



सत्यमेव जयते  
Ministry of Science and Technology  
Government of India

**Mission Innovation  
Carbon Capture & Utilization IC#3  
Country Workshop**

## **Mission Innovation Challenge IC# 3 “Carbon Capture and Utilization”**

**Workshop Date: September 13<sup>th</sup>, 2017**

**Venue: India Habitat Centre, New Delhi**

### **Conference Report**

Workshop on Carbon Capture & utilisation, IC#3 challenge of Mission Innovation was held on 13<sup>th</sup> Sept, 2017 at Magnolia Hall, India Habitat Centre. The agenda of the workshop is enclosed. Inaugural lecture in the Workshop was delivered by Prof. K. VijayRaghavan, Secretary Department of Biotechnology, Ministry of Science & Technology, Government of India. He re-emphasised the need to move to low carbon economy and how new innovations can be a game changer. Workshop was addressed by Dr. Renu Swarup, Senior Adviser, Department of Biotechnology and she gave an overview of establishment of Mission Innovation programme and the active role being played by India. Dr Sangita Kasture, Jt Director, DBT gave a presentation describing the seven innovation challenges selected by 22 countries and the European Union. Dr. D K Tuli, DBT Chair introduced the structure of the interactive workshop and also listed the expected deliverables. The list of participants is attached in Annexure-I.



**Participants of MI-India Workshop on Carbon Capture & utilisation**

The workshop technical programme started with thematic presentations by subject experts from industry and academia followed by discussions in two sub groups on different aspects of Carbon Capture and Utilization. The presentations were made by three experts in two major areas under Carbon capture and utilization to discuss the R&D gaps and current developments in the specified field. The details of experts and topics of discussion are enclosed in Annexure-II. The photographs of participants involved in group discussion are enclosed in Annexure III.

After 3 main talks which were helpful in setting the context, the participants were divided into 2 groups to discuss about the topic with the following deliverables:

1. What is the current status of Technology in India?
2. What are the R&D gap areas?
3. What type of R&D projects should be taken?
4. Need for National/International collaborations.
5. Short, Mid and Long-term strategies.
6. Which other stakeholders/groups to be included in future?

*The first group discussed CO<sub>2</sub> Capture, Separation and storage. The second group discussed CO<sub>2</sub> value addition to chemicals and value-added products. The recommendations from the two groups are as follows:*

### **Recommendations of Group A on CO<sub>2</sub> capture, separation and storage**

Current status of Technology:

There are four major separation technologies for CO<sub>2</sub> capture as absorption, adsorption, membrane based and cryogenic.

*R&D gap areas/suggestions:*

#### ***Absorption***

- For a solvent based absorption: Development of efficient absorbants, their regeneration, life and capacity.
- Currently in the area of CO<sub>2</sub> capture, there is no industrial scale pilot experience.
- There is a requirement for a cost economics evaluation.
- This technology has been demonstrated at TRL 9 by Clean Carbon Solutions. However, for regeneration of absorbant material, the energy consumption is high, thus the process has to energy efficient.
- Enzyme (biomimetic) assisted solvent mediated CO<sub>2</sub> capture to reduce CAPEX & OPEX.
- In order to increase the efficiency of absorption, there is a requirement for Hybrid model of the two technologies.

***Adsorption***

- This technology has achieved a TRL 5/6 level, however Industry validation still needs to be done.
- Facilities to manufacture the adsorbant in India are available; however the cost economics has to be assessed.

***Cryogenic***

- Not viable, not being pursued anywhere else and therefore presently not relevant.

***Membrane Technology***

- TRL level 5, Industry evaluation not done.
- International collaboration for new material development, lowering of cost, high selectivity and high temperature operation is desirable for achieving quantum jump.
- Membrane which can separate CO<sub>2</sub> and water vapour should be explored.

**Sequestration** (EOR) done by Oil industry on limited scale; though it is being adopted abroad on a larger scale.

Some ideas of algal based CO<sub>2</sub> capture were discussed but it was decided to take this subject in IC#5 workshop.

**Recommendations of Group B on CO<sub>2</sub> value addition**

- Globally, advances have been made in this area and some large-scale activity is reported.
- In India, carbonates synthesis and dry reforming of CO<sub>2</sub> has been done on lab scale.
- Low TRL level of this technology.
- No industry involvement.
- IOCL has done bench scale carbonates for fuel/grease additives and is planning to scale up.
- NCL is working on CO<sub>2</sub> to polymers but TRL is presently low.
- Biggest gap area is lack of industry-academia interaction.
- Utilization of CO<sub>2</sub> must be for value addition in terms of LCA and energy balance.
- Industry validation is required for every claimed development for economics.
- Short term (3 years): fuel additives.
- Med term (3-6 years): CO<sub>2</sub> dry reforming, CO<sub>2</sub> to methanol, polymer.
- Long term (> 6 years): biological and photochemical processes.

**Annexure-1: List of Participants**

Sl.No	Name	Organization/ Institution Name
1.	Prof. K. VijayRaghavan	DBT, New Delhi
2.	Dr. Renu Swarup	DBT, New Delhi
3.	Dr. Sanjay Bajpai	DST, New Delhi
4.	Dr. Prabhat Ranjan	TIFAC, New Delhi
5.	Dr. Sangita Kasture	DBT, New Delhi
6.	Dr. D.K. Tuli	DBT -IOC Centre for Bio-Energy Research, Faridabad
7.	Dr. Shams Yazdani	DBT-ICGEB, New Delhi
8.	Shri. H.K. Sikri	Ministry of Power, New Delhi
9.	Dr. Neelima Alam	DST, New Delhi
10.	Dr. Malti Goel	Ex-DST, New Delhi
11.	Dr. Brajesh Barse	DBT-ICGEB, New Delhi
12.	Prof. G.P.Karmakar	IIT Kharagpur
13.	Dr. Pramod Wangikar	IIT Bombay
14.	Prof. C. Subramaniam	IIT Hyderabad
15.	Dr. S. V. Mohan	IICT Hyderabad
16.	Dr. S. K. Puri	IOC (R&D), Faridabad
17.	Dr. A. K. Arora	IOCL (R&D), Faridabad
18.	Dr. Krishnarao	IOCL (R&D), Faridabad
19.	Dr. Dalip Singh	IOC (R&D), Faridabad
20.	Dr. Paresh Dhepe	NCL Pune
21.	Dr. R. Nandini Devi	NCL Pune
22.	Dr. T. Raja	NCL Pune
23.	Dr. Ulhas Kharul	NCL Pune
24.	Mr. P. Chugh	GAIL, New Delhi
25.	Sh. Arun Shukla	GAIL, New Delhi
26.	Dr. Anshu Nanoti	CSIR-IIP, Dehradun
27.	Dr. Jasvinder Singh	CSIR- IIP, Dehradun
28.	Dr. Soumen Dasgupta	CSIR- IIP, Dehradun
29.	Dr. Harshad Velankar	HPCL Bangalore
30.	Dr. K. Indumathi	NTPC-NETRA, Noida UP
31.	Dr. Prakash d Hirani	NTPC-NETRA, Noida UP
32.	Dr. Piyush Srivastava	NTPC-NETRA, Noida UP
33.	Dr. K Palanivelu	Anna University, Tamil Nadu
34.	Mr. Prateek Bumb	Carbon Clean Solutions
35.	Mr. S.R. Soni	India Glycols Ltd. Noida UP
36.	Ms. Prachi Khanna	MOP Deloitte, New Delhi
37.	Ms. Alpana Saha	DBT Communication Cell
38.	Dr. Deepika Singh	Mission Innovation India, New Delhi
39.	Dr. Ayashaa Ahmad	Mission Innovation India, New Delhi

**Annexure-II: List of Experts and topics for Thematic Presentation and Discussion**

1. Carbon capture technology for flue gas applications by Mr. Pateek Bumb, Carbon Clean Solutions, Mumbai
2. Sequestration of CO<sub>2</sub> for EOR by Prof. G.P. Karmakar, IIT-Kharagpur
3. Carbon capture technologies & NETRA activities by Sh. Prakash D. Hirani, GM (NETRA), Noida UP
4. Low temperature discharge plasma-catalysis for CO<sub>2</sub> activation by Prof. C. Subrahmanyam, IIT- Hyderabad

**Annexure III: Photographs of participants during panel and group discussion**

Prof. K. VijayRaghavan, Secretary, Department of Biotechnology and Dr. Renu Swarup, Senior Adviser, Department of Biotechnology, Ministry of Science & Technology, Government of India, addressing the participants of MI-India Workshop on Carbon Capture & utilisation



*Discussion on the R&D gap areas in Carbon Capture & utilisation*