



सत्यमेव जयते
Ministry of Science and Technology
Government of India

Mission Innovation
Sustainable Biofuels IC#4
Country Workshop

Mission Innovation Challenge IC# 4 “Sustainable Biofuels”

Workshop Date: October 09th, 2017

**Venue: International Centre for Genetic Engineering and Biotechnology
(ICGEB), New Delhi**

Conference Report

Innovation Challenge (IC) #4 workshop was organized by Department of Biotechnology (DBT), Ministry of Science and Technology, Govt. of India on 9th October, 2017 at the International Centre for Genetic Engineering and Biotechnology (ICGEB), New Delhi. The workshop was aimed at identifying key technological advances in the field, and roadblocks hindering breakthrough technologies. The list of participants is enclosed as Annexure I.



Participants of MI-India Workshop on Sustainable Biofuels

On behalf of DBT, welcome address and brief introduction on Mission Innovation structure was delivered by Dr. Sangita Kasture, Joint Director DBT (Department of Biotechnology). Dr. Dinkar Salunke, Director, International Centre for Genetic Engineering and Biotechnology welcomed the participants to ICGEB facility and emphasised the need to develop sustainable and economic biofuels which can impact the GHG emissions. Dr. Renu Swarup, Senior

Adviser, DBT in her inaugural address highlighted the importance of Mission Innovation program for development of the clean energy technology. She noted that Sustainable Biofuel development challenge of Mission Innovation has a special importance for a country like India and several groups are in advance stage of technology development and commercialization. She said this program will help in learning best practices and can also lead to national/international collaborations.

Presentations were made by experts in three major areas i.e. Research and Development, scale-up and commercialization under Sustainable Biofuels to discuss the R&D gaps and current developments in the specific areas. The details of experts and the topics of discussion are enclosed in Annexure II. Based on three main talks which helped in setting the context, the participants were divided into three groups to discuss about the topic with 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 discussions?

The groups discussed about Renewable Fuel Alternatives for Gasoline, Biodiesel and CNG/Biogas focusing on Research and Development, Scale-up and Commercialisation covering the above-mentioned deliverables. The photographs of participants involved in group discussion are enclosed in Annexure V.

I. Recommendations of groups on including 2G Ethanol, Dimethyl Ether (DME) and Butanol/Hydrogen.

Current R&D, Scale Up and Commercialization status:

A. 2G Ethanol: TRL Level- 6

1. Presently demonstration plants are setup by DBT-ICT Centre Mumbai, Praj Industries and DBT-IOC Centre.
2. Lanzatech is providing facility for CO₂ to acetic acid and Gas fermentation to Ethanol.
3. IOCL has research capability aiding acetate to lipid conversion.
4. Novozyme has developed most active enzymes acting on the biomass.
5. BPCL is setting up Lignocellulosic 2G Ethanol Biorefineries at: Bargarh (Odisha), Bina (Madhya Pradesh) and Khamgaon (Maharashtra).
6. HPCL is setting up similar Biorefinery at Bhatinda(Punjab) and two more refineries elsewhere.
7. DBT-ICT centre Mumbai and Praj industries, Pune have emerged as major technology suppliers for commercial scale 2G Ethanol plants and both have been able to tie up with major oil marketing companies.

R&D gap areas/suggestions:

1. Biomass collection chain still needs some improvements. Enzyme production is another bottleneck with production and the productivities achieved so far not matching the required or global industrial standards in price equality.
2. At bench scale enzyme production has been successfully carried out by DBT-ICGEB, DBT-ICT, DBT-IOC centres and many other institutes.

*Types of Projects to be undertaken:**Short-Mid term actions:*

1. Extensive mapping of all biomass feedstocks by ICAR.
2. Setting up of Integrated Biorefinery towards 2G Ethanol, Biogas and CNG.
3. Tapping and Optimizing existing enzyme components into a cocktail.
4. Enhancing scientific collaboration (national/international) is priority.

Mid-Long term actions:

1. Enhancing In-situ and/or indigenous production of Enzymes.
2. Setting up a Core Central Fungal facility with a concept of scaled up incubation.
3. Establishing a repository of enzymes.

Long Term actions:

1. Isolation of new thermophilic fungal strains.
2. Development of a cost-effective laccase production for efficient pre-treatment and reactor development for catalytic conversion including pre-treatment.
3. Enhancing Off shore large scale production of algal biomass.
4. Substantial engineering inputs required for Marine structural support for Macroalgae.
5. Development of Multi-Phase reactors towards Biofuel production with improved rheology.
6. Implement research and exchange collaborations, evaluate the success of these measures, develop new measures based on lessons learnt.

Need for National/International collaborations:

1. Collaborations for conversion technologies (NREL)
2. EMBRAPA – Brazilian Agriculture Yield Corporation for feedstock mapping and characterization
3. South Dakota School of Mines and technologies

B. Dimethyl Ether (DME): TRL status- 3-4

1. Synthetic gasoline may be produced from coal-derived synthesis gas via the methanol-to-gasoline (MTG) process and is a proven technology.
2. DBT-ICT Centre Mumbai has proposed novel strategies via chemical and biological routes for Methane to Methanol conversion for DME production.
3. Five main producers of methanol in India- Gujarat Narmada Valley Fertilizers Company Ltd. (GNVFC)- the lead producers, Deepak Fertilizers & Assam Petrochemicals use technology from ICI to produce methanol. Rashtriya Chemicals & Fertilizers Ltd. (RCF) and National Fertilizers Ltd use technology from Haldor Topsoe.

R&D gap areas/suggestions:

1. Coal based Gasoline synthesis is an expensive methodology thus cost-effective method need to be developed for effective gasoline production.
2. Low viscosity, low lubricity, high pressure storage system and seal compatibility are challenges with DME.

Types of Projects to be undertaken:

1. Basic knowhow for DME is available, but new strategies for enhanced efficiency required.

C. Butanol / Hydrogen: TRL status-3

1. Murugappa Chettiar Research Institute (MCRC) Chennai, demonstrated hydrogen production in batch-scale from distillery waste. The pilot plant can produce up to 18,000 litres of hydrogen per hour.
2. IIT, Khargapur and TERI has very large reactor facilities for bio-H₂ production.
3. The BHU, IIT Chennai, and the National Physical Laboratory are working on the hydrogen storage methods.
4. The BHU has developed various types of metal hydrides with storage capacities of up to 2.4 weight%. It has also demonstrated the use of 1.6% weight storage in metal hydride on a pilot scale.

R&D gap areas/suggestions:

1. Cost effectiveness and Productivity.
2. Infrastructure is very expensive due to easy Hydrogen diffusion.
3. Safe, Efficient storage and delivery of Hydrogen.
4. Process economics not yet favourable.
5. Scattered infrastructure and lack of collaboration.

*Projects to be undertaken:**Short-Mid Term actions:*

1. Upscaling and modelling stimulation for biomass pyrolysis.
2. Enhancing Bio-H₂ separation, bottling and bench marking based on petroleum Naptha.

II. Recommendations of groups on Renewable Fuel Alternatives for Biodiesel: Biodiesel, algae and Alkane/Drop-in Fuel**A. Biodiesel: TRL status: 4-5**

1. Indian Patent filed: CSIR-IIP-Room Temperature Process for Biodiesel production: Transesterification Process
 - a) This process is suitable for feedstocks having FFA up to 10 %.
 - b) Process suitable for small scale operation.

R&D gap areas/suggestions:

1. Process economics not yet favourable.
2. Non-availability of feedstock

3. Shelf Life and Cold Flow issues.
4. Productivity & GMO issues for Algae.

Projects to be undertaken:

Mid-Long Term actions:

1. Development of potable and automated device for conversion of used cooking oil to bio-diesel.
2. Emphasis on high cell density culture development for lipid production for yeast, fungi and algae.

Long Term actions:

1. Algal Lipid enhancement using magnetic and chemical stress on potent strains.
2. Emphasis on new Indian strains for Micro Algae.
3. Genome Sequencing and development of strain vectors and molecular tagging of Indian strains.
4. Consortium approach from the beginning of the project with right R&D partners and expert groups for scaling and used (multidisciplinary approach).

Need for National/International collaborations:

1. Collaborations in Synthetic Biology (JBEI, UCB).

B. Alkane/Drop-in Fuel: TRL Status: 4-5

1. Hydro processing of lipid feedstock.
2. Fermentation of sugars to hydrocarbons.
3. Catalytic conversion of sugars to hydrocarbons.
4. Upgrading of syngas (carbon monoxide and hydrogen) from gasification.
5. Pyrolysis or liquefaction of biomass to bio-oil with hydro processing.

R&D gap areas/suggestions:

1. Low yield
2. Challenges in maintaining that yield upon scale-up
3. Lower energy content in the fuel product.

Projects to be undertaken:

Short-Mid Term actions:

1. Catalytic upgradation in cost effective manner.
2. Industrial scale evaluation of pyrolytic products.

Mid-Long Term actions:

1. Hydrothermal Liquefaction (HTL) technology with catalytic upgradation of Biofuel.
2. Consortium approach from the beginning of the project with right R&D partners and expert groups for scaling and used (multidisciplinary approach).

III. Recommendations of groups on Renewable Fuel Alternatives for CNG/BIOGAS

A. CNG/BIOGAS: TRL Status: 5-6

1. Mid-sized biogas plants based on cattle manure and other similar wastes for heat, electricity or motive power.

2. 5M household biogas plants based on cattle manure for cooking fuel.
3. Bio-CNG from segregated MSW, sugar industry solid waste, distilleries and sewage treatment plants with capacity ranges from 0.4 to 8 TPD bio-CNG.
4. 14 biogas-fertilizer plants (BGFP) projects for generation, purification, bottling and piped distribution of biogas. with aggregate capacity of 23,116 cum/day have been sanctioned.
5. Biogas from rice straw and other LCSs. Biogas from MSW is very attractive
6. Bio-CNG approved for use as transport fuel.

R&D gap areas/suggestions:

1. Low quality biomethane production, High CH₄ losses (low BioCH₄ recovery).
2. Low efficiency and low economic viability of the system.
3. Lack of technical know-how and after sales services.
4. Technical problems like installing large capacity plants for biogas production, under collection of organic substrates (bio-waste), under feeding, faulty construction, also lead to non-functioning and eventual failure of the biogas plants to produce good quality raw biogas.

Projects to be undertaken:

Short-Mid Term actions:

1. Development of consortium for enzyme and microorganisms for Bio-gas.
2. Setting up of large scale biogas plants with treated feedstocks of agricultural waste and MSW.

Mid-Long Term actions:

1. Consortium approach from the beginning of the project with right R&D partners and expert groups for scaling and used (multidisciplinary approach).

Annexure-I: List of Participants**Ministry of Science and Technology**

Name	Organization	Affiliation
Dr. Renu Swarup	DBT	Sr. Adviser/Scientist H
Dr. Y. B. Ramakrishna	MoPNG	Chairman Working Group Biofuels MoPNG
Dr. Sangita Kasture	DBT	Joint Director/Scientist E

Research Organization/University

Name	Organization	Affiliation
Dr. A. M. Lali	ICT Mumbai	Head and Professor in Chemical Engineering
Dr. Vibha Dhawan	TERI New Delhi	Distinguished Fellow and Senior Director
Dr. Shams Yazdani	ICGEB New Delhi	Group Leader Microbial Engineering
Dr. Reena Pandit	DBT-ICT Mumbai	Associate Professor
Dr. Annamma. A. Odaneth	DBT-ICT Mumbai	Associate Professor
Dr. Padmini Iyer	DBT-ICT Mumbai	Executive assistant
Dr. Brajesh Barse	ICGEB New Delhi	Project Manager/Research Scientist
Dr. Pannaga Pavan Jutur	ICGEB New Delhi	Group Leader Omics
Dr. Shashi Kumar	ICGEB New Delhi	Group Leader
Dr. Naseem Gour	ICGEB New Delhi	Group Leader
Mr. Sunil Dhingra	TERI New Delhi	Fellow
Dr. D C Kannan	TERI New Delhi	Fellow
Dr. Sanjukta Subudhi	TERI New Delhi	Senior Fellow
Dr. Piyali Das	TERI New Delhi	Fellow

Experts

Name	Organization	Affiliation
Dr. Anjan Ray	IIP Dehradun	Director
Dr. A.K Dhussa	Former Adviser MNRE.	Former Director MNRE
Prof. V Kumar Vijay	IIT New Delhi	IREDA Chair Professor and Head Coordinator
Dr. Ashok. N. Bhaskarwar	IIT New Delhi	Professor
Dr. Rintu Banerjee	IIT Khargpur.	Professor
Dr. Ramkrishna Sen	IIT Kharagpur	Professor
Dr. Saikat Chakraborty	IIT Kharagpur	Associate Professor
Dr. P. Guptasarma	IISER Mohali	Professor
Dr T.V. Ramachandra	IISC Bengaluru	Coordinator
Dr. Deepak. K. Saini	IISC Bengaluru.	Associate Professor
Prof. K.J. Mukherjee	JNU New Delhi.	Professor
Dr. A. V. Umakanth	IIMR Hyderabad	Principal Scientist
Dr. R. K. Mishra	Amity University.	Associate Professor

Dr. Nutan Kaushik	Amity University.	Head
Dr. Sudit Mukhopadhyay	NIT Durgapur.	Associate Professor
Dr. S. Ramaswamy	InStem Bengaluru	Senior Professor
Dr. Thallada Bhaskar	IIP Dehradun	Head and Principal Scientist
Dr. C.R.K Reddy	CSMCRI Gujarat	Chief Scientist
Dr. D. Prabakaran	Bharathidasan University TN.	Professor
Dr. N. Thajuddin	Bharathidasan University TN.	Professor and Head
Dr. A. K. Kumar	SPRERI Gujarat.	Professor
Prof. B.S Chadha	GNDU Amritsar.	Professor
Dr. Sivakumar Uthandi	TNAU.	Professor
Dr. S.K Soni	PU Chandigarh.	Professor
Dr. A. Uma	JNTU Hyderabad.	Assistant Professor and Head
Raghavendra. K. Mishra	AUMP Gwalior.	Associate Professor
Dr. Pushpa Sharma	UPES Dehra Dun.	Professor

INDUSTRIES

Name	Organization	Affiliation
Mr. Nitin Shete	Praj Industries Ltd. Pune	Vice President
Mr. Sangeet Jain	Lanzatech Gurgaon	General Manager
Lt. Col. Monish Ahuja	PRESPL Mumbai	Managing Director
Mr. Purushottam Shenoy	Primove Engineering Pvt. Ltd Pune.	Founder
Mr. Daler Singh	SREL.	Manager
Ms. Rashmi Chowdhary	Gencrest Mumbai	Technical Operations Head and LLP
Mr. Ravi Agrawal	Gencrest Mumbai	Managing Director
Mrs. Swati Mathur	Jubilant Life Sciences	Sr Business Manager
Mr. S. R. Soni	India Glycols Ltd. Kashipur	Vice President
Dr. Sanjay V. Patil	VasantDada Sugar Institute Pune	Head and Technical Adviser
Rabinder Kant Sikri	Energy and Energy Consultants New Delhi.	Principal Consultant and CEO

Public Sector Units

Name	Organization	Affiliation
Dr. Ravindra Kumar	IOCL Faridabad	Sr. Manager
Mr. Ajay K. Gupta	BPCL	Deputy General Manager
Mr. Mohan Yama	BPCL	Senior Research Scientist
Dr. Shilpi Gupta	BIRAC New Delhi	Program Manager
Dr. P.K.S Sarma	BIRAC New Delhi	Head Technical (Discovery and Product development)

Mission Innovation India Unit Team

Name	Organization	Affiliation
Dr. Deepika Singh	Mission Innovation-India New Delhi.	Programme Manager
Dr. Ayashaa Ahmad	Mission Innovation-India New Delhi.	Research Associate
Dr. Amit Prabhakar	Mission Innovation-India New Delhi.	Programme Manager

Annexure II: List of Experts and topics for Thematic Presentation and Discussion**Renewable fuel alternative for Gasoline**

1. Advanced biofuels for India: Research, development, demonstration and deployment by Dr. Arvind Lali, DBT-ICT Centre for Energy Biosciences, Mumbai
2. Biomass to Ethanol: Specifics on the technologies by Dr. Ravindra Kumar, Indian Oil Corporation Limited, Faridabad
3. Lignocellulosic 2G ethanol Bio-refineries by Mr. A. K. Gupta, Bharat Petroleum Corp. Ltd. (BPCL), Mumbai
4. Sustainable biomass value chain: Aggregation, processing & supply for sustainability of bio-refinery & biomass based projects by Lt. Col. Monish Ahuja (Retd.), Punjab Renewable Energy Systems Pvt. Ltd., Mumbai

Renewable fuel alternative for Diesel

1. Renewable fuel alternative for diesel by Dr. Anjan Ray, CSIR- Indian Institute of Petroleum, Dehradun
2. Renewable fuel alternative for diesel- Specifics on the technologies by Dr. Thallada Bhaskar, CSIR- Indian Institute of Petroleum, Dehradun
3. Drop-in Biofuels by Dr. Shams Yazdani, DBT-ICGEB Centre for Advanced Bioenergy Research, New Delhi

Renewable fuel alternative for LPG/CNG

1. Overview of Renewable fuel alternative for LPG/CNG by Shri A. K. Dhussa, Former Adviser, MNRE, Govt. of India
2. Spectrum Renewable Energy Private Limited (SREL) at a glance by Mr. Daler Singh, Spectrum Renewable Energy Private Limited (SREL), Hyderabad

Annexure III: Photographs of participants during panel and group discussion

Dr. Renu Swarup, Senior Adviser, Department of Biotechnology, Dr. Y. B. Ramakrishna, Chairman Working Group Biofuels MoPNG, along with Dr. Sangita Kasture, Joint Director, Department of Biotechnology, Ministry of Science & Technology, Government of India, and Dr Dinkar Salunke, Director, International Centre for Genetic Engineering and Biotechnology addressed the participants of MI-India Workshop on Sustainable Biofuels and highlighted the importance of Mission Innovation program for development of the clean energy technology.



Speakers for Renewable Fuel Alternatives for Gasoline



Speakers for Renewable Fuel Alternatives for Biodiesel



Speakers for Renewable Fuel Alternatives for CNG/Biogas



Group discussion on R & D



Group discussion on Commercialization



Group discussion on Scale-Up