CO2.

A lot of work is being conducted regarding reservoir integrity – examining whether old oil and gas fields have the necessary geological characteristics for carbon dioxide storage on a large scale.

The results so far are encouraging. A study from a team at Leeds University, published last year in 'Geology' magazine, concluded:

"The safety case for CO2 storage in such reservoirs is greatly facilitated if it can be shown to react with the host pore waters and rocks on a human time-scale; and the results of this study indicate that this is indeed the case"

"It's very difficult to make economic sense of CCS without a substantial contribution from the public sector" - Martin Grant, Managing Director, Atkins

It is research like this which moves big industry figures, such as former Shell Chairman Lord Oxburgh, to call on the offshore industry to take CCS much more seriously.

In a recent speech to industry players, Lord Oxburgh said that managing carbon capture and storage projects could be one of the major roles for oil and gas companies in the future.

He also said that it would be ideal to trial CCS in the Southern North Sea, although it would require "detailed geologi-

	UK	Norway
Storage capacity in gas-fields (includes condensate fields)	5,982 Mt (75 fields)	4,440 Mt (42 fields)
Storage capacity in oilfields	4,225 Mt (74 fields)	4,768 Mt (36 fields)
Storage capacity in saline aquifers	14,466 Mt (32 sites)	1,681 Mt (33 sites)
Incremental oil recoverable through EOR	2.006 MMSTB (37 EOR fields)	1,756 MMSTB (22 EOR fields)

Table 1: Aggregate gross CO2 storage capacity and oil estimates for UK and Norwegian Sinks – oil and gas fields and aquifers - in the North Sea.

[1]DEVELOPMENT OF A CO2 TRANSPORT AND STORAGE NETWORK IN THE NORTH SEA. Report to the North Sea Basin, Task Force: BERR

cal/geophysical work, marine support facilities, heavy steel fabrication, new/refurbished pipelines and an East of England CO2 pipeline system".

In other words, there will have to be significant new national infrastructure spending before we can even think about CCS seriously in the North Sea.

It's very difficult to make economic sense of CCS without a substantial contribution from the public sector. Therefore, the message to the offshore industry, once again, must surely be that it makes sense to wait for all of these decisions to be taken before moving at all?

Reviewing some of the research again indicates that this might not be the case; that it might be prudent to start building CCS into future planning scenarios, and investment decisions which have to be made here and now, in 2008.

Let's assume that a market mechanism will be established that is sufficiently large and long-term enough to reward carbon abatement using CCS, and that the complex legal issues (especially regarding offshore storage) are resolved.

If this does happen, given the kind of evidence which we have touched on here, it seems there is a chance that the government will kick-start CCS with some kind of national infrastructure programme, and that it will look to the offshore industry to participate in a major way.

Exactly when that will happen, no one can be sure, although the BERR report pinpoints 2013 as a 'realistic start date' for UK or Norwegian CCS projects.

It might be wise, therefore, to consider some technical analysis of the following:

1. What impact would different CCS scenarios have on life-cycle planning for existing installations?

If, as we are suggesting, depleted oil fields have a major role to play in any future CCS solution, what decisions should operators make about the infrastructure which currently serves those fields?

If a platform is forty years old, it's likely to require substantial upgrading before it's ready for CCS. In some cases, it might be more economical to do that, in others to build an entirely new one next door or use subsea technology.

Alternatively, CCS cost-benefit analysis might indicate extending the lifetime of an installation when previously it would have been rational to close it down.

2. What would the implications be for planned close of production dates at existing fields, given that these are highly uncertain and based on any number of complex technical and economic factors?

Might there be different decisions made for fields which are expected to end their current useful lives in the next five years?

"The government is giving pretty strong signals now that it favours CCS as a major carbon abatement strategy for the UK" - Martin Grant, Managing Director, Atkins

3. How do CCS scenarios impact on decisions about enhanced oil or gas recovery in the North Sea?

The industry has had a cautious attitude towards major EOR spending, even with rising prices. And it's fair to say that, so far, carbon storage is considered to be incidental to the main EOR objective of extracting more core product. CO2 injection is just one of the techniques for EOR, and not always the most economical or technically superior. But a national commitment to CCS would change that.

A price for carbon in the future could combine with even-steeper crude prices to make EOR economical where it wasn't before. Analysis of this issue is especially urgent because, as the authors of the BERR report indicate, many of the fields which would be suitable for EOR are reaching the end of their lives, and decisions will have to be taken sooner rather than later.

If it makes sense to re-use existing oil and gas infrastructure for CCS, much more focus on the pros and cons of EOR decisions is needed.

4. Is existing pipeline infrastructure in good shape for CCS?

Although the legacy oil and gas pipeline infrastructure has good potential for re-use in a new CCS solution certain issues require careful consideration including:

• the residual life expectancy of the pipeline given that it may be anything from 20 to 40 years old;

• the inspection and maintenance regime required to ensure integrity;

• the risk of corrosion should there be water ingress to the CO2 stream;

• the potential for excessive swelling or explosive decompression of elastomeric seals – requires careful consideration of any components such as valves that are being re-used

• increased risk of propagating brittle fracture..

5. Would it be sensible to conduct much more detailed analysis of those saline aquifers in the North Sea, given the potential storage capacity for CO2?

As the BERR report stresses, we can only guess how much carbon dioxide could be stored in those aquifers, but it's likely to be substantial. Much more research and data in this area could open up significant new business opportunities for the offshore business in the decade ahead.

Conclusion

Making CCS an economic and technical reality is like putting together the pieces of a giant jigsaw puzzle. A large number of players are involved in this game of which the offshore industry is just one.

Although the temptation is to wait, and let the others put down their pieces – so your own role becomes more defined, it is probably sensible to start building CCS analysis into industry planning in 2008.

The government is giving pretty strong signals now that it favours CCS as a major carbon abatement strategy for the UK, and is thinking about how this will become a reality.

The offshore industry seems to be at the centre of that thinking, and that the North Sea will be a major part of a future CCS strategy.

Powerfuel Hatfield Project

Powerfuel is developing a £1 billion 900MW IGCC plant which will implement carbon capture from the outset on its site in Hatfield, South Yorkshire, UK. It has also made an entry to the UK government's CCS demonstration project competition.

Michael Gibbons, Director, Powerfuel Power, began by talking about the change of attitude towards coal as a major part of the energy mix in the EU.

"It was not long ago that [UK government] green papers labeled nuclear and coal as 'undesirables'," he said. "The UK needs 20GW replacement by 2015 [for power generation]; we need coal or gas to make this happen in eight years."

Coal has long been seen as an outdated, dirty option, but has a number of advantages for the UK including its relative abundance, proven and improving technologies and low cost.

The EU and the UK have now recognised that coal is secure, affordable and a long term solution, he said, and the EU goal should be to maintain at least current coal fired power, but move to lower emission including CCS.

"The case for coal is that it can follow demand; you can't do that with renewables. The only problem is CO2 – this is the challenge for coal," he said.

"CCS needs to be implemented urgently," he said. "The EU has now implanted the idea of mandated CCS by 2020. I think this will happen, but only when the technology is proven and there is no risk to mandate across Europe."

However there was still little sign of the necessary funding to make the EU's stated goal of ten to twelve flagship CCS projects happen, he said. "It remains to be seen what EU mechanism will be developed; in the meanwhile we need a support framework for all CCS projects," he said.

As a major financing option the EU Emissions Trading System (ETS) needed to result in a long term stable and robust carbon price, he said. "The carbon price is nearer to what we need to support CCS but still not bankable as a project finance option."

"When the government says it can't afford it, point to the £61 billion from auctioning [carbon permits in Phase 3 of the EU ETS]."

The case for Humberside

The Hatfield Colliery near Doncaster, South Yorkshire is centrally located within a cluster of existing power stations and has around 100 million tonnes of British coal reserves. It is 25 miles from the sea and relatively close to possible CO2 storage sites in the North Sea.

"This is a pretty good place to start in developing infrastructure for CO2."

In total around 80 million tonnes of CO2 could be captured within a 30km radius of the Humber.

"This is the most intensive area in the EU for CO2 emissions, double the level in Rotterdam per square metre," said Mr Gibbons. "We want the government to key on to the cluster concept."

"Yorkshire Forward has organized a careful study of pipeline infrastructure for this area [published on 29th April 2008], showing where CO2 pipelines should go."

"The same study has looked offshore at possible sinks. Around twenty depleted gas fields each taking about 40M tonnes of CO2 were identified, each capable of looking after a power station for many years."

"Two of those have greater than 250M tonnes capacity and of course there are aquifers with very large capacity, so a lot of work has been done defining exactly where the CO2 could go," he said.

The IGCC plant

The vision for Hatfield is to be the first commercial coal fired power station in the world to generate with carbon capture. "We chose IGCC so we could implement CCS from the outset," said Mr Gibbons. The current target date for generation is 2013.

It has received partial section 36 approval for a 450MW installation and an application has been made to double this to 900MW. Companies intending to build power stations with a capacity over 50MW require Government consent under section 36 of the Electricity Act 1989.

Jacobs has had full FEED (Front end engineering and design) from August 2007.

"The case for coal is that it can follow demand; you can't do that with renewables."
- Michael Gibbons, Director, Powerfuel Power

Licenses have already been agreed for Shell gasifiers while Air Products will own and operate the ASU (Air Separation Unit) for O2 supply.

The connection issues to the national grid, which can often be a source of project delay, have already been taken care of, with an 800MW connection available in 2011.

"I can't think of another project with a known fuel source at a known price lasting more than 15 years."

The IGCC will therefore be preceded by a gas CCGT in 2011, although without carbon capture at first. "We have the opportunity to generate early from natural gas and use the grid connection, so we will do it simply because we can, and earn money for the project" he said, "but the priority is always to put coal into the IGCC and capture carbon."

"One side benefit is that the IGCC plant produces H2; we have received some interest from the local council to use it for running buses."

The plant could also supply syngas for the CCGT burner, which would use post combustion carbon capture.

Mr Gibbons raised the idea of a national gas grid for supplying syngas around the country.

The post combustion demo

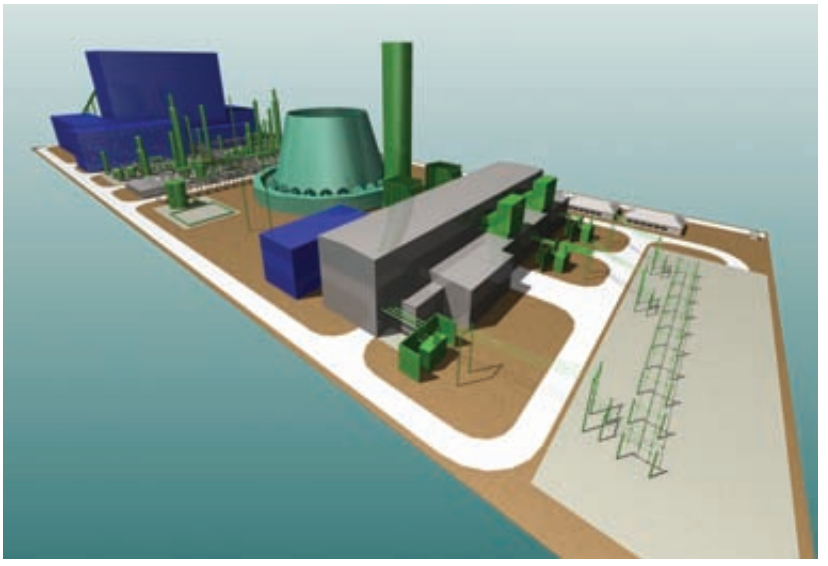
Powerfuel has joined with Jacobs and Clean Energy Systems (CES) for its entry into the UK CCS demonstration project competition. The entry is based on post combustion capture with a pulverized coal plant using oxy-fuel technology.

Mr Gibbons said there were a number of problems with the idea of a small scale standalone demonstration project. "How can you mount a case to the taxpayer for a pipeline if there is a small and unreliable stream [of CO2] from the one demo project? We tried to give the government a solution rather than just pointing out the problems," he said.

He also raised an objection to the choice of technology in relation to interest from countries such as China. "It seems that the Chinese are more interested in IGCC so it doesn't match the objective," he said.

"The advantage of the Hatfield project is that you get two for the price of one; the IGCC provides the O2 and syngas that the demo needs," he said.

It also facilitates CO2 pipeline infrastructure in the region, and the combination with a large CO2 stream from the IGCC plant reduces costs. "The same funding gives a much bigger CO2 reduction and is interesting to the Chinese who have tested gasification themselves," he said.



The proposed 900MW Hatfield IGCC plant in South Yorkshire, UK

References

This article is a report of a talk given at the SMI Gasification conference, London, 14th & 15th April 2008.

www.smi-online.co.uk

Carbon capture projects - leading news

UK government commits 'tens of millions' to CCS pilot project

www.berr.gov.uk

The UK Government has pledged a subsidy worth "tens of millions of pounds" to the winner of its CCS power plant pilot project competition.

Nine companies are currently bidding to build the power plant, which will trial the commercial viability of coal-fired CCS technology.

Speaking at a conference, Michael Jacobs, a Senior Adviser to Prime Minister Gordon Brown, said that the Government was committed to supporting the first CCS power station.

He added that "this is a very big commitment".

However, industry sources were reported as being disappointed by the amount on offer for a project that will cost at least £1 billion in total.

The amount is far less than the government's stated commitment to fund "up to 100% of the additional costs of carbon capture", which are estimated to be up to £1 billion.

E.ON enters UK Government's CCS competition

eon-uk.com

E.ON will be one of the entrants to the Government's carbon capture and storage competition, launched last year.

The company's entry into the competition is based on its proposed Kingsnorth coal-fired project in Kent, which it plans to build CCS-ready in anticipation of this technology being successfully developed.

E.ON is also proposing that a decision on its Kingsnorth planning application is not made until later in the year, following completion of the Government's consultation into what will be required to make a coal-fired power station CCS-ready.

The company's entry into the CCS competition is supported by partners, including:

- Arup - for project management;
- EPRI - for international technology dissemination.
- Fluor - as carbon capture technology supplier;
- MHI - as carbon capture technology supplier;
- Penspen - for pipeline transportation;
- Tullow Oil - for carbon dioxide storage.

March 31 2008 was the deadline for entrants to the first pre-qualification phase of the competition. Successful applicants will now progress to a second round in May.

ExxonMobil to build commercial capture demonstration plant

www.exxonmobil.com

ExxonMobil is committing more than $100 million to complete development and testing of an improved natural gas treating technology which could make CO2 capture more efficient.

The company plans to build a commercial demonstration plant near LaBarge, Wyoming, at its Shute Creek Treating Facility, where it will use ExxonMobil's Controlled Freeze Zone technology (CFZ).

CFZ is a single-step cryogenic separation process that freezes out and then melts the CO2 and removes other components including hydrogen sulfide, as a high pressure liquid stream.

If successful, the process could reduce the cost of carbon dioxide removal from produced natural gas and eliminate the use of solvents and sulfur plants.

The new demonstration plant will advance the CFZ technology to commercial application. It will process about 14 million cubic feet of gas per day for injection and test a wide range of gas compositions to evaluate the extent of its applicability to the world's undeveloped gas resources.

Construction will commence summer 2008 for operational startup in late 2009. Testing is expected to occur over one to two years. The detailed engineering, procurement, and construction management will be provided by URS Washington Division.

CFZ was developed by ExxonMobil Upstream Research Company and has undergone significant improvements since the 1980s, when, in an industry first, it proved the concept of freezing carbon dioxide in natural gas separation with a CFZ pilot plant.

Aker invests up to a billion Kroner in capture facility

www.akercleancarbon.com

Aker will build what its says is likely to become the world's first and largest CO2 capture facility of its kind.

The CO2 capture plant will be in operation by 2009, removing CO2 from exhaust emissions from the natural-gas-fired power plant and gas processing facilities at Kårstø in the southwestern Norwegian county of Rogaland.

The facility will cost around NOK 725 million, with operating costs estimated at NOK 150 million over a three-year period.

However the company says that until a public system for transportation and storage of CO2 is in place, carbon dioxide from the CO2 capture facility will be released to the atmosphere.

Aker says it has worked intensively on developing new CO2 capture technology over the past few years. he primary purpose of the new facility is not primarily further technology development, it says, but the development of construction methods and effective execution models that make carbon sequestration so inexpensive that it becomes cheaper to clean emissions than to pollute.

Leif-Arne Langøy, Aker ASA Chairman and CEO, explained that Aker finds it interesting to invest significant funds in such a project because both the market and potential for future value creation are great.

Aker Clean Carbon has confirmed to Gassnova, the Norwegian state owned company to promote environmentally friendly gas industry technology, that Aker Clean Carbon would like to bid for the front end engineering and design (FEED) contract and, eventually, the construction of a full-scale CO2 capture facility at Kårstø.

According to current plans, a FEED contract will be awarded in May 2008, and an overall contract for building the facility will be awarded in 2009.

Aker Clean Carbon will also work closely with the SINTEF research center and the Norwegian Institute of Technology (NTNU) in Trondheim concerning their efforts to develop new and improved aqueous amine solutions.

Aker Clean Carbon is participating actively in the development work, and will also contribute funding to this development project, which has a total budget framework of about NOK 250 million over a eight-year period.

US subcommittee reviews DOE's plans for FutureGen

science.house.gov/subcommittee/energy.aspx

The House Science and Technology Committee's Energy and Environment Subcommittee held a hearing to review the Department of Energy's (DOE) decision to restructure its signature climate change initiative, FutureGen.

Subcommittee Members questioned

witnesses regarding the process by which DOE made the decision to undertake a major revision of FutureGen and whether this is the best path forward to develop and demonstrate CCS technologies.

Subcommittee Chairman Nick Lampson (D-TX) stated his concerns about the Administration's justification for the major revision of FutureGen.

"Climate change is a tremendous environmental challenge. If we are to meet this challenge, new low- to no- emission technologies are absolutely necessary," he said.

"Our ability to rely upon coal to produce electricity depends upon the successful development and deployment of carbon capture and sequestration systems."

"For the last five years, the Administration has told us that FutureGen was the key project that would move coal-fired electricity production forward. But now they are telling us we must go in a new direction."

In early 2003, DOE announced its plans for a federal pollution-free power plant. By late 2007, the DOE finalized FutureGen's Environmental Impact Statement.

Originally, FutureGen was established to accomplish three main tasks: produce hydrogen, demonstrate CCS technologies, and serve as a test bed for emissions of cleaner coal technologies. Due to growing concerns over climate change, there is a need for the DOE to accelerate the development of CCS technologies in a cost-effective manner.

"We must have a comprehensive, well-managed and coordinated research, development and demonstration program to ensure we design the most effective technology strategy forward to help solve the climate change problem," said Lampson.

"We all know that coal supplies approximately 50% of the electricity in the United States, but we also know that coal-fired power plants contribute considerably to our greenhouse gas emissions. If we need coal for power, then we need technology solutions to burn it more cleanly because the problem of climate change is real."

Early this year, DOE announced a large scale restructuring of the FutureGen Program. Under the revised plan, the agency will join industry's efforts to establish Integrated Gasification Combined Cycle (IGCC) clean coal power plants.

Instead of building a small-scale clean coal power plant, DOE will provide additional funding to multiple IGCC coal power plants for CCS technologies.

Full Committee Chairman Bart Gordon (D-TN) also expressed concern that the revised FutureGen program will delay the demonstration and advancements in CCS technologies.

"I think it is unfortunate that the Department chose to make this sudden shift in the FutureGen program with no congressional consultation," he said.

"I am very concerned that this major revision of FutureGen will delay our development of these technologies which in my opinion is terribly unwise."

"I believe that investment in advanced technologies such as renewables, increased energy efficiency, and carbon sequestration are integral pieces in reducing our greenhouse gas emissions. We cannot afford to take any steps backwards in our federal initiatives to address the challenge of climate change."

Subcommittee Members heard testimony from Mr. C.H. "Bud" Albright, Under Secretary of Energy for the DOE; Mr. Jeffrey N. Phillips, Program Manager for the Advanced Coal Generation EPRI; Mr. Ben Yamagata, Executive Director for the Coal Utilization Research Council; and Mr. Paul W. Thompson, Senior Vice President of Energy Services at E.ON U.S. LLC.

Australian and Japanese firms partner for CCS project

www.jpower.co.jp/english

Three Japanese companies including the Electric Power Development Co. will participate in an Australian project to capture CO2 from a coal power plant.

The two other companies are heavy machinery maker IHI Corp. and trading house Mitsui & Co. The project is a joint venture between CS Energy, the Australian Coal Association (ACALET), Schlumberger, Xstrata Coal and the three Japanese firms.

The Australian Government has contributed $50 million to the project from its Low Emissions Technology Demonstration Fund.

The project, starting in 2010, will cost 20 billion Yen and will test oxyfuel technology developed by IHI and Electric Power Development.

The project will seek to capture 90% of the CO2 emitted from a 30 MWe unit at Callide A power station, located 450 kilometers northwest of Brisbane.

TransAlta and Alstom to develop CCS facility in Alberta

www.alstom.com

TransAlta Corporation, a Canadian power generation company, and Alstom will work together to develop a large scale CCS facility in Alberta, Canada.

The project will pilot Alstom's proprietary Chilled Ammonia Process. TransAlta says it considers the Chilled Ammonia Process as one of the more promising and potentially lowest cost solutions for CCS.

TransAlta's plan with Alstom is to retrofit the technology at one of TransAlta's coal fired generating stations west of Edmonton and reduce current CO2 emissions by one million tonnes per year.

The first phase of the overall project, aimed at advancing and improving understanding of CO2 capture and storage technology, will begin this year with engineering, stakeholder relations and regulatory work at a cost of approximately $12 million (7.5 million).

This, and subsequent phases, are subject to partner and government funding, and will continue over the next five years with testing expected to commence in 2012.

TransAlta has also partnered with experts at the Institute for Sustainable Energy, Environment and Economy (ISEEE), part of the University of Calgary, to quantify CO2 sequestration potential in the Wabamum area west of Edmonton.

The results, due in January 2009, will provide a scientific assessment of potential sequestration sites in the area surrounding several power plants including their capacity and security.

Aibel wins contract for EU CO2 test centre

www.aibel.com

The engineering, procurement and construction management (EPCM) contract for the new European CO2 test centre, to be established at StatoilHydro's Mongstad production plant on the west coast of Norway, has been awarded to Aibel.

Work has already started and the test centre is planned to be completed winter 2010/2011 with CO2 capture testing commencing spring 2011.

The Test Centre Mongstad (TCM) is the result of an agreement between the Norwegian Ministry of Petroleum and Energy and StatoilHydro, to establish a full scale CO2 capture and storage site.

The key objectives are to test, verify and demonstrate novel CO2 capture technologies for national as well as international application. Reducing financial, technical and environmental risk for later full scale applications of the tested technologies is another critical focus area.

The engineering work will be carried out at Aibel's offices at Billingstad outside Oslo and will involve up to 150 people. Fabrication/installation at Mongstad is planned

to take place from 2009.

Two CO2 capture technologies will be tested at the centre, and vendor contracts for these will be awarded separately.

The owners of the TCM are Gassnova, Dong Energy AS, Vattenfall AB, AS Norske Shell andStatoilHydro, with Gassnova representing the Norwegian State in the project.

Gassnova announces four companies to compete for the construction contract at Kårstø

www.gassnova.no

Gassnova announces four companies to compete for the construction contract at Kårstø.

Four companies have qualified for carrying out front end engineering and design (FEED) studies for the CO2 capture facilities that are to be constructed at Kårstø.

The contractors considered to be the best qualified after an assessment of the FEED studies will be invited to compete for the construction contract for the CO2 capture plant to be built in conjunction with the gas-fired power plant at Kårstø.

The four companies are:

• HTC Purenergy Inc. and Bechtel Overseas Corporation from Canada/USA

• Aker Clean Carbon from Norge

• Fluor Daniel Construction Company from England/USA

• Mitsubishi Heavy Industries from Japan

The contract involves constructing CO2 capture facilities, installing pipelines for CO2 transport and storing CO2 in geological formations.

The Kårstø project was transferred from the Norwegian Ministry of Petroleum and Energy to Gassnova SF as of 1 January 2008.

Gassnova SF will present the documents on which the investment decision is to be based to the government in autumn 2009. This recommendation will also include updated financial estimates.

Policy, company and regulation news

CERA launches climate change and clean energy forum

www.cera.com

The Forum will provide industry and government stakeholders with an independent assessment of how new climate change policies, evolving greenhouse gas markets and accelerated investments in clean energy technologies are reshaping the global energy business.

Cambridge Energy Research Associates (CERA), an IHS company, announced the launch at the IHS London Energy Symposium on 16th April 2008.

The Forum builds on CERA's new multi-client study, "Crossing the Divide: The Future of Clean Energy" which analyzes new and conventional energy technologies that can provide a minimal carbon footprint and facilitate greater energy security.

CERA's analysis used a scenarios framework to assess the winners and losers among various clean energy technologies and help define key risks and opportunities as companies seek to place their technology bets.

In the Launch Pad scenario, strong energy prices, growing public pressure to control CO2 emissions, and a stable investment environment coalesce to drive the development and adoption of a wide range of clean energy technologies.

Renewable power capacity grows from three to 16 percent of global capacity and biofuels grow from less than two percent to 16 percent of the total road transportation fuels market.

In contrast to Launch Pad's broad-based advancement of clean energy, the Global Fissures scenario highlights how weaker global economic growth coupled with increasing global tensions and political insecurity could lead to an uneven outlook for clean energy technologies.

In the Global Fissures scenario, renewable power capacity grows to seven percent of the global power mix, but nuclear power experiences little growth and carbon, capture and storage technology fails to develop commercially by 2030.

The Asian Phoenix scenario describes a world where the global balance of geopolitical and economic power shifts to Asia, expanding Asia's role as both consumer and exporter of clean energy technologies.

Although concerns over climate change influence political agendas, a global patchwork of uncoordinated policies result in inconsistent government support programs leading to periods of fits and starts for private investment flows, and limiting technological and commercial breakthroughs.

Renewable power grows to 10 percent of global capacity and biofuels capture seven percent of the market for road transportation fuels.

Carbon Sequestration Leadership Forum meets

www.cslforum.org

Led by 21 nations and the European Commission, the Carbon Sequestration Leadership Forum (CSLF) met in Cape Town, South Africa to develop cost-effective technologies for the separation and capture of CO2 for long-term storage.

Formed in 2003, the Carbon Sequestration Leadership Forum is a voluntary climate initiative of developed and developing nations formed to enable early reduction and steady elimination of large-source greenhouse gas emissions.

Its 22 members, which produce approximately three-quarters of world emissions, cooperate and collaborate in technology development and demonstration projects.

At the meeting, CSLF declared its support for the G8 recommendations for near term deployment of CCS, and agreed on a mechanism leading to an updated CSLF strategic plan.

The meeting also produced recognition of a 20th demonstration project – this one for zero-emissions production of electricity and hydrogen from fossil fuels.

Other results from Cape Town included:

• An examination of CSLF priorities for moving CCS forward that may be recommended to Energy Ministers at the next meeting in 2009.

• Agreement on appropriate initiatives and projects which would form an overarching strategy for removing the barriers for CCS.

• Agreement on an updated roadmap for bridging the gap for affordable technology so as to obtain substantial progress in both emerging and industrialized economies.

• Agreement on creating successful pathways for Capacity Building as the vehi-

cle for the transfer of technologies, knowledge, and experience about CCS to engineers, scientist, and policy makers in emerging economies.

• A resolution to increase the role of stakeholders in implementing the policy priorities, and recognition that stakeholders' expertise is key to assisting in removing the barriers for CCS deployment as they are ultimately responsible for deploying the CCS technologies.

Delegates also continued work on fundamental CCS issues such as financial tools, risk management, regulation, legislation and achieving public acceptance.

These issues and others will continue to be examined at the next conference, a CSLF ministerial level meeting set to convene in London in late 2009.

Forum membership spans the world's largest blocs of economic activity, including the North America Free Trade Area, the European Union and the leading economies of Asia.

Members are Australia, Brazil, Canada, China, Colombia, Denmark, the European Commission, France, Germany, Greece, India, Italy, Japan, Mexico, the Netherlands, Norway, Russia, Saudi Arabia, South Africa, South Korea, the United Kingdom and the United States.

Natural Resources Canada announces $125 million CCS fund

www.ecoaction.gc.ca

The Honourable Gary Lunn, Minister of Natural Resources, has introduced two new funds for the development of clean energy technologies in Canada.

The Honourable Gary Lunn, Minister of Natural Resources

Industry can submit proposals under two new funds:

• A $125 million fund to advance carbon capture and storage technologies that will reduce greenhouse gas emissions from the oil sands and coal-fired electricity plants;

• A $15 million fund to advance the development of technologies that will reduce the environmental impacts of oil sands production, such as tailings ponds.

The announcement was made on a tour at the Institute for Sustainable Energy, Environment and Economy at the University of Calgary.

$5 million was committed to the Institute in the Budget 2008 which it says is intended to ensure that it can collaborate with stakeholders on outstanding regulatory, economic and technological issues in response to the Canada-Alberta ecoENERGY Carbon Capture and Storage Task Force Report.

The Government of Canada invests in CCS in Nova Scotia

www.nrcan.gc.ca

The Government of Canada will provide $5 million to support CCS research in the province of Nova Scotia.

According to the report of the Canada–Alberta ecoENERGY CCS Task Force, CCS technology could allow Canada to cut its greenhouse gas emissions by as much as 600 million tonnes a year by 2050 – an amount equal to almost three-quarters of Canada's current annual emissions.

The potential for underground storage of carbon dioxide in Western Canada is already well known. The new funding from the Government of Canada will be used to assess whether similar CCS opportunities can be developed in Nova Scotia, where coal-fired generating stations supply some three-quarters of the province's electricity.

The Government of Canada's contribution to the research was included in Budget 2008 and will be delivered once legislation has been passed.

Budget 2008 committed $250 million in funding for CCS research. In addition to the $5 million in funding for the Nova Scotia project, Prime Minister Harper announced $240 million for the Boundary Dam Project in Saskatchewan on March 25, and Minister Lunn announced $5 million in funding for the Institute for Sustainable Energy, Environment and Economy at the University of Calgary on April 4.

Alberta launches carbon council

www.gov.ab.ca

The Government of Alberta, Canada has launched a council that will develop a roadmap for implementing carbon capture and storage.

The council will be led by Jim Carter, the former Syncrude president, who was involved in making advances in oil sands productivity and environmental performance, the government said.

"When it comes to implementing carbon capture and storage, Alberta has both the practical and scientific expertise," said Premier Ed Stelmach. "That experience will support the Alberta Carbon Capture and Storage Development Council in making recommendations for industry to move forward with this technology and make sure we get it right."

The council includes representatives from the government and from different sectors including those with expertise in operating pipelines and using CO2 to enhance oil recovery.

The council will develop a roadmap for implementing CCS in Alberta, reporting back to government in the Autumn, and will also respond to recommendations made in January by a federal-provincial task force on CCS.

Setting up the council was a commitment made under Alberta's 2008 climate change strategy. Under the strategy, Alberta committed to reducing projected emissions by 200 megatonnes by 2050. Analysis indicated CCS would account for 139 megatonnes of the total reductions.

Industry and academic members sitting on the council are: Don Lowry, Epcor, Roger Thomas, Nexen, Steve Williams, Suncor Energy, Bill Andrew, Penn West Energy Trust, Dave Collyer, Shell Canada, Kathy Sendall, Petro-Canada, Art Meyer, Enbridge, Randy Eresman, EnCana, and Dr. Mike Percy, University of Alberta.

WWF joins world's leading environment proponents in CCS call

www.wwf.org.au

WWF has joined some of the world's leading environment proponents in calling for the rapid deployment of carbon capture and storage (CCS) demonstration plants.

The conservation organisation says it must be determined as a matter of urgency whether the technology works or not, and whether it will play a role in the world's response to climate change.

"If we reach a three-degree rise in temperature, 35 per cent of species will become extinct. WWF has a responsibility to try to prevent this from happening, which means supporting a range of climate change solutions," said WWF-Australia CEO Greg Bourne.

"Rapid deployment of demonstration plants is necessary to determine whether CCS is practical for broad application, and if it doesn't work we need to know even sooner."

WWF's position is supported by the Intergovernmental Panel on Climate Change, NASA scientist Dr James Hansen, environment groups such as the Climate Institute and PEW centre, pre-eminent research centres, and the vast majority of Govern-

ments.

"There is no single solution to climate change, the world must simultaneously become more energy efficiency, halt and reverse loss of forests, and replace traditional fossil fuels with zero and low emission technologies, including CCS," Mr Bourne said.

WWF's Climate Solutions report finds that if one or two of the zero or low emission technologies fail or are delayed, including CCS, the chance of beating the climate and energy challenge drops dramatically.

"The problem for CCS is that at the current rate of technology developmentit could take 15 to 20 years to contribute to the climate change solution, which would be too late for the planet," said Mr Bourne.

"This is precisely why WWF is calling for a national co-ordinated approach to accelerate CCS technology development, so it contributes to greenhouse gas reduction sooner."

WWF is also calling for a moratorium on new coal-fired power stations without CCS on commission, and for CCS demonstration funding to be levied from the industries known to contribute to greenhouse gas pollution.

"In addition to pursuing acceleration of CCS technology, WWF will continue to push for greater investment and regulation for energy efficiency,renewable energy and adaptation*," concluded Mr Bourne.

*WWF's Federal Budget submission is available upon request.

Basin Electric's coal-based facility at the Antelope Valley Station near Beulah, North Dakota

Basin Electric selects Powerspan for carbon capture demonstration

www.powerspan.com

Basin Electric Power Cooperative has chosen Powerspan's CO2 capture technology for a commercial demonstration at Basin Electric's coal-based facility at the Antelope Valley Station near Beulah, North Dakota.

Approximately one million tons of CO2 will be captured annually from a 120 megawatt slipstream, making this demonstration among the largest in the world.

The captured CO2 will be fed into an existing CO2 compression and pipeline system owned by Basin Electric's wholly owned subsidiary, Dakota Gasification Company.

Loy Yang Power signs with HTC Purenergy for feasibility study

www.htcenergy.com

Australian based Loy Yang Power has signed an agreement to undertake a site specific feasibility study into an integrated carbon management system using the HTC Purenergy CCS technology.

Loy Yang operates a 2200 MW brown coal fired power station in Victoria's Latrobe Valley.

The Purenergy CCS CO2 Capture System is the world's first pre-engineered, prebuilt and modularly constructed CO2 Capture System, which can be retrofitted on existing power plants or any large industrial greenhouse gas emitter facility.

IEA launches CCS regulators' network

Together with the Carbon Sequestration Leadership Forum (CSLF) and University College London (UCL) the IEA has been charged with establishing an International CCS regulators' network to bring together expertise in order to discuss developments in legal & regulatory frameworks for CCS

The IEA will host its launch event on 13-14 May 2008, in Paris.

In the context of the ambitious greenhouse gas (GHG) stabilisation scenarios considered necessary to mitigate climate change, carbon capture and storage (CCS) is receiving increased attention.

Alongside efforts to develop and operationalise appropriate technology for CCS, regulatory and legal frameworks for CCS are now under development in a range of jurisdictions.

The International Energy Agency (IEA) has been charged by the Group of Eight (G8) with tracking and reporting on legal and regulatory advances in CCS, among other activities concerning CCS and a "clean clever and competitive energy future."

As part of this mission, the IEA and the IEA GHG Implementing Agreement are working with the Carbon Sequestration Leadership Forum (CSLF) and University College London (UCL) to establish an International CCS Regulators' Network.

This network will bring together policy practitioners with various areas of expertise, and from local, state/provincial, national, regional and international levels.

The network will provide participants with an objective, neutral forum in which to present case studies and status updates, ask questions, and discuss possible solutions to the challenges faced in developing adequate CCS legal & regulatory frameworks.

Activities

The network will undertake two primary activities:

(1) hosting a series of meetings and internet/web conferences on specific legal and regulatory aspects of CCS;

(2) creating a public IEA website that will document case studies and regulatory developments at the national, sub-national and international levels.

Participation in meetings and web conferences will be by invitation only and will be free of charge.

Non-government and private sector representatives will be involved as appropriate.

The IEA has established an International CCS Regulators' Network to bring together policy stakeholders in a neutral forum to discuss CCS regulations

Issues

Key regulatory areas to be covered by the network include:

- Establishing jurisdiction among different agencies/classifying CO2
- Property rights for CO2 storage and transportation
- Environmental risk mitigation, including public health protection, groundwater protection and protection of flora and fauna
- Monitoring and verification methodologies for CO2 retention in storage sites
- CO2 transport issues, including pipeline access, quality issues and permitting
- Public consultation and acceptance of proposed CO2 storage sites
- Legal status of CO2 when it is stored offshore in international waters
- CCS in the context of emissions trading, GHG markets and a post-2012 international framework for climate change

The International CCS Regulators' Network will be launched by way of a two-day meeting, to be held at IEA Headquarters in Paris, from 13-14 May 2008.

This event will involve presentations and discussions on CCS legal and regulatory developments in various jurisdictions, including the European Union, the USA, Australia, Canada, the United Kingdom, Japan, Norway and in relation to the international marine protection treaties.

It will also involve discussion of monitoring and verification of CO2 retention at storage sites, the treatment of CCS in emissions trading schemes and GHG markets, property rights matters, pipeline siting and access issues, and matters relating to long-term liability.

Finally, participants will discuss prospects and future activities for the Regulators Network itself.

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

Capture Technology

Newcastle scientists develop CO2 conversion process

www.ncl.ac.uk

Scientists at Newcastle University have developed a highly energy-efficient method of converting CO2 into chemical compounds known as cyclic carbonates.

The Newcastle University team, led by Michael North, Professor of Organic Chemistry, estimates that the technology has the potential to use up to 48 million tonnes of waste CO2 per year, reducing the UK's emissions by about four per cent.

Cyclic carbonates are widely used in the manufacture of products including solvents, paint-strippers, biodegradable packaging, as well as having applications in the chemical industry.

Cyclic carbonates also have potential for use in the manufacture of a new class of efficient anti-knocking agents in petrol. Anti-knocking agents make petrol burn better, increasing fuel efficiency and reducing CO2 emissions.

The conversion technique relies upon the use of a catalyst to force a chemical reaction between CO2 and an epoxide, converting waste CO2 into this cyclic carbonate, a chemical for which there is significant commercial demand.

The reaction between CO2 and epoxides is well known, but one which, until now, required a lot of energy, needing high temperatures and high pressures to work successfully. The current process also requires the use of ultra-pure CO2 , which is costly to produce.

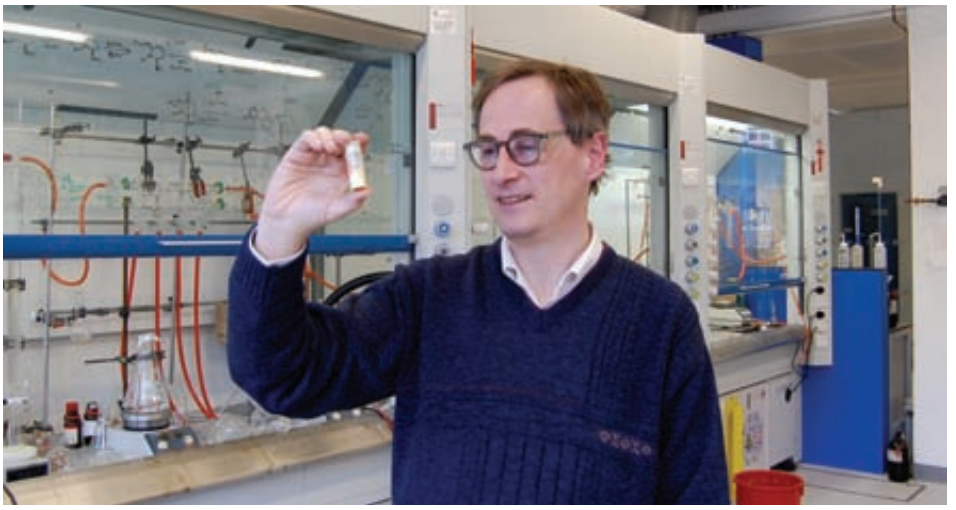
The Newcastle team has succeeded in developing an exceptionally active catalyst, derived from aluminium, which can drive the reaction necessary to turn waste carbon dioxide into cyclic carbonates at room temperature and atmospheric pressure, vastly reducing the energy input required.

To date, alternative solutions for converting CO2 emissions into a useful product has required a process so energy intensive that they generate more CO2 than they consume.

Professor North compares the process developed by his team to that of a catalytic converter fitted to a car.

"If our catalyst could be employed at the source of high-concentration CO2 production, for example in the exhaust stream of a fossil-fuel power station, we could take out the carbon dioxide, turn it into a commercially-valuable product and at the same time eliminate the need to store waste CO," he said.

"To satisfy the current market for cyclic carbonates, we estimate that our technology could use up to 18 million tonnes of waste CO2 per year, and a further 30 million tonnes if it is used as an anti-knocking agent."



Michael North, Professor of Organic Chemistry, in his lab at Newcastle University

The technique has been proven to work successfully in the lab. Professor North and his team are currently carrying out further lab-based work to optimise the efficiency of the technology, following which they plan to scale-up to a pilot plant.

The paper "Synthesis of cyclic carbonates from atmospheric pressure carbon dioxide using exceptionally active aluminium (salen) complexes as catalysts" has been published in the European Journal of Inorganic Chemistry.

Babcock Power and ThermoEnergy agree to develop 'TIPS' clean coal technology

www.babcockpower.com
www.thermoenergy.com

Babcock Power based in Danvers, Massachusetts and ThermoEnergy Corporation have signed a Memorandum of Understanding as a prelude to the formation of a joint effort to commercialise the Company's zero air emission power plant design called ThermoEnergy Integrated Power System ("TIPS").

Based on pressurised oxy-fuel combustion technology, TIPS converts coal, natural gas, oil, and biomass into energy with near-zero air emissions.

In addition, it captures CO2 in a pressurised form ready for sequestration or beneficial reuse such as enhanced oil recovery.

"The simplicity and efficiency of the TIPS approach offers a reliable and cost effective design for carbon-capture, near-zero emission power plants," said Alex Fassbender, President of ThermoEnergy Power Systems.

"With relatively few unit operations, TIPS enhances power plant reliability, while its process efficiency comes from recovering the latent heat of vaporization of produced and entrained water."

"Adding a second reheat to the steam cycle efficiency, coupled with a simple, low-energy process to recover pipeline quality CO2 gives TIPS a competitive edge over other conversion technologies" said Fassbender."

Babcock and ThermoEnergy engineers will begin work immediately to finalise the data needed to design, construct and operate a large-scale pilot plant at a host site.

Electrabel, E.ON and Hitachi to set up CO2 capture testing facility

www.electrabel.be

The three companies will design, build and operate a test facility to investigate the behaviour of different solvents for CO2 capture from flue gases.

The main aim of the project is the execution of scrubbing tests under real flue gas conditions with different chemical solvents; it will be able to treat up to 5,000 Nm^3/h of flue gas.

The test facility will be operated over a four year period and will alternate for periods of 12 to 24 months between different sites at Electrabel's and E.ON Kraftwerke's power plants in Germany, The Netherlands, Belgium or other European countries depending on where the most interesting projects can be performed.

Hitachi Power Europe will be responsible for the design, set up and the operation of the facility and will supply the required personnel.

The anticipated outcomes are an increase of efficiency especially for turbines and steam generators, and also for CO2 capture and emissions reduction.

The companies say the relatively large scale of the test installation will deliver reliable data that can be used in scaled-up facilities.

Senergy Alternative Energy

We interviewed John McCurry, Carbon Storage Manager, Senergy Alternative Energy

Senergy Alternative Energy seem to be one of the more active consultancies in Carbon Storage – how did that come about?

Things really took off from an industry perspective in 2003. Senergy had long been active as geoscience, reservoir engineering and wells engineering consultants to the oil and gas industry since the early 1990s so it was natural for industry to turn to us when getting serious about carbon storage.

The key change was when BP decided to develop the Miller Field (UK North Sea) as a CO2 storage site for the proposed pre-combustion CCGT power plant they were developing with Scottish and Southern Energy at Peterhead.

We already had a management agreement with BP for the field so it was natural for them to want to use us as lead consultants to support subsurface design of the development.

The other key element was that the UK government was already using us to look at CO2 injection into oil fields for EOR (enhanced oil recovery). In fact, David Hughes (Senergy Technical Head Carbon Storage) has been looking at the CO2 injection potential for the government since the early-1980s.

Can you say more about the UK government's role over this period?

Yes. Initially the government was only interested in the EOR potential. They saw UK oil fields depleting over time and wanted to introduce new technologies to maximise mature field production.

This interest started way back in the 1980s, as I mentioned David Hughes had been looking at the CO2 injection options for the government since then. This got more serious after the turn of the millennium, the DTI (now BERR) asked Senergy to set up regular workshops and run an EOR website on their behalf, which we still do today.

Needless to say this was when all the industry interest in CCS was taking off, so a lot of the input to the workshops and website related directly to the carbon storage options for UK fields.

The government then commissioned Senergy to undertake two CO2 injection studies. One of these was an onshore pilot study into a depleted oil field in the English West Midlands and the second involved an appraisal of the technical and economic issues constraining the application of CO2 EOR in the North Sea.

What is your evaluation of the economic potential of EOR in the North Sea?

Well the high oil price certainly helps things and we get asked this a lot. As I stated the Miller field had excellent storage potential and although we have not done the full economics the offshore project may well have been fully commercial without the need for subsidy using current oil prices.

The key issue is as much to do with timing as each field has only a window of opportunity for development before the infrastructure issues become prohibitive – indeed this ultimately was the issue with Miller, all the design work was done and BP could not wait around any longer. You cannot mothball an offshore oil field.

There remain excellent candidates and the best are being worked. We do at least as much work on depleted gas fields and saline aquifers, both in the UK and internationally, and we believe all are part of the solution.

It is certainly advantageous though if a basin has already undergone extensive exploration for hydrocarbons and / or we have dynamic production data.

Do you believe they are getting the promotion of CCS right in the UK and European context?

The UK Government's role has been a positive one. A top civil servant once told me their role was to facilitate and legislate so things could happen, industry's role was to make them happen and I believe he got it about right.

The UK government has been engaged in trying to move things forward in the UK while being influential in a European context and global sphere, particularly China, India and linking with the US.

As we know there is a lot of complexity here regarding legislation and economics that needs international agreement as well as significant ongoing technical work needed on the capture front.

John McCurry, Carbon Storage Manager, Senergy Alternative Energy

The government has grasped the issues and has tried to act with foresight – only time will tell if it has made the right decisions, but the absolute worst would have been not to engage.

So do you think the government got it right in not supporting BP and Scottish and Southern Energy with the subsidy required for the Peterhead-Miller CCS power plant last year?

It was disappointing. The incentive they required was no more than that currently given to other sectors in the energy industry such as wind through ROCs and probably less than that which will be required in the current UK CCS competition.

Miller was an excellent potential storage site. If it had gone ahead, the UK would be well on its way to operating the first large-scale pre-combustion CCS power plant in the world.

When industry decides to move it does so quickly and I believe BP and Scottish and Southern Energy were simply ahead of the game but the structures were not in place in time for the government to provide the incentive required at the appropriate time.

What's your perspective on the UK CCS competition and the government decision to only support a post-combustion project?

We will wait and see. Our expertise is in assessing capacity and containment at the storage sites, injectivity and in monitoring and transportation – these remain the same whether the plant incorporates pre or post-combustion capture so it is not our argument.

You are best to take this up with some of our IGCC clients who have already made their views known. The UK government has taken a punt – there is undoubtedly a future for both.

On the broader competition issues this is a large-scale innovative project which we believe may require more flexibility and more cash than the government initially estimated – in addition to the environmental benefits, the advantages for UK industry of being in the vanguard of a new large-scale emissions free power generation industry are immense.

As an international consultancy active in projects across the industry, presumably you are speaking with power companies, oil companies, progressive technology companies, finance companies and governments; you must have a good perspective on how key industry players view the future of CCS.

Indeed, although confidentiality is absolute and most companies do keep their intentions close to their chests. We work on a need to know basis and are pleased to make connections between companies when asked.

I think it's the international perspective that's most interesting. We have offices in Kuala Lumpur, Abu Dhabi, Perth Australia, Stavanger, London and Aberdeen and are running carbon storage projects out of each of these locations.

It's very easy to get caught up with what's happening in the UK and Europe but it's a global industry and this international experience feeds back into what we bring to clients.

Indeed this highlights one concern that has been noted from a number of industry clients that the government legislators have perhaps become a little too influenced and limited by the 'academic' CCS community and drawn a lot of conclusions based on one or two well known demonstration projects which by their nature tend to be atypical compared with likely commercial projects.

In engineering a range of international projects across saline aquifers and depleting gas and oil fields we see both what is possible and where the showstoppers are.

Certainly there is a need for industry to engage fully with the legislators and for government to be speaking with those with hands on experience.

Can you elaborate?

No I don't want to labour what is a relatively minor point. I believe there is a willingness to listen, it's a case of us all finding the time to communicate effectively and not become too blinkered – I think that's what the international perspective gives you.

So where are Senergy active internationally and what are the drivers for these projects?

Well I've mentioned the different office locations. Some projects intend using the CDM (Clean Development Mechanism, some have an EOR component but really the drivers for most are no different from those in Europe and the US.

Companies increasingly want to avoid making CO2 emissions and are prepared to be innovative in using CCS, they want to be 'greener', they want to raise the profile of their company, but ultimately the commercial drivers will need to be there for them to make it happen.

Continuing on the international perspective how do you see the market developing in China and India?

Both these countries have to be key in any solution to escalating CO2 emissions and indeed both are crucial if we are going to get the incentives in place to make CCS happen, not just there but also in Europe and the US.

I applaud the efforts of the UK Government and the EU to provide the support and cooperation with both that is required and it's good to see the US getting engaged.

I sense a willingness to make this happen, both in China and India, and Senergy is keen to combine its expertise with the considerable Chinese and Indian capability that already exists to engineer local CCS solutions.

So back to Senergy - your Carbon Storage Team is part of Senergy Alternative Energy - how does this differ from Senergy?

Yes, good question. How are we organised? Well Senergy employs over 230 consultants in geoscience and reservoir / well engineering across six international locations and has traditionally focused on oil and gas projects.

The Senergy team: From Left – John McCurry, David Hughes, Mark Raistrick, Andy Beckly.

Our Carbon Storage Team is led by myself as Carbon Storage Manager and David Hughes as Technical Head. Andy Beckly has lead responsibility for Geoscience and Mark Raistrick for Monitoring. We are the four core team members and we have a wider CO2 Technical Team of about 20 consultants working on carbon storage projects.

In addition we bring in expertise from the wider pool of 200+ consultants as required. Senergy has been expanding rapidly and has ambitious plans for carbon storage and alternative energy, including expansion into geothermal power and offshore wind energy. We set up Senergy Alternative Energy under the directorship of Nial McCollam earlier this year to take this forward and as well as reflecting our own vision of the future it fits well with that of our clients.

So you see an exciting future ahead?

Yes, we are at a time of great challenge and great opportunity for energy in addressing the paradox of meeting increasing demand, while resolving the difficult environmental issues and doing all this in a commercial environment.

It is these issues we are all grappling with and certainly the changes over the next 10-20 years will make it a stimulating time for us all to be working in energy.

For more information about Senergy contact:

John McCurry
john.mccurry@senergyltd.com

or visit the Senergy website at:
www.senergyltd.com/carbon

The Gorgon LNG project

The Gorgon Project will be one of the most energy efficient liquefied natural gas (LNG) developments in the world, and will use CCS to reduce its greenhouse gas emission by around 40 per cent.

www.gorgon.com.au

The Gorgon Project, with an estimated resource base of more than 40 trillion cubic feet of gas located up to 200 kilometres offshore and in water depths of up to 1300 metres, has a nominal development life of around 60 years.

It is operated by the Australian subsidiary of Chevron in joint venture with Australian subsidiaries of ExxonMobil and Shell.

Producing just 0.353 tonnes of CO2 per tonne of LNG, it is one of the most efficient LNG developments in the world.

This has been achieved as a result of a number of factors:

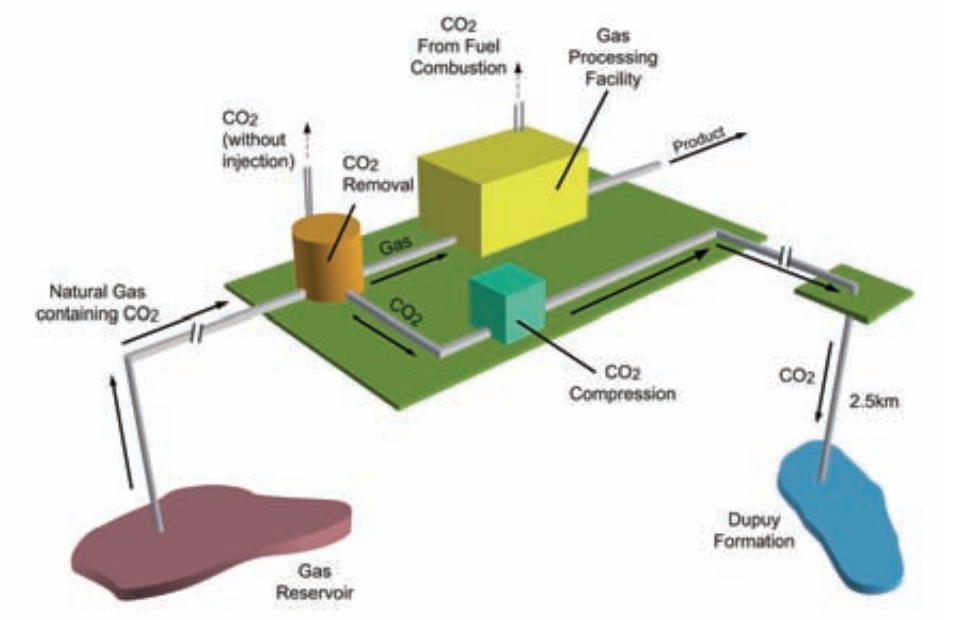
• replacement of the offshore gas processing platform with an all sub-sea development

• replacement of the offshore gas processing platform with an all sub-sea development

• changes in LNG process technology

• improved waste heat recovery on the gas turbines resulting in a significant reduction in the use of supplementary boilers and heaters

• significant reduced greenhouse gas emissions resulting from the injection of reservoir carbon dioxide into the subsurface.



Major CO2 sources for the Gorgon project

CO2 injection

CO2 Injection into the Dupuy Formation, a saline formation located more than two kilometres beneath the surface of Barrow Island, will reduce the Projects' greenhouse gas emissions by approximately 40 per cent.

"The project's Barrow Island location, located 60 kilometres offshore north Western Australia, presents a unique geological opportunity to reduce the Gorgon Project's greenhouse gas emissions through injection of reservoir CO2," said Chevron.

The CO2 Injection program was extensively documented and subjected to public comment as part of the Gorgon Project's Environmental Impact Assessment Process conducted under Australian and Western Australian governments' approval framework.

Following this process the Western Australian Environment Protection Authority found that the environmental risks associated with the carbon dioxide injection project were acceptable and recommended that CO2 injection must proceed as an integral component of the Gorgon Project.

"The carbon dioxide injection project will be one of the world's largest CO2 Injection projects and will make a valuable contribution to the commercial demonstration of this technology," said Chevron.

The Gorgon Project has undertaken a drilling and injectivity testing program in the injection area, to gain additional data to support the proposal to inject CO2 beneath Barrow Island.

This data augments the existing knowledge that the Gorgon Project's operator, Chevron Australia, has of the Barrow Island environment and geology which the company has gained from operating Australia's largest and oldest onshore oilfield on the Island for the past 40 years during which time more than 1000 wells have been drilled.

The Gorgon Project has also been offered a $60 million grant under the 2006 Australian government's Lower Emissions Technology Development Fund (LETDF) program to assist in the commercial scale demonstration of CO2 injection technology.

Monitoring

The Gorgon Joint Venturers have given an undertaking to make monitoring data from the carbon dioxide injection project publicly available.

A range of monitoring activities is planned as an integral component of the CO2 injection proposal.

These monitoring activities will include routine observation and recording of injection rates and surface pressures at the injection wells; health, environment and safety motivated surveillance to detect the unlikely event of CO2 migrating to the surface; and measurement via well and/or seismic surveys to track the migration of the CO2 plume in the subsurface.

The use of seismic surveys and well pressure data will provide information required to update the reservoir models used to predict the behaviour of the injected CO2.

A Reservoir Management Plan will be developed to integrate the monitoring activities, reservoir modelling and the management of injection operations.

"The availability of this data will provide a valuable resource to researchers and facilitate the ongoing development of CO2 injection technology," said Chevron. "This will assist with developing Australia as a centre of excellence in geosequestration technology."

CO2CRC launches first CO2 storage project in Southern Hemisphere

The CO2 Otway project involves compressing and transporting 100,000 tonnes of CO2 and then sequestering it in a depleted natural gas reservoir two kilometres below the Earth's surface.

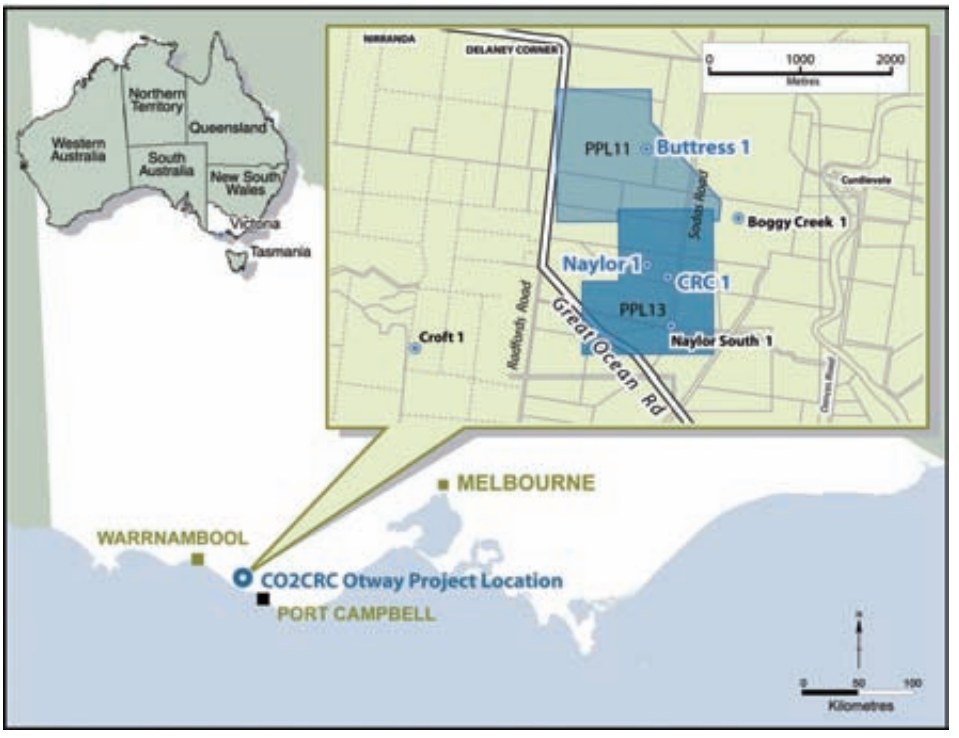
www.co2crc.com.au

The Otway Basin has a large source of natural CO2 and an abundance of now-depleted gas fields containing rock formations with a geologic history of permanent storage.

CO2 will be produced from an existing well, then compressed to a supercritical state to more efficiently move and store it at a final location.

"The launch of the project has a very important role in demonstrating the technical and environmental feasibility of geosequestration to Australia and the world and preparing the way for its widespread application," said CO2CRC Chief Executive Dr Peter Cook.

Another project outcome was the establishment of one of the world's first CCS companies, CO2CRC Pilot Project Ltd, which was set up specifically to manage the operations of the Otway Project on behalf of CO2CRC.



Location of the Otway project (image copyright CO2CRC)

Monitoring the CO2 storage

According to Dr Cook a key feature of the project is that it involves one of the world's most comprehensive subsurface CO2 monitoring programs ever undertaken, which was designed, developed and implemented by CO2CRC researchers from Australia, New Zealand, the USA and Canada.

Monitoring the Soil

Soil gas sampling aims to evaluate the gases associated with natural gas deposits including naturally occurring CO2, hydrocarbons such as methane, and oxygen and nitrogen.

During the survey, researchers will evaluate naturally occurring CO2, methane, oxygen and nitrogen, which are the usual gases found near CO2 sources.

This work will provide CO2CRC with a baseline against which researchers can compare the soil tests that will be undertaken throughout the CO2CRC Otway Project and identify any changes to the soil gas chemistry that may take place.

"There could be a number of reasons for changes to the soil gas levels. The baseline surveys undertaken by CO2CRC would enable us to identify the reason for those changes."

The area has a variable geology that includes limestone, sand dune, swamp/lake and river sedimentary deposits.

Each geological variation results in the production of different soil and soil gas chemistry, which in turn affect the biology and productivity of the area.

Soil gases will also differ depending on climatic conditions; for example warmer conditions lead to enhanced biological production and in time increased concentrations of CO2 in the soil.

The survey will also detect any gases from deeper natural gas sources including natural hydrocarbons and CO2.

The baseline soil sampling will cover the immediate area where the CO2 will be injected and areas where CO2 has naturally accumulated in the past and is currently stored.

The soil gas surveys will continue throughout the life of the project.

Monitoring the Water

As part of the monitoring program, CO2CRC researchers will sample and analyse the groundwater in wells, both public and private in and around the pilot project area, throughout the life of the project.

The groundwater tests have the same objective to that of the soil gas surveys: to identify the baseline or current levels of CO2 in the water and monitor those levels for the life of the project.

As with the soil gas surveys, CO2CRC will investigate the cause of any changes to the composition of the groundwater. Reasons for such changes include seasonal variation, climate, drought or high rainfall, landuse and geology.

Monitoring the Air

CO2CRC has set up atmospheric or air monitoring program that, like the soil gas surveys and the groundwater sampling, will record baseline or current levels of CO2 in the air.

The monitoring is planned to start well

before operations begin and will continue through the life of the project. It will take place at the CO2 source well (Buttress) and storage reservoir site at the Naylor-1 well.

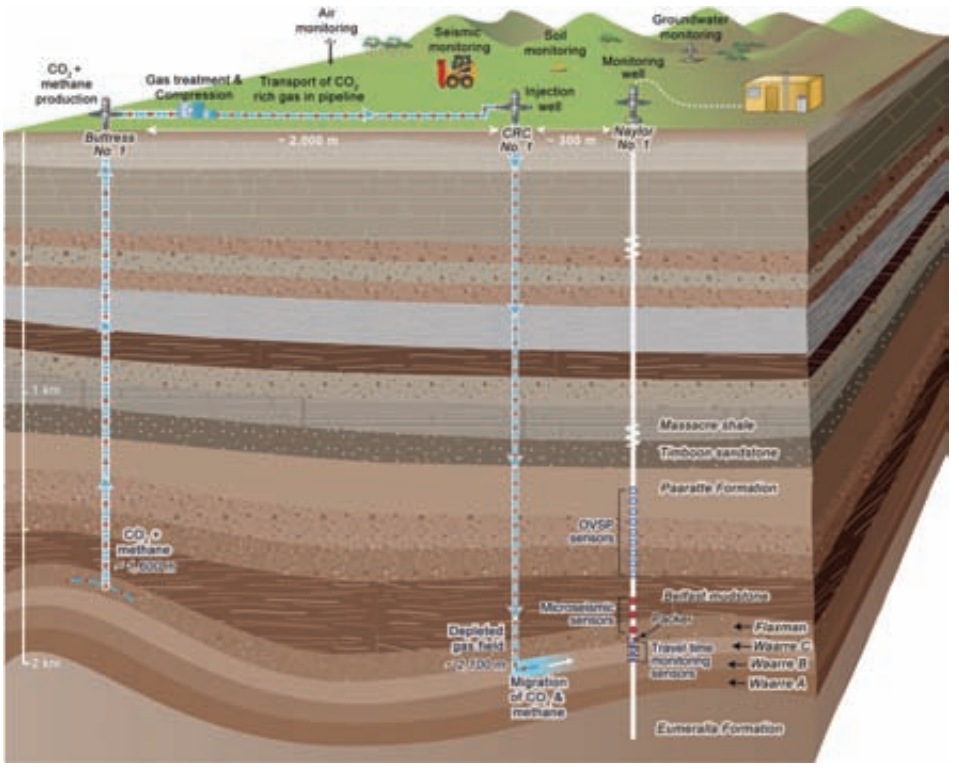
Monitoring the subsurface

In research sponsored by the US Office of Fossil Energy's National Energy Technology Laboratory (NETL), the Lawrence Berkeley National Laboratory (LBNL) developed instrumentation that will be used to track the CO2 plume during and after the injection.

Sophisticated seismic techniques will provide data about the location, migration, and permanent storage of the CO2 plume.

Another technique is a unique formation well sampling method that taps the reservoir and delivers fluid samples to the surface for determination of CO2 content and other geochemical analyses.

Using geophysical, geochemical, and other reservoir data acquired during storage operations, the researchers will also be able to refine models to significantly increase the predictability of formations to permanently store CO2.



Schematic of the Otway site (image copyright CO2CRC)

Transport and storage news

StatoilHydro begins CO2 injection at Snøhvit

www.statoilhydro.com

The carbon injection systems at Melkøya are now online, pumping carbon dioxide to the Snøhvit field for storage.

The first carbon flow reached the formation where it was stored on 22 April 2008.

At full capacity on Snøhvit, 700,000 tonnes of CO2 will be stored per year, which equals the emission volume from 280,000 cars.

The natural gas which is piped from the Snøhvit field to Melkøya outside Hammerfest contains five to eight percent CO2.

At the onshore plant on Melkøya, CO2 is separated from the natural gas and piped back to a formation at the edge of the Snøhvit reservoir, where it is stored 2600 metres beneath the seabed.

CO2 is injected into a sandstone formation called Tubåsen. A shale cap which lies above the sandstone will seal the reservoir and ensure that the CO2 stays underground without leaking to the surface.

Development at the Melkøya plant. Photo: Eiliv Leren / StatoilHydro

Carbon storage on the Snøhvit field is StatoilHydro's second large carbon storage project in Norway. One million tonnes of CO2 are already stored annually beneath the seabed on the Sleipner field. StatoilHydro is also involved in carbon storage on the gas and condensate field In Salah in Algeria in cooperation with BP and Sonatrach.

StatoilHydro reports 10 million tonnes of CO2 stored at Sleipner

www.statoilhydro.com

Over 10 million tonnes of CO2 have been stored in the Utsira formation since the project was started in 1996.

2,800 tonnes of CO2 are removed from natural gas produced on the Sleipner West field in the North Sea every day.

CO2 capture is done at Sleipner with a conventional amine process. It was a challenge to design this process compact enough so that it could be placed on an offshore platform in the middle of the North Sea, 250 kilometres from land.

The CO2 is injected and stored in the Utsira formation, a salt water containing sand layer, rather than being emitted into the atmosphere. This sandstone formation extends over a large area in the Norwegian sector of the North Sea.

The facility has been online since the autumn of 1996 recording a very high regularity, says Statoil.

Research and monitoring of the carbon injection into the Utsira formation show that the greenhouse gas is retained in the formation and that this is an environmentally friendly and safe way of reducing climate gas emissions.

"We wish to build on the experience we have gained through 12 years of operations employing carbon capture and storage techniques," says Sjur Talstad, vice president, Sleipner production.

Used for other discoveries?

The Sleipner organisation is exploring the possibilities of offering other petroleum discoveries in the area the opportunity to process gas, remove CO2 from the gas and store it in the Usira formation.

The possibility of receiving carbon dioxide from land for injection into the Utsira formation is also being considered.

The EU aims to cut Europe's carbon emissions by 20 percent by 2020. Carbon storage may be one of several necessary actions.

A decision by the EU Parliament as to whether, and on what conditions, such storage may be permitted is scheduled for 2008.

The Sleipner T platform where CO2 is separated from the well stream. Photo: Dag Myrestrand / StatoilHydro

Montana carbon sequestration study receives state funding

www.montana.edu

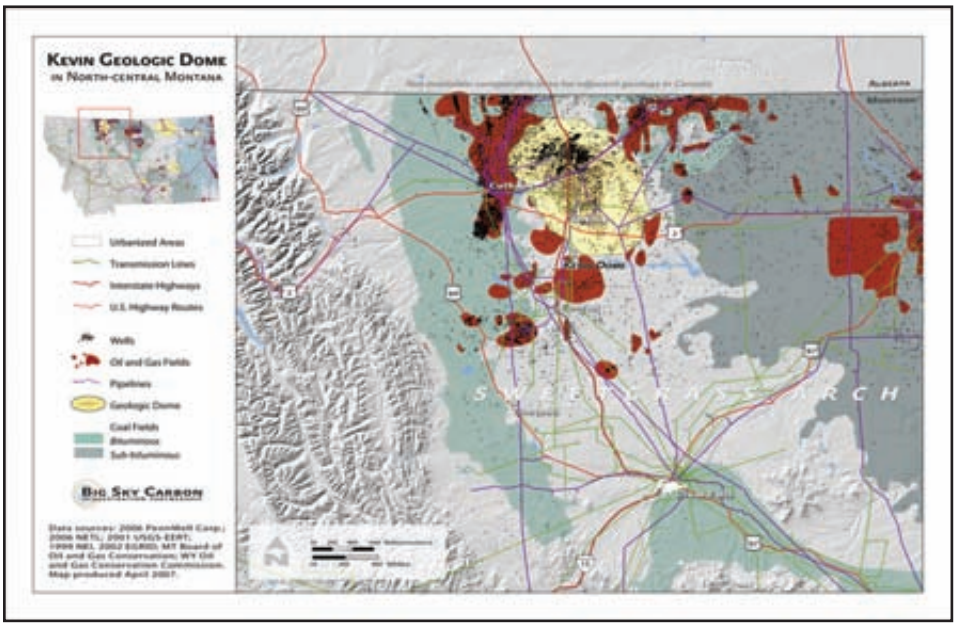
Montana State University's (MSU) Big Sky Carbon Sequestration Partnership has received a $157,000 grant from the Montana Board of Research and Commercialization to help fund a study of the potential for geologic carbon sequestration at Kevin Dome in northern Montana.

The study is a part of the partnership's Validation Phase research activities being funded by the U.S. Department of Energy's National Energy Technology Laboratory.

Kevin Dome is a subsurface dome-shaped rock structure. This study, led by MSU geologists David Bowen and David Lageson, will evaluate the potential of the dome as a storage site for man-made carbon dioxide emissions.

The scientists will use existing well logs, core samples and a variety of subsurface data, including seismic surveys, to characterize the porosity, permeability, thickness, areal extent, and structural features of the dome.

The similarity of Kevin Dome to other large domes in Montana and Wyoming make this an important research opportunity with regional significance, according to MSU scientists. Field activities are planned to take place during this summer.



The Kevin Dome in North Central Montana

The Big Sky Carbon Sequestration Partnership is one of seven regional partnerships funded by the U.S. Department of Energy to work on the best approaches for capturing and permanently storing greenhouse gases.

The Big Sky partnership relies on existing technologies from the fields of engineering, geology, chemistry, biology, geographic information systems and economics to develop novel approaches for both geologic and terrestrial carbon storage in this region.

Saskatchewan carbon storage project planned

www.arc.ab.ca

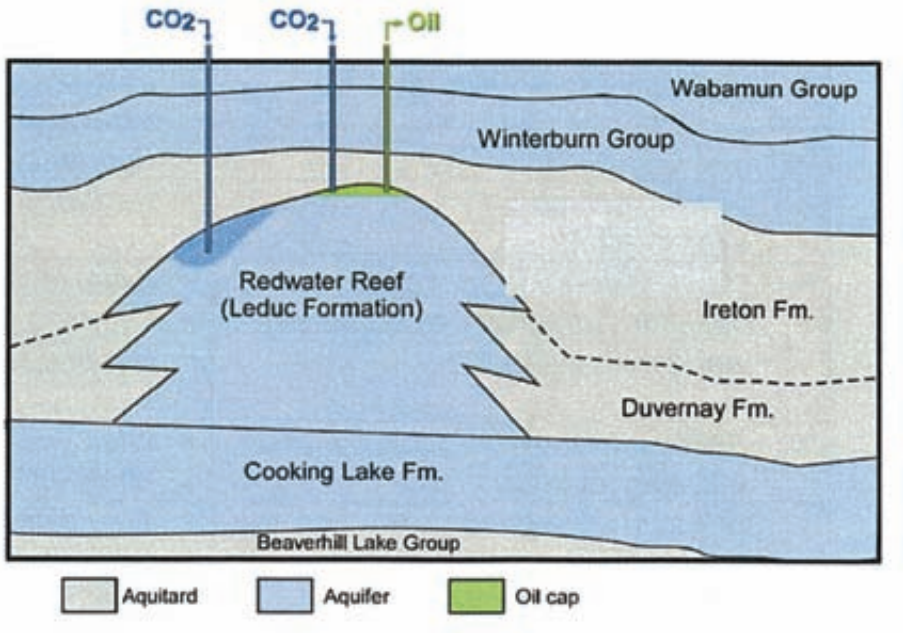
The Alberta Research Council and ARC Energy Trust of Calgary have teamed up to create the Heartland Area Redwater Project (HARP), an initiative to evaluate the potential for the Redwater Leduc Reef complex to store as much as 1,000 Megatonnes of CO2.

This could accommodate more than 20 years worth of CO2 emissions from the large emitting facilities existing and planned for the Industrial Heartland Area.

"We've looked at the geology across the province, and we feel this area has ideal attributes for a CCS project," says Dr. William Gunter, the Alberta Research Council's principal scientist for CCS.

"Reducing emissions related to Alberta's oil sands production is a top priority," says Gunter. "This reef is directly underneath Alberta's Industrial Heartland, which translates into less transportation infrastructure and the least-cost method of carbon storage for industries in that area."

The project brings together government, industry and research scientists to work collaboratively on proving that the Redwater Reef complex can provide a long-term solution for greenhouse gas emissions from Alberta's Industrial Heartland.



The Redwater Leduc Reef formation showing CO2 injection for storage and EOR

The Heartland Area Redwater Project has three phases: phase one will evaluate in detail the size and suitability of the site for CCS, phase two will involve the drilling of a well to collect more detailed data, while phase three is planned to demonstrate actual CO2 injection and storage.

The $1.8 million first phase is being funded by ARC Energy Trust, the Alberta Energy Research Institute (AERI) and Natural Resources Canada (NRCan). Phase one is scheduled to be completed in spring 2009.

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