

# 6<sup>TH</sup> US-INDIA ENERGY PARTNERSHIP SUMMIT

## US-INDIA: PAST COOPERATION, FUTURE STRATEGIES AND NEW OPPORTUNITIES

21 September 2015 | Washington Marriott Wardman Park, Washington DC

### CARBON CAPTURE, COMMODITIZATION AND UTILIZATION

President Barack Obama traveled to India in January 2015 to participate in the Indian Republic Day celebrations in New Delhi as the Chief Guest. On the sidelines of this visit, Prime Minister Narendra Modi and President Obama agreed on a number of joint actions for advancing mutual prosperity, energy security, a clean and healthy environment, and greater economic cooperation. Their Agreement included a number of actions related to climate and clean energy.<sup>1</sup>

Specifically, the two leaders emphasized the critical importance of jointly expanding clean energy research, development, manufacturing and deployment, which increases access to energy and reduces greenhouse gas emissions. In addition, their agreement included initiatives to enhance financing to help India purchase American technology for clean-energy projects.

Nonetheless, India has plans to double its coal production by 2020, which will cause a concomitant increase in its greenhouse gas emissions. This goal will challenge the ability of India to meet its climate goals set forth in the India - US agreement.

Carbon capture combined with carbon dioxide (CO<sub>2</sub>) utilization, specifically in conjunction with enhanced coal bed methane (ECBM) technology, could play a large role in India helping to mitigate its emissions, which India has pledged to do during President Obama's State visit. Also, both of these technologies are considered clean technologies and have been supported extensively by the U.S. Government, primarily through the Department of Energy.

The 21st century needs sustainable business strategies that provide an increasing energy supply while supporting climate protection and social development goals. Transformational technologies, such as carbon capture and storage, including CO<sub>2</sub> utilization, as well as carbon capture and reuse will need to play a key role. The Special Issue commemorating the 10th year anniversary of the publication of the Intergovernmental Panel on Climate Change Special Report on Carbon Capture and Storage indicates that "capture and geological storage of CO<sub>2</sub> is truly ready for large scale deployment to mitigate climate change." Furthermore, the Report states that "there are several demonstrations of this already at large scale and several others will join in the near future. The cost of avoided CO<sub>2</sub> from the full chain, once corrected to account for inherent variations in the market of power equipment, will go down as leading technologies are deployed. Emerging technologies are also being demonstrated at increasing scales, offering opportunities for more substantial reductions in cost and energy penalties."

The CCCU thematic track would also emphasize that profitable CO<sub>2</sub> utilization and reuse options within carbon capture projects, i.e., treating carbon as a commodity instead of waste, can attract business groups and industry early on to engage in commercial scale applications and demonstration of carbon capture projects.

"Commoditization" of carbon will drive down overall costs, making those carbon capture technologies applicable and affordable in emerging economies. Beneficial utilization or reuse of CO<sub>2</sub>, creating a revenue stream from captured CO<sub>2</sub>, can be realized through enhanced oil recovery, enhanced coal bed methane recovery, through support of the algal biomass industry, and other pathways.

In fact, operating industrial scale carbon capture projects (like post-combustion carbon capture project Boundary Dam in Canada or the carbon reuse project Capitol SkyMine Mineralization plant in Texas), as well as those under construction (Kemper County IGCC, Southern Company; Petra Nova poly-generation in Texas, NRG) are dependent on CO<sub>2</sub> utilization or CO<sub>2</sub> reuse.

The CCCU thematic track will present a 'Screening-Level Assessment of CO<sub>2</sub> Enhanced Oil Recovery and Enhanced Coal bed Methane Opportunities in India' that identified significant CO<sub>2</sub> utilization potential. India is one of the largest energy consumers in the world, and coal is expected to continue to dominate energy supply in India for decades. To offset this, carbon capture and storage (CCS), perhaps in association with enhanced coal bed methane (ECBM) production or CO<sub>2</sub> enhanced oil recovery (CO<sub>2</sub> -EOR),



<sup>1</sup> <http://www.whitehouse.gov/the-press-office/2015/01/25/fact-sheet-us-and-india-climate-and-clean-energy-cooperation>

has been identified as a critical CO<sub>2</sub> emissions mitigation strategy for India. This thematic track proposes to identify potential early opportunities for large-scale, economically viable utilization of CO<sub>2</sub> for ECBM and CO<sub>2</sub>-EOR in India, using the CO<sub>2</sub> (and possibly N<sub>2</sub>) from oxy-combustion based CO<sub>2</sub> capture technology.

An approach is being examined to the basins in India that are currently producing CBM or have CBM development planned. These areas account for nearly ten trillion cubic feet (275 billion cubic meters) of CBM resources in place. About 2.6 Tcf (73 Bcm) is estimated to be technically recoverable from the application of conventional primary CBM technology, and another 1.9 Tcf (55 Bcm) could be recovered from the application of ECBM with CO<sub>2</sub> injection. Depending on natural gas prices, this technically recoverable ECBM potential could be worth from \$8 to \$16 billion (US). In total, an estimated 824 million metric tons of CO<sub>2</sub> storage capacity could exist in the un-mineable coal seams in these areas.

The required CO<sub>2</sub> can be sourced from man-made CO<sub>2</sub>, like coal fired power plants or industrial plants (steel, cement, refineries). Up to 10,000 MWe of coal-fired boiler capacity (retro-fitted or new build carbon capture plants; assuming 15 to 20 years of carbon capture from those boilers) could serve those initial ECBM sites.

Another technology the oxy-combustion based carbon capture technologies in conjunction with CO<sub>2</sub> utilization for enhanced coal bed methane recovery offer multiple benefits. It utilizes a combination of CO<sub>2</sub> and nitrogen for well injection (nitrogen is a by-product from oxy-combustion application), which will increase the volume of injection gases significantly and thus improve economic results from selling CO<sub>2</sub> and nitrogen as commodity to ECBM operators.

Additional co-benefits to coal fired power plants from applying high flame temperature oxy-combustion technology, combined with the Integrated Pollutant Removal system (IPRTM), will be air pollutant control (SO<sub>x</sub>, NO<sub>x</sub>, particulate matter and mercury), latent heat recovery, as well as process water reuse.

As per an estimate for India, 70 to 90 trillion cubic feet (2.0 to 2.6 trillion cubic meters) of coal bed methane in place, of which 20 trillion cubic feet are recoverable with Coal bed Methane Recovery (CBM). Another 20% of the gases in place are potentially recoverable with ECBM, with storing capacity of billions of tons of CO<sub>2</sub> through this clean energy strategy.

This track also aims to further the philosophy of the U.S. DOE-NETL 'Annual Carbon Capture, Utilization and Storage Conference', with lessons learned from progress in CCUS project development and potential technology transfer to India.

To explore business opportunities for cleaner fossil energy projects, through enhanced coal bed methane recovery, Public Indian energy companies, like NTPC and ONGC, had been approached concerning cleaner fossil energy strategies. It is proposed to establish a new 40MWe to 60MWe carbon capture demonstration plant to serve the needs of a CO<sub>2</sub>- ECBM or CO<sub>2</sub> - EOR commercial scale project and for expanding the possibility of developing Public-Private Partnership.

The latest IEA report on 'Projected Costs of Generating Electricity'<sup>2</sup> states that leveled cost of electricity (LCOE) from coal-fired generation is expected to increase by 30% to 70% due to the addition of CO<sub>2</sub> capture with currently available capture technologies. Furthermore, the report states that by 2030, this cost mark-up could decline through learning effects to a range of 25% to 40%, assuming a deployment level of around 100 GW for coal-fired CCS plants.

Commoditization of CO<sub>2</sub> and other by-products (latent heat recovery, water recycling, ash reuse, etc) from integrated carbon capture systems can significantly reduce parasitic power losses associated with the carbon capture process, and simultaneously improve overall economics. First mover carbon capture projects can be supported through the CCS Trust Fund that is administered by the Asian Development Bank and the World Bank.

It is felt that The Green Climate Fund needs to support accelerated carbon capture project deployment in emerging economies that are heavily dependent on coal consumption for economic growth in the coming decades.

This thematic track is organized with an objective to explore:

- Methods to enhance bilateral cooperation on joint research, development and deployment of carbon capture and CO<sub>2</sub> utilization, as well as carbon capture and CO<sub>2</sub> reuse projects
- Capacity building for CO<sub>2</sub> utilization options like enhanced oil recovery (EOR) and enhanced coal bed methane recovery (ECBM) in India
- Capacity building for CO<sub>2</sub> reuse options like carbon mineralization or algal biomass production
- Public Private Partnerships to demonstrate commercial scale carbon capture and CO<sub>2</sub> utilization, as well as carbon capture and CO<sub>2</sub> reuse projects in India
- Funding support from Multilateral Development Banks for commercial scale demonstration of carbon capture and CO<sub>2</sub> utilization, as well as carbon capture and CO<sub>2</sub> reuse projects in India
- Establish methods of monitoring, reporting and verification (MRV) of CO<sub>2</sub> emissions permanently stored underground or locked into new products

<sup>2</sup> International Energy Agency (IEA) and Nuclear Energy Agency (NEA); Projected Costs of Generating Electricity - 2015 Edition

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