ExpertSpeak

Carbon capture and utilization technology can lead to immense benefits in the long run

With CO_2 being the main product of coal combustion, **Dr. Malti Goel**, President & CEO, Climate Change Research Institute and former Scientist 'G', Government of India, feels that developing capabilities in carbon capture and goal oriented utilization in products of scarcity can lead to immense benefits in the long term.

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The news about carbon capture technology that made us proud in early 2017 was the success of Aniruddha Sharma, Carbon Clean Solutions in capturing carbon dioxide from a 10MW coal fired power plant in Chennai and its utilization by Tuticorin Alkali Chemicals & Fertilizers for making baking soda in a cost-effective manner from waste gas. In the same year, in an important national development, the government launched 'Carbon Capture Innovation Challenge' to engage academia and industry interest and build collaborations on R&D breakthroughs for accelerating the clean energy development.

Carbon dioxide (CO_2) is having the highest contribution to greenhouse gas warming and removal of excess CO_2 by its underground disposal or utilization in an environmentally friendly manner is vital for sustenance of coal use as energy fuel. It is in this context that carbon capture and storage (CCS) is widely acknowledged as an emerging technology to address the problem of excess CO_2 in the atmosphere. Globally, the importance of CCS in limiting future temperature increase to well below 2°C as in the Paris Accord has been discussed in many forums. International Energy Agency suggested 12% would be the share of carbon capture in the cumulative emissions reductions needed across the energy sector by 2050. It may look further for deeper emissions reductions if the temperature is limited to 1.5°C.

Carbon management in India

In India, the new targets for renewable energy to achieve 175 GW of installed capacity by 2022 and increasing price of coal coupled with high carbon cess of INR 400 per ton, are making it difficult to sustain coal use. Draft National Electricity Plan of CEA envisages no new coal plants during 2017-2022. Technically speaking, be it a smart grid or storage battery technology, coal which is the baseline load goes together with renewable energy, unless there is another new discovery for sustained energy supply. In this context, all of the following options for carbon management would be required to be pursued viz. (1) Improvement in energy efficiency in various sectors of economy in buildings, transportation, and industry, thus reducing the demand for fossil fuel supplies; (2) Improvement in the efficiency of coal-based plants so that less fuel is needed to meet the same demand; (3) Replacement of high-carbon fossil fuels with lower-carbon or zero-carbon alternatives such as renewable energy and, (4) Use of carbon capture technology for sequestration of excess CO_2.

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The approach to CCS originated with the idea of capturing CO_2 from the flue gas of fossil fuel based power plants or industrial point sources and storing it in depleted oil or gas field using existing pipeline infrastructure. Capturing of atmospheric CO_2 is possible by using various chemical, physical and biological separation methods. The approaches are: Chemical absorption, Physical adsorption, Membrane separation, Cryogenic separation and through Hydrate making. Each of these is constrained due to high cost and high energy penalty in achievement of the scale of operation. The cost of capture can go up to 70% in the total cost of CCS technologies. Significant research & development efforts are therefore required to upscale to plant scale and make it cost-effective as well as to reduce the associated energy penalty.

There are two ways to make coal-based plants sustainable, either storage as waste in underground reservoirs or reuse into value added products. For storage, captured CO_2 is transported in liquid form (in supercritical phase

temperature - 304.1K and pressure - 73.8 bars) to be injected in an appropriate geo-environment. Storage reservoirs for liquid CO_2 are: deep saline aquifers, oil & gas fields, un-mineable coal seams, shale and basalt rocks. Inter-Governmental Panel on Climate Change (IPCC) study estimated that geological formations have capacity of 2,000 gigatonnes (Gt) of likely CO_2 storage. These capacities are subject of intense investigation globally. Among these saline aquifers, having highest CO_2 storage potential would require appropriate porosity, thickness and permeability of a reservoir with a good cap rock of sealing capability. Main challenges in CO_2 storage are the permanency of storage and associated risk from leakage.

India with its rich coal resources is party to International Conventions & Protocols on Climate Change. In 2003 Department of Energy, USA launched Carbon Sequestration Leadership Forum, a Ministerial level multi-country science diplomacy initiative to promote collaborative R&D in CCS. India became a founder member to CSLF. The CSLF recognized collaborative projects aimed at mid-range of research activities in CCS technology. The recognized R&D projects with two or more countries as partners were recommended by the CSLF Technical Group, to which India became Vice Chair in 2006.

India succeeded in having one CSLF registered joint project out of the seventeen recognized projects by CSLF in 2007. The projects helped in gaining experience in knowledge sharing and provided global visibility to CCS technology. Soon after, the carbon capture and storage (CCS) research began to take shape in the country. The CCS was included in the Roadmap studies of Clean Coal Technology. It was maintained that it is important for Indian coal consuming industry to become responsive towards research and technology development while the global technology might take some time to be cost-effective. Unfortunately, the policy debate in application of CCS, being an infrastructure intensive technology, failed to give it momentum.

Mission Innovation

A renewed thrust to R&D in Carbon Capture and Utilization is expected under Mission Innovation (MI). The MI was launched during the CoP21 in Paris. India, with its commitment to provide affordable clean energy access to its population, was one of the first few countries to join MI. With CO_2 utilization from energy industry coming into purview, the US Senate introduced a Carbon Capture Utilization and Storage Act in July 2016 to encourage the industry participation. The world highest emitter, China, has invested on CO_2 capture and utilization research and large-scale programmes with international collaboration in CCS. Already, a few pilot and commercial scale plants for CO_2 utilization have been built across the globe for production of polymers like polycarbonates and polyurethanes as well as monoethylene glycol (MEG) - a pre-curser to polyester fibers. Recent developments are directed to more efficient processes for CO_2 conversion into energy fuels using nano-catalysts. New range of applications is becoming feasible through microalgae absorption of CO_2 to produce biofuels or food or pharmaceuticals by trans-estrification process.

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The CCU is conglomeration of technologies, not only for power sector but also for energy industry like steel, cement, aluminum and others to achieve low carbon growth strategy. A number of R&D laboratories and institutions in the country are directing their efforts in this field. Good news is that oil companies in India are also looking for the success of CCU, having developed a catalyst using renewable energy for triggering conversion of CO_2 from refinery gases into value added chemicals. Indian Oil R&D Center is aiming to construct the world's first refinery off gas-to-bioethanol production facility in India by utilization of waste CO_2.

Under international initiatives, the research investment in carbon capture is expected to double by 2020. The most vital issue remains, required clear policy guideline for adoption of technologies like CCS or CCU, whose basic purpose is to mitigate excess CO_2 in the atmosphere. There are two fundamental issues. The first is goal setting for emission reduction in new coal plants, like those for renewable energy, with carbon capture having a share. It would be a difficult proposition, but purposeful and of great value. The second is about research investment, which should be met from huge coal cess fund being collected from the coal industry. It is somewhat similar to COAL21 fund, which is based on voluntary levy on coal production in Australia and is committed for demonstration of low emission coal technology like CCS. The CO_2 being the main product of coal combustion, developing capabilities in CO_2 capture and goal oriented utilization in products of scarcity can lead to immense benefits in the long-term.

The views in the article of the author are personal. For suggestions email at feedback@infraline.com