Carbon Capture and Storage in the Industrial Sector

The world's leading climate change experts advocate that carbon capture and storage (CCS) deployment reduces the costs and risks of achieving goals under the United Nations, both sustainable development goals and climate goals under the Framework Convention on Climate Change (UNFCCC). Considerable progress has been achieved to date in the research and development (R&D) as well as demonstration and global deployment of CCS. There are now 15 large CCS projects in operation worldwide (including the world's first large-scale CCS project in the power sector). Seven additional projects are expected to come online in 2016 and 2017, and there are more projects in the planning and development phases. Nonetheless, challenges and barriers to wide-scale CCS deployment remain, and the public and private sectors can do more to advance CCS technologies from the laboratory to the commercial marketplace.

The International Energy Agency (IEA) estimates that emissions must be reduced by 42 gigatons (Gt) carbon dioxide (CO_2) per year by 2050 (relative to a business-as-usual scenario) in order to limit temperature increases to 2°C and that CCS could contribute about 6 Gt CO_2 of the total in a minimum cost mitigation scenario. Almost half (45%) of the CO_2 captured in this scenario would be from industrial sources with between 25 and 30 percent of the global production of steel, cement, and chemicals equipped with CCS by 2050. The Intergovernmental Panel on Climate Change echoes the importance of industrial CCS in its fifth assessment report. That report also concludes that without CCS, the costs of climate change mitigation would increase by 138 percent and that the 2°C threshold may not be possible. As we now work towards the 1.5°C goal agreed upon at the 21st UNFCCC Conference of the Parties in Paris in December, bioenergy with CCS (BECCS) in the industrial and power sectors also becomes increasingly important.

CCS is currently the only option for deeply decarbonizing process industries such as refineries, the chemical sector, and cement and steel production.[1] These sectors currently represent about one-fifth of global CO_2 emissions, and industrial CCS is becoming increasingly important in the context of discussions on how to achieve deep decarbonization. Industrial CCS is the low-hanging fruit among CCS opportunities, because many industrial processes produce relatively pure streams of CO_2. Industrial sources often occur in clusters, and creating scenarios where sources can share transportation and storage infrastructure could accelerate deployment.

Operational CCS industrial demonstration projects are emerging in North America, Europe, the Middle East, and Asia. Since 2013, the Air Products Port Arthur project in the United States has been capturing one million tons of CO_2 each year from a steam methane reformer at a refinery and using it for enhanced oil recovery (CO_2-EOR). Three industrial CCS projects – the Uthmaniyah project (CO_2-EOR) and the Saudi Basic Industries Corporation project (CO_2 utilization for petrochemicals) in Saudi Arabia and the Quest project in Canada – came online in 2015, collectively capturing and storing nearly 2.5 million tons of CO_2 per year. In April 2016,

[1] Energy efficiency can play a role in reducing emissions from the industrial sector, but deep decarbonization will require some deployment of CCS.

Japan started injecting CO_2 captured from emissions generated from hydrogen production for storage in an offshore geologic formation at an anticipated rate of 100,000 tons of CO_2 per year. The Al Reyadah project in the United Arab Emirates – the first ever steel facility equipped with CCS – is scheduled to go operational later this year. The Archer Daniels Midland plant in the United States will also go online in 2016, as the world's first commercial scale BECCS project at a bioethanol refinery. In China, up to 0.5 million tons per year from a Yanchang Petroleum coal-to-chemicals plant are planned to be captured and used for CO_2-EOR. And in Norway, three industrial sector CCS projects (Norcem, Yara, and Klemetsrud) are currently undergoing feasibility studies and competing for funding.

Despite the progress, investment in and deployment of CCS technology in the industrial sector has been so far insufficient in the context of the needed emissions reductions and the urgency of climate mitigation action. In a 2011 *Roadmap on Industrial CCS*, the IEA and the United Nations Industrial Development Organization called for governments to ensure adequate funding for CCS demonstration projects at the scale of 27B USD by 2020 to fund 60 large scale projects in industrial and fuel transformation sectors. More recently, at the 2015 Carbon Sequestration Leadership Forum (CSLF) Ministerial meeting, Energy Ministers declared support for industrial CCS applications as a pathway to implement substantial, scalable CCS pilot plants. Nonetheless, investment to date in industrial CCS has fallen far short, and CSLF and other bi- and multi-lateral CCS efforts have historically tended strongly towards addressing the power sector.

There is a near-term opportunity for Energy Ministers to continue momentum generated at the CSLF Ministerial by identifying concrete actions that countries can take to accelerate CCS deployment worldwide under the framework of the Clean Energy Ministerial (CEM) and/or Mission Innovation. Such actions could include strong global commitments to increase R&D funding for innovative, next-generation carbon capture technologies with broad application to both the power and industrial sectors; international collaboration to promote development through shared learnings and to build capacity for additional large-scale CCS projects worldwide, with an emphasis on exploiting early opportunities for industrial CCS; and implementation of supportive government policies that support CCS alongside other clean energy technologies, such as renewable energy and efficiency measures.