GLOBAL CCS INSTITUTE

FOCUS ON CCS

OPINION LEADERS SERIES

CCS at a Crossroads

By Howard Herzog

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About the Author

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Focus on CCS - Opinion Leaders Series

Focus on CCS is the theme of a series of opinion articles by world leading authorities on carbon capture and storage (CCS) and their perspectives on the role for the technology in reducing our carbon dioxide emissions. The series is published by the Global CCS Institute to contribute to the conversation about CCS within the portfolio of technologies to help tackle climate change. The views expressed remain those of the author and not necessarily those of the Institute.

CCS at a Crossroads

By Howard Herzog

Every Saturday night
I felt the fever grow
Do ya know what it's like
All revved up with no place to go
- Meatloaf (1977)

Last October, the world's first commercial-scale Carbon dioxide (CO_2) Capture and Storage (CCS) coal-fired power plant came online at Boundary Dam in Saskatchewan, Canada. Also last year, CCS was front and center in the Intergovernmental Panel on Climate Change Fifth Assessment Report on the Mitigation of Climate Change, being mentioned 39 times in its Summary for Policy Makers (compared to wind and solar at four times each). In its roadmap for mitigating climate change, the International Energy Agency has repeatedly said CCS is a key technology.

Given the above, this should be a time of great joy and optimism in the CCS community. Yet the reality is CCS is at a crossroads and its role in a carbon mitigation portfolio is very uncertain. In the immortal words of Meatloaf, we are "all revved up with no place to go".

To understand how we arrived at this crossroads, we need to review the history of CCS. Significant research programs in CCS were first initiated in the early 1990s, around the time the United Nations Framework Convention on Climate Change (UNFCCC) was being drafted at the Earth Summit in Rio. This timing was not a coincidence as there is a strong relationship between technology development and policy development. This relationship is critical to the future of CCS and understanding why we are at a crossroads today.

From the 1990s to about 2009, there was great growth in CCS. Statoil's Sleipner project, which captured CO_2 from a natural gas processing plant, started-up in 1996 in the North Sea off Norway. It was the world's first large-scale (greater than a million tons of CO_2 per year) CCS plant, demonstrating that CCS was a commercial reality. Over the next decade, CCS saw explosive growth, as measured by a variety of metrics such as size of research budgets, number of papers published, and number of pilot and demonstration projects.

CCS was flying high in 2009. President Obama was just elected and there was immense optimism that the US Congress would pass cap-and-trade legislation. There was also optimism that the Conference of the Parties (COP) to the UNFCCC meeting in Copenhagen would produce a new international agreement to supersede the Kyoto Protocol. In the US, the CCS research, development and deployment (RD&D) budgets were effectively tripled for the next seven years with the injection of US$3.4 billion of stimulus funds. In Europe, the NER300 program was established to incentivize up to a dozen CCS demonstration projects to come online by 2015.

However, things did not turn out as planned. In the US, instead of cap-and-trade legislation, we now have snowballs in the Senate. Copenhagen was a failure. The NER300 program produced exactly zero demonstration projects, while the US saw the cancellation of FutureGen, its largest and most visible demonstration project.

The news was not all bad. In addition to the previously mentioned Boundary Dam project, CCS projects at a refinery and an ethanol plant are operational. Two additional CCS power plant projects, Kemper and Petra Nova, are under construction, and a third, the Texas Clean Energy Project, may follow.

The number one reason for CCS not meeting the expectations of 2009 has been the lack of market development. Because it is always cheaper to emit CO_2 to the atmosphere than to capture and store it, markets will only evolve if climate policy is put in place that forces reduction of atmospheric CO_2 emissions. We thought it was imminent in 2009, but that was just an illusion.

Today, the exact timing and extent of climate policy is not at all clear. This makes it hard for industry to make big investments in CCS. Companies that have made significant investments in CCS are now cutting back or dropping out. Of the many examples, the following two illustrate just how substantial this retrenchment has been. Vattenfall, a large European utility, invested €100 million in a CO_2 capture pilot plant in Germany in 2007, but recently abandoned all its CCS RD&D. This included dismantling the pilot plant. Schlumberger, a world leader in subsurface technology, has been involved in almost every major carbon storage project around the world through its Carbon Services unit. Earlier this year, it was announced that Schlumberger Carbon Services was closing down.

The current situation has led many in the CCS community to conclude that although the technology is ready to go, we need climate policy to lead us forward. In October 2014 at the 12th International Conference on Greenhouse Gas Control Technologies, 'GHGT-12', Professor David Victor of the School of Global Policy and Strategy at UC San Diego responded in a keynote talk. Paraphrasing, he said if you are waiting for climate policy to lead, you will be waiting a long time. In other words, policy generally does not get way out in front of the technology. Instead, policy and technology generally move forward together. Unfortunately for the technology developers, as well as the climate scientists who advocate for limiting the warming to 2^{o}C, the pace is excruciatingly slow.

The next big international event in climate policy is the COP meeting in Paris in November. My reading of the tealeaves is that it will almost certainly be hailed as a great success because: (1) most countries will submit plans to limit their greenhouse gas emissions and (2) it will reaffirm the 450 parts per million (ppm)/2^{o}C stabilization target. However, the countries with the largest emissions have already submitted or announced their plans and they fall far short of stabilizing CO_2 concentrations in the atmosphere at any level, let alone 450 ppm. By themselves, these plans will not incentivize any large-scale deployment of CCS. Worse still, Paris will push the timeframe for any stronger climate policy out for at least another decade.

On the bright side, even with limited "market pull" from climate policy, CCS can keep moving forward if there is appropriate "technology push". This can be accomplished through energy technology programs that bridge the gap between the current costs of CCS and the price the market can afford to pay today. The number of CCS projects incentivized through this approach will be much smaller than with a robust climate policy, but it is the best hope for deploying CCS in the nearer-term.

Renewables have enjoyed a large technology push from governments worldwide, including investment tax credits, production tax credits, feed-in tariffs, and portfolio mandates. Similar programs for other low carbon technologies like CCS and nuclear have been lacking. Why is this so? Part of the reason is political. Both nuclear and CCS lack the advocacy that is associated with renewables. But beyond that, the scale of the projects makes policy more difficult to implement. A rooftop solar project is typically less than 10 kilowatts (kW), while a utility solar project may be 20 megawatts (MW). However, CCS projects are measured in 100s of MW with costs in the billions of dollars. While solar projects can be developed and built in less than a year, CCS projects take at least several years. On the other hand, one CCS project can save millions of tons of CO_2 per year, more than tens of thousands of rooftop solar installations.

The Boundary Dam project is a good example of how market pull and technology push can work together to incentivize CCS. On the policy side, Canada requires that all coal-fired power plants that turn 40 years old either have to do a CCS retrofit or shut down. One of the coal-fired units at Boundary Dam needed upgrading, so this left SaskPower with two choices, either retrofit the unit with CCS or replace it with a natural gas combined cycle (NGCC) unit. Since Boundary Dam is powered by lignite, an asset that SaskPower owns and would become stranded if they repowered with gas, they preferred the former option. To proceed, they needed to show that the retrofit option was economically competitive with the NGCC option. This was accomplished with the help of a US$240 million subsidy from the Canadian government (about 20 per cent of the original projected capital cost), as well as the opportunity to sell the captured CO_2 into the Enhanced Oil Recovery market.

Going forward in the US, the market pull can come from the newly released Clean Power Plan, which will require utilities to reduce CO_2 emissions by 32 per cent by 2030 from 2005 levels. On the technology push side, the US Department of Energy's fiscal year 2016 budget request to Congress included a 30 per cent investment tax credit for CCS, as well as a production tax credit of US$50 ton/$CO_2$ stored. These incentives compare very favorably to those that drove Boundary Dam forward and, if approved, should help incentive some CCS projects in the US.

Technology push can take many forms. In the UK, a £1 billion competition is underway to help fund two CCS demonstrations. In addition, these facilities would qualify for a "contract for differences", which would have a similar impact as a production tax credit. In the EU, there is talk of a new NER program (hopefully better thought out this time) to help pay for pay down the capital costs of a CCS plant.

While having a robust climate policy to limit CO_2 emissions is necessary for CCS to flourish, it is not sufficient. CCS has to be competitive with the other large-scale, low-carbon supply technologies, specifically renewables and nuclear. Study after study has shown all of these low-carbon technologies are needed. Furthermore, they say without CCS, the costs of meeting stabilization targets are greatly increased. These results are not surprising because of the inherent strengths of CCS. It produces dispatchable power, as opposed to intermittent power from wind and solar. It provides the major pathway to negative emissions when combined with biomass-fired power plants. Finally, it is the only mitigation technology that can rescue potentially hundreds of trillions of dollars of stranded fossil assets.

In summary, CCS is a critical technology if we want to meet long-term climate goals. However, CCS needs to be driven by climate policy and the resulting climate markets. These have been very slow in developing. In order to keep moving CCS forward, stronger technology push programs are needed today. These programs have been successfully applied to renewables. If similar efforts are applied to CCS, the results would be even more successful.

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