CCS: Another Inconvenient Truth

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As questions over the reality of climate change recede and are replaced with the search for solutions, it is high time to take a sober look at the options for reducing greenhouse gas emissions, especially carbon dioxide. Power generation, with its reliance in many parts of the world on coal, is the single largest contributing sector for anthropogenic CO_2 emissions, so the industry finds itself—voluntarily or otherwise—at the forefront of mitigation efforts.

Renewables, nuclear and second-generation (and beyond) biofuels will all be part of the portfolio. But our ability to rapidly deploy them cost-effectively and at the scale required to accommodate the planet's growing electricity needs is highly questionable. We need to remember too that the largest growth in power generation is occurring in emerging regions, China and India in particular. These countries cannot afford high-cost alternatives to fossil fuels but CO_2 is CO_2 wherever it is emitted.

That leaves the onus on fossil-fuelled power generation to come up with ways of reducing CO_2 emissions quickly. This is a complex, multi-faceted problem but the first step is uncontroversial: energy efficiency must be a priority. It's a very easy formula to understand: reduce the energy needed to make your product, satisfy the regulators, save money and enhance your bottom line. With investments in automation, control and optimization, significant reduction in fossil fuel use can be realized with benefits both economic and environmental.

However, energy efficiency is a necessary, not sufficient, imperative. In order to limit the impact of greenhouse gas emissions on climate change, CO_2 reductions on the scale of 90 percent or more need to be targeted.

It's time to face the power industry's—for that matter, the whole manufacturing industry's—own inconvenient truth: given what we know today, carbon capture and sequestration (CCS) is essential for CO_2 reduction in power generation. It's inconvenient because there is no business case for CCS. It is a technology that increases cost of production and reduces the efficiency of generating plants. From a commercial investment perspective CCS is not viable without regulatory or economic incentives. But the truth is that if fossil fuel is to be used for power generation then a significant proportion of that capacity must be fitted with CCS, at least until other sources of energy are available at a scale and cost that enable a global shift away from fossil-fuelled power.

CCS consists of capturing CO_2 emissions from a process, compressing it, transporting it via pipelines or ships and storing it underground. Implementations of all elements of the CCS chain already exist. For example, operational CCS facilities are storing on the scale of a million or more tons of CO_2 underground per year. On the transportation side, a few thousand miles of pipelines in the U.S. supply CO_2 for enhanced oil recovery today. (EOR has also been used for some time in China.)

What we lack as a critical milestone on the road to fully commercial CCS are integrated demonstrations of CCS for power generation plants. But, as should be apparent from the projects operating in other sectors, getting there from here does not require rocket science-caliber breakthroughs.

Let's not overlook the inconvenience, however. The techno-economics of CCS, and especially of the capture processes for conventional coal power plants, are simply not favorable today. The capital and operational costs associated with CCS for pulverized coal plants—"post-combustion" CO_2 capture—impose 25 percent to 30 percent or higher penalties on overall efficiency.

Alternatives to post-combustion capture can offer cost and efficiency benefits. Integrated gasification combined cycle (IGCC) plants permit "pre-combustion" capture and are cheaper to equip with CCS and also cheaper to operate. An emerging alternative to conventional coal power is oxy-fuel combustion, in which the coal or other fossil fuel is burned in oxygen instead of atmospheric air. Research and development efforts are underway on capture technologies for all combustion processes, especially post-combustion—improvements here are crucially needed since the installed coal power base is comprised almost entirely of pulverized coal plants.

One opportunity that holds across-the-board promise is "co-design," a term that refers to the integration of automation (including control and optimization) and process technology considerations during design. Processes can be optimized to reduce equipment size and consumables and to improve overall efficiency thereby reducing capital and operating expenditures

Several actions are needed to realize the promise of CCS: achieving large scale CCS implementation at manageable and definable cost. We need

- to promote the deployment of the technology in order to start gaining experience with it,
- to forge ahead on research and development to improve efficiencies and reduce cost,
- to establish economic and/or regulatory incentives to make CCS commercially viable.

These actions need to be pursued aggressively and expeditiously if we are to succeed in making the inconvenient truth of CCS "convenient" for industry and society. pe

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