IOGCA 2024

IOGCA organises Panel Discussion on CBG "Challenges & Sustainable Solutions in CBG: Feedstock-to- Products"

26-27 September 2024; Hotel Radisson Blu, Dwarka, New Delhi

The concept of Compressed Bio Gas (CBG) is progressing fast in real life because of the multiple benefits such as

- An important contributor to energy basket of India by providing a buffer against energy security concerns, crude/gas price fluctuations and import reduction of natural gas.
- Lowering pollution and carbon emission, thus boosting fulfilment of National commitments in achieving climate change goals.
- Contribution towards Swachh Bharat Mission through responsible waste management by utilization of agricultural residue, cattle dung and MSW (Municipal Solid Waste).
- Providing fermented organic matter which is a rich source of nutrients for soil.
- Providing additional source of revenue to the farmers, rural employment and amelioration of the rural economy

CBG production was conceptually very well known since years and BioGas production in villages that emerged in the nineteen seventies and was adopted by Indian villages can be considered as precursor to CBG. But CBG is mass scale commercialization activity, which itself is a big challenge. The other challenges faced in CBG production include logistics of raw material, continual quality and quantity assurance, production technology, design and engineering, marketing and logistics of FOM (Fermented Organic Manure) etc.

IOGCA 2024 organised a special Panel Discussion on "Challenges and Sustainable Solutions in CBG: Feedstock -to- Products". The panelists were industry experts from different domains including marketing, agriculture, engineering and design and included the following members:

IOGCA organises Panel Discussion on CBG
"Challenges & Sustainable Solutions in CBG: Feedstock-to- Products"

Name	Designation	Company
Mr. Atul Kharate	COO	IndianOil Adani Ventures Limited
Mr. Sanjeev Nagpal	Managing Director	Sampurn Agri Ventures
Dr. Kanwar Singh	General Manager - Product Development	EverEnviro Resource Management Pvt. Ltd.
Mr. Bhaskarjyoti Baruah	General manager	HPCL
Mr. Biswanath Sarkar	DGM	IOCL R&D
Mr. Ashutosh Kulkarni	DGM – CBG	Praj Industries
Dr. Parmeshwar Patil	Senior Manager	Bharat Petroleum Corporation Ltd

The panel discussion was ably moderated by Dr. Sachin Kumar, Deputy Director/ Scientist, Sardar Swaran Singh National Institute Bio-Energy. He has rich experience in the field of biomass and bioenergy. He steered the discussion so as to bring forward the burning issues on this topic of immense significance for the energy and sustainability.

Dr. Sachin Kumar: I welcome all the Penalists and the audience to this Panel Discussion on great economic interest for India and world. To begin with, I would like to invite Mr. Atul Kharate, who is COO with a company which has vast experience in CBG.

Mr. Atul Kharate: Just to set the context for the discussions around energy transition & role of new and green energies in India: It has been globally accepted & documented in records that Indian economy is one of the most stable & established in the current scenario and we are going to maintain this situation for a sizable number of years. And what does it mean to us: in terms of having a reference to energy industry? Indian economy is having a direct link with the Indian energy sector. So, it reflects that the product which we have been dealing from years, like say, petroleum product. The demand of petroleum product in the country is even growing at the rate of 3 to 4 %. The LPG demand has grown to a tune of 4 % plus in last couple of years. Even the traditional fuel like coal, has grown to an extent of 7 to 8 % post-COVID era. And largely, the electricity generation in the country depend on the thermal today. And we are one of the one-third of the weighted average of the globe in terms of the energy consumption pattern, or we can say our energy intensity levels are comparatively very low.

In terms of crude, we are the second largest importer, and we are the second largest refiner globally & that how in energy segment we are the leading player in the world.

Large scale infrastructure like roads, bridges, states connectivity projects, border infrastructure development, commercial and industrial space growth is happening in India these days and we will be maintaining this journey as a part of our journey towards our 100-year completion as a nation. So, what does it mean: energy is at the centre of all these requirements and energy sector is going to move at the large phase.

When we talked about new and green energy, i.e., CBG as a segment. So, gas percentage in the whole

energy pie is just 6.8 %. If I were to talk about the last financial data. And we have a very clear-cut vision to increase it to 15 %. So, when we talk about this journey, it's almost 2.5 times of quantum jump which we must take. Currently in CBG segment as green initiatives, about 85 plants are up and running and another 200 are in various stages of construction and project activities. And we are determined to have around 500 plants in next couple of years of time. So, it's clear-cut indication that we need to put cautious efforts on how we can basically speed up the process of land availability in shortest possible timelines, feedstock guarantees and in parallel developing a market for CBG, which will further bring the growth to CBG / Green energy segment.

Dr. Sachin Kumar: Thank you, Mr. Atul for setting the tone of this Panel Discussion by sharing vital statistics of the topic. Please share your thoughts on commercial aspects of future of CBG.

Mr. Atul Kharate: From the perspective of investors present here & we also have people from various ministries & Oil Marketing companies, I must mention that there are 5 to 6 ministries and departments involved in the whole process of new & Green energies. If I have to mention couple of names, I may be missing few names, but Ministry of Petroleum and Natural Gas (MoPNG), Ministry of New and Renewable Energy (MNRE), Ministry of Fertilizers and Chemical, Department of Science and Technology (DST). There are various national level institutions at the research level like IIT's, Sardar Swaran Singh National Institute of Bio-Energy, CSIR Institutes, who are supplying and supporting in terms of the knowledge partnering in India.

So, there is a huge amount of involvement from academia, industryand ministries. The Government of India is very positive about new and green energies segment. The policies and framework are being taken at the highest level by Government of India and overall outlook is very positive for investment & being part of new and green energies journey in India.

As a part of this Panel discussions we have people from OMCs& I am sure they will be definitely talking about existing SATAT (Sustainable Alternative Towards Affordable Transportation) scheme but from the industry prospective since I represent IndianOil Adani Ventures Limited (50:50joint venture of IOCL and Adani ports & SEZ), I think it's my responsibility to mention that the journey which has started under SATAT is really helpful, however, now we have to take it to the next level of industry support. Maybe we have to plan for SATAT 2.0 which is more industry oriented & provides grater assurance to investors and ensures the sustainability of Industry. There is a scheme available by MNRE in terms of capital financial assistance (CFA)& there are sizable number of benefits being passed on to industry.

Very recently there is a scheme in terms of CBG-CGD (Compressed Bio Gas-City Gas Distribution) synchronization and I personally feel that it's really a gamechanger & would play a very vital role in terms of encouraging the industry to set up a more CBG plants with a sizable number of outcome or commercial size plant. So, we basically need a plant in terms of 10, 15, 20 tones which are residing in an around the CGD network, as most of our Highways and the Secondary state roadways are covered with CGD Pipelines and it would be a real value addition in terms of serving to the industries and people at large.

There is also policy in place in terms of for MDA (Marketing Development Assistance) of ₹1500/- per ton for the fertilizers which we are producing from Biogas plants, as a FOM (Fermented Organic Matter) or Bio Fertilizer.

There is CFA for the equipment which are being used for the Agri product handling or raw material collection & handling.

There is also a discussion happening how can production centres in the country can be increased & incentivized as a part of MAKE IN INDIA Initiative.

I always keep talking to various IITs and Research professionals and my personal views are: we as a progressing country is in larger need of technology partnering for example countries like Brazil, Germany are very well proven technologies and design engineering, so we can have a collaboration only for Technology Partnering & Production has to happen in INDIA, under AATMANIRBHAR BHARAT Scheme, which helps us optimize CAPEX and lower operating cost, which is real value addition for industry.

Dr. Sachin Kumar: Thanks a lot for your comprehensive views about Indian potential and expectations from Policies and frameworks / Government of India. Let's give him a big round of applause.

Let me now turn to Mr Sanjeev Nagpal, one of the earliest entrepreneurs in India in this field. My first question to him is, what was the motivation to set up a plant when there was no reference plant available in the country. I would request you to share your views in that.

Mr. Sanjeev Nagpal: Yeah. Thank you very much, and I do appreciate your recognition of this project. In fact, I have come from an agrarian background. At times, I have mentioned that I'm a qualified mechanical engineer, but farmer by birth. I'm born in a farming family and I've seen agriculture from the day the green revolution was introduced and what it is today. My farm was one of the model farms taken up when the green revolution was introduced. So, I've seen that the sustainability of our agriculture is at stake today. We are facing a huge challenge, and if we do not act now, India or globally, there's going to be a huge food shortage. Our productivity is declining. And for that, when we examined this and we started this, our soil healthhas deteriorated. Our whole agriculture is revolving around NPK (Nitrogen Phosphorous Potassium). And even when the Soil Health concept was introduced,it was, again, in terms of the nutrients. But what I'm talking about Soil Health, and I observed is the soil biology. The soil biology means the microbial activities, organic carbon, and the best which have been generated, which we don't see, in the soil, and we don't see them, so we don't acknowledge them. So that is where this whole soil improvement is concerned, is required, for which soluble silica, which is practically depleted in our soil, plays a very important role. To manage the best within the soil, improve the soil health, availability of nutrients and its uptake in the plant. You require plasma, which is silica-based. So that's how the largest source of this available silica, where we can process it into a soluble silica(SiO_2). Silica is everywhere. But for our agriculture, what we require is monosilicic acid (H_4SiO_4). So, after going through this research, Paddy is the largest source of silica available in this, where we can process it. And the process we wanted to develop is fermentation process, where the project was so designed that this silica in this Paddy Straw gets converted into monosilicic acid. And when we use this in agriculture as a manure, this has a huge implication. And we are further even able to develop certain value-added products on this FOM or liquid FOM. I have received even a patent for one of our products. It's unimaginable the impact it is going to have on the agriculture and also as silica-based bio fungicides and bio-pesticides. So, we have been able to develop the product which acts much faster or even better than even the chemical pesticides and fungicides. That is

where my initial very first focus was silica in paddy straw to be converted into a fertilizer. And that's how I started this project.

Dr. Sachin Kumar: Wonderful. A wonderful journey you have. I remember one discussion with you. When I visited your plant, I asked you how we can support to increase the biogas yield. And your answer was, we are not for... I mean, focus is not for biogas, but for the manure. So, in that sequence, I will have a question. What are the major challenges you face in promoting this fermenting organic manure? And what steps you have taken to create this market?

Mr. Sanjeev Nagpal: Over the last 50 years of green revolution, the NPK and the chemicals have been promoted to a very large extent. That farmers don't even understand that there is an alternate to that. And although the use of chemical has exponentially grown, even when the area is shifting, like some of the agriculture land is getting diverted to colonization or industrial, but our consumption of chemicals is growing every year to the extent compounded to 20%. At a constant yield of food grain, we have to use more and more chemicals. farmers do any alternate then, the chemical. I do understand that FOM will not be able to replace chemical in a 100% manner. But yes, we can to an extent. Even there is a recognized fact that to maintain the same yield, we have to use five times more chemical fertilizers. So, the grain production per kg of NPK in '66, '67 was 80 kg, which has come down to 16 kg today. It's a reported. So, to go back to that 80 kg yield, we have to bring back the soil biological health to the level of '66, '67. Taking the first step forward, it was difficult for us, for me, to convince the agriculture universities of the systems to adopt this new approach to agriculture. But I'm glad that today, government, ICRA (Indian Council of Agriculture Research) has come forward into this, and they have actually recognized this fact. This year, only just three months ago, ICRA has posted six scientists at the KVK (Krishi Vigyan Kendra), Fazilka and we have jointly taken up this lab to promote use of this FOM and improvement of soil biology. And this year we have adopted two villages. Our plan, along with the ICRA, is to develop Fazilka district as an export hub for every product. And out of those crops, we have Basmati, Citrus, and mushroom farming. So, we are developing this agriculture for targeting these crops for export purposes. And we are introducing a new concept in agriculture this year. It's a water system, but we are asking farmers to consolidate their agriculture base, give it to us, and exchange, we will give you a certain package of practices so that once they use it, then the farmer will start realizing this. So, taking the first step forward was a challenge, and now we have a full support from ICRA, and we are going to actually demonstrate to the farmers that this makes a difference.

Dr. Sachin Kumar: So, besides the quantity, quality also was one of concern. So FOM is the one. I mean, if you see nowadays in the market, organic products are more popular.

HPCL is one of the leading companies in Indian oil, and they have very good infrastructure for R&D facility at Bangalore. I would like to know from Mr. BhaskarjyotiBaruah if you have come up any new technology or new product or new feed stock, then designing is one of the things which we have to take care for the success of your process or your overall product formation. And next question will be what are the challenges faced and measures been taken for designing of CBG plans from different feedstocks, mainly paddy stock?

Mr. Bhaskarjyoti Baruah: Good afternoon. Depending upon the feed type, we can classify the CBC plants into four categories. Plant with animal

manure such as cow dung as feed stock, plant with Municipal Solid Waste or MSW as feed, plants with industrial waste such as spent wash or press mud as feed, and plant with lignocellulosic biomass such as rice straw as feed. Each type of feed poses different challenges in designing. First, I shall cover common challenges faced by all these types of CBG plants with special emphasis on rice straw-based plant, and subsequently I will cover briefly about specific challenges for each type of feed.

Now let me talk about common challenges faced by CBG plants.

First of all, we know that depending on the feed compositions such as lignin, moisture, cellulose, hemicellulose content in feed; different feed stocks will give different amount of CBG yields. For example, Rice Straw can give 10 to 12 wt% % of purified CBG yield, Napier grass can give about 3.5 wt % yield. MSW can give about 3 wt% CBG and cow dung can give 1 to 2 wt% CBG yield. So, if you design a plant for certain feed rate, that is feed processing capacity in MT per day, depending upon the feed type, quantity of CBG produced will be different. In case you fix the CBG production capacity for the plant in MT per day, then feed rates will be different for the different feed types. Accordingly, capacities of feed handling section, size reduction equipment, pre-treatment facility, digesters, gas purification systems etc. will be different for different feedstocks. Analysing feed quality for CBG potential in Laboratory and accordingly fixing feed rate or CBG production target is very much important before designing a plant.

Another important point is that different feed stocks require different type of size reduction and pre-treatment facilities. For example, rice straw is a tough feed and needs elaborate size reduction and pre-treatment facility to make it easy to digest, but same is not applicable for MSW, where simple crusher is adequate if feed is segregated MSW. So, size reduction and pre-treatment facility to be decided suitably for the feed type.
Next point is that before establishing a plant, we must check its feasibility. We should do a pre-feasibility study, followed by a proper basic engineering of the plant, and also a detailed feasibility study. Also, proper detailed engineering, systematic equipment layout and cost estimation to be done to avoid project cost or time overrun, or to avoid plant issues during running.

Also, we must use common sense before establishing a plant. Let me give one example. For a rice straw based CBG plant to be successful, I believe that the entire rice straw is to be transported and stored in the form of bales. Otherwise, cost of transportation and storage will go up and plant operation will not be economical. Now, if we set up a plant in a place, where rice straw is available, but farmers' plot sizes are very small so that mechanical harvester or baling machine cannot be used, or rice straw storage facilities are not available. In such a scenario, we may need to buy bales at distant place and transport them a long distance to plant. Also, if there is no retail outlet to sell CBG, or there is

no market for fertilizer produced, establishing CBG plant may not be economical in such a place. In case the capacity of the plant is more than say 5 tons per day of CBG, there should be gas grid nearby as only cascade selling may not be feasible.

Another important point is that being a very new sector, equipment suppliers and vendors may not be that well-developed. Specially we should be careful about performance of size reduction equipment and pre-treatment facility for rice straw. So, we should thoroughly check vendors' offer vs our equipment specifications sheet, vendors track record on past performance, reliability, guarantee etc.

Also, we have to optimize both the OPEX of the plant, and CAPEX of the plant during design stage itself.

One more point I would like to add is that there are different types of gas purification systems available in the market. The purification system can be simple water wash, amine-based treatment, VPSA (Vacuum pressure Swing Adsorption) based system, or membrane separation system. While selecting the suitable separation system, we need to take the call based on capital expenditure, operating expenses, system reliability, ease of operation etc. Targeted methane purity, targeted methane recovery from raw CBG are also important parameters.

Another important point is that in CBG plant, biomass slurry is handled. So, conventional valves like gate valves or globe valves cannot be used in slurry service due to plugging issues. We need to use knife gate valve for the purpose. Also, conventional centrifugal pump cannot be used in slurry service unlike in a process plant; and progressive cavity pumps need to be considered.

In the morning session, Dr. Sachin Kumar mentioned about a drop in CBG yield in a plant in North India during winter whenever ambient temperature goes down. So obviously in the design itself, we have to take care that the digester should be insulated, if it is made of metal.Further, we must provide heating coil provision in digester using hot water to maintain required temperature. If necessary, heating of feed may also be considered. In a typical rice straw based CBG plant, 90% of the water is recycled back after filter press / separator and heating of this recycled stream can also be considered if required. Also, during design itself, any outage requirement of digester in future to be considered and piping loop to be designed cleverly to enable running of plant during any digester outage for cleaning & repair. Proper designing of recycle loops provided for maintaining digester pH, is also important. Providing proper instrumentations for monitoring major parameters, control system to avoid manual intervention & improving safety, proper safety system to avoid incidents in a CBG plant is also important.

Also, for CBG plant, HDPE (High Density Polyethylene) piping to be used to the extent possible to reduce the cost.

Coming to specific feed stock challenges, rice straw should undergo proper size reduction and pre-treatment for proper digestion and bring down Hydraulic Retention Time (HRT) in digesters. Proper mixtures should be provided in digesters to avoid floatation or settling of rice straw. Location and size of mixers can be decided based on CFD (Computational Fluid Dynamics) study by supplier. Also, adequate space for covered storage / storage may be considered in plant's plot plan itself. In case of press mud or spent wash, these being seasonal, use of mixed feed or press mud purchase may be needed to make the plant operational round the year. HRT to be considered for spent wash is higher than other biomass. In case of MSW, unless

segregated feed is received, segregator shall be considered in design itself.

Dr. Sachin Kumar: Thank you, Mr Baruah for elaborate discussion on design aspects of a CBG plant.

Now I would like Mr. Ashutosh Kulkarni to share his thoughts on the subject. My question is, in your terms, what is the popular Field stoppers for CBG, and what are the challenges faced and measures taken for its storage? Because these, FeedStocks, which are available for a short span of time, but you have to run the plant for throughout the year. Then storage facilities should be there. So, for that, how do you manage?

Mr. Ashutosh Kulkarni: Thank you, IOGCA, for giving this opportunity to talk on the CBG subject. This is the question regarding what are the common feedstocks available for CBG? Typically, if we see the sugar belt like UP, Maharashtra, Karnataka, where the most popular feedstock for CBG is a press mud, of course, which is a bioproduct of a sugar industry. Another one is agriculture waste. So, depend upon the locality and the crops which are being cultivated in your area, the various crops like rice straw, wheat straw, corn cobs, Napier grass, all these lignocellulose feedstocks can be used. Then the municipal solid waste and the food waste These are also commonly available feed stock for the CBG plants. So, these are the typical bifurcation. Now, quickly coming to the storage part. And before that, what he was referring that some of the feedstock would be available in a typical less time frame, but we have to use complete throughout the year. So yes, in case of sugar and dust with press

mud, which is generated, it would be four months or five months in year. We have to the plant for a complete one year. And press mud is a degradable raw material.

It will start degrading organic content as soon as it is generated. So, Praj has developed a patented technology where we can preserve the press mud. For or throughout the one-year performance, where the yields will not be reduced. So that is one of the unique technologies about the Praj. Now, coming to the rice straw, which is typically available once in a year for 45 days or maximum in some of the states, it is available twice a year. Of course, there are a lot of challenges in terms of rice straw storage, typically in a rainy season, because You can't cover the whole area of the feedstock to be shaded and the rainfall will not happen. It is going to happen. Your rice straw is going to get wet. Of course, in that case, you should have a system for pre-treatment of the rice straw or shedding or willing of the rice straw, even if it is a wet condition. So, this is important element. In case of rice straw, this is very important that you should not store the rice straw or any agriculture dry waste at a one location because fire hazards are possible.

So, it is advisable always to have a small storage within a CBG plant, and then the rest, satellite storage can be managed. So. Thank you.

Dr. Sachin Kumar: How we are handling FOM or liquid FOM (LFOM), or how this selling is handled?

Mr. Ashutosh Kulkarni: If we can bifurcate between the solid FOM and liquid FOM. Solid FOM, which is generated from press mode or a cloud down, doesn't have so much challenge in terms of selling in the market. There are fertilizer companies like IPL, IFFCO, KRIBHCO, RCF etc., they are ready to sign the contract with CBG producers to completely take all solid manures on a bulk basis. So, this is not so big challenge as of today. Typically, the FOM generated from agriculture waste of a rice straw, this FOM need to be improved by adding cultures and other NPKs into it. To get it marketable, it should give

the performance on an agriculture pattern. There's a little challenge with this. And related to the liquid manure, which typically generate when it comes from the press mud, but it also has very good NPK values and have been demonstrated in various plant offers by helping the farmers. So, the farmer's demand for liquid manure is increasing day by day now. Thank you.

Dr. Sachin Kumar: Mr. Bishwanath Sarkar, He is from IOCL. So IOCL is again involved in R&D, not only R&D and offtake of CBG. SATAT scheme is initiated by through IOCL only. So, my question to Mr. Sarkar is, what are the recent advancement in R&D for compressed bio Gas technology?

Mr. Biswanath Sarkar: Good afternoon, everyone. I would like to extend my gratitude to IOGCA for giving me the opportunity to speak on such a relevant topic, particularly in light of the current emergency scenario. My colleague, Mr. Sachin, has already provided an overview of the CBG process during his talk. However, for the benefit of all, I will briefly reiterate the key steps involved in the process.

The CBGproduction process involves four primary stages: pre-treatment, main digestion, and solid-liquid separation, followed by gas purification. Each of these stages presents its own set of challenges, which is why ongoing R&D efforts are focused on improving reliability, operational ease, and efficiency to enhance overall performance.

In the pre-treatment stage, as discussed earlier by Mr. Bhutani and Bhaskar present in the dais, this process is energy-intensive, especially since we are dealing with waste, which often contains a lot of contaminants. Proper care must be taken to remove these contaminants and ensure the feed is appropriately treated to maximize yield in the main digester. Pre-treating materials like agricultural residue may require mechanical processes that demand significant energy. There is an ongoing challenge to reduce this energy consumption, and alternative sources like solar power are being explored. Additionally, more energy-efficient equipment is being developed, with some efforts focusing on bacterial pre-treatment to minimize energy requirements.

Moving on to the main digestion stage, while the biological process behind it is simple, something we've observed in our early days in a small-scale household application for generation of biogas from decomposition of cow dung. However, scaling up this process to handle large volumes (e.g., 100-200 tons of cattle dung) presents major challenges. Digesters at this scale, with diameters ranging from 20 to 30 meters, must carefully manage hydrodynamics. Since this is an anaerobic bacterial process, even minor changes can significantly affect performance. Critical factors to monitor include maintaining uniform temperature and consistent organic loading throughout the digester. Achieving this requires the use of an appropriate mixing system, which may involve mechanical stirrers, gas-based mixing, or recirculation systems. Each option has its own maintenance requirements, and optimizing these systems together can lead to more efficient operation. Temperature regulation on a large scale also demands substantial energy. To address this, researchers are exploring energy-saving technologies like solar power and high-efficiency heat pumps, which could improve the energy efficiency of large-scale digesters.

The purification stage is another critical aspect, as any loss of methane during this process has significant economic impacts. While PSA (Pressure Swing Adsorption) systems are widely used, they tend to result in a methane loss of over 10%.

Alternatives like membrane systems and water scrubbing systems are being explored to minimize this loss. However, the cost of membranes is a concern, and current research aims to extend the membrane's life cycle to reduce both operating and capital costs. Some approaches research activities are being focused by combining membrane and water scrubbing systems to optimize costs further.

Finally, regarding the utilization of by-products, such as organic and liquid manure, there is a lot of untapped potential. While most focus has been on solid organic manure, liquid manure also holds great promise, particularly because it can be more easily absorbed by plants. Research is ongoing in this area, including methods to spray liquid manure directly on trees and soil to enhance plant growth and efficiency.

In summary, CBG process holds immense potential as a renewable and sustainable energy source, it faces several challenges related to feedstock availability, processing, biogas upgrading, and market viability. However, by adopting sustainable solutions such as diversified feedstocks, low-energy upgrading technologies, and supportive policy frameworks, CBG production can become a key contributor to the global shift towards clean energy and circular economies. Long-term success will depend on collaborative efforts between governments, industry stakeholders, and local communities to create a viable and sustainable biogas ecosystem.

Thank you.

Dr. Sachin Kumar: Thank you. Thank you, Mr. Sakar. Next panellist, Dr. Parmeshwar Patil. He's from BPCL. So BPCL also having its R&D Center a Greater Noida. I have visited that R&D facility, too. So, my question with Dr. Patil also the same. What advancement has been done by BPCL in CBG sector?

Dr. Parmeshwar Patil: Good afternoon. Thank you, IOGCA, for inviting BPCL to this forum.. Basically, BPCL and BPCL R&D, we are working on development of this CBG technology. So, if you look at this CBG sector, as several panelists have highlighted, a major challenge in the CBG sector is achieving the economic viability of biomass-to-CBG plants To address this challenge, it is crucial to efficiently utilize all biomass components. So, at BPCL R&D we are working on development of dry anaerobic digester where we can use high solid protein, which is not used in the conventional technology. So, we have put up a plant in collaboration with CSIR-IICT at Hyderabad, where we are processing almost more than 20% of solids to produce biogas. And this plant is in operation for the last few months. Another aspect I would like to mention is that Currently, during the conversion of biomass to biogas, only sugar components (C6 and C5 sugars) are utilized. However, significant components like lignin remain underutilized. In this CBG scenario, we have only two main streams. One is CBG and another one is the manual. With the manual, still we are struggling.
How to make this whole sector viable by producing other products along with the CBG? How to produce that? Whether we can valorise this Lignin from the paddy straw and produce some value-earned products. Another important component, that is the silica. The paddy straw is having high amount of silica. Whether we can reoccur that silica and valorise into the other products. At BPCL R&D, we have developed to extract silica from Paddy straw. And that silica is widely used in the try industry, toothpaste industries and Footwears Industries. We have all plates of that silica. We have supplied that product to the various leading manufacturers, and they have approved our products, and we

are moving next steps to valorising all these components. So if we valorise each component of biomass, particularly silica or lignin, we have additional streams. Let's say we have we have valorised silica. Precipitated silica goes at a rate of around ₹50 to ₹60 per kg. So, along with the CBG, we have an additional product which can provide us a revenue around ₹50 to ₹60 per kg. If we can valorise lignite, we have another revenue stream into our CBG sector. So, in conclusion, I would like to mention that we need to look at each component of biomass and we need to valorise each component to make this sector economically viable.

Thank you.

Dr. Sachin Kumar: My question to Dr. Kanwar is, MSW is one of the complex feedstocks, and the challenge is starting from the source of collection centre to the storage yard, and then its utilization. Many challenges are there so, I would request him to show the major challenges which you have been faced in collection of MSW with mixed and diverse field stocks and how is the process affected. And along with that, how the MSW waste is converted to FOM and further disposed of at farmer's field. What is the demand for it?

Dr. Kanwar Singh: Thank you, Dr. Sachin. Thank you, IOGCA, for inviting me, and particularly Dr. Anil Bhardwaj Sir. And basically, I think this is one of the platform, where we can share our experiences for the benefit of the society and the environment could be mad sustainable. I think Dr. Sachin has already explained that we are the only industry in India who is dealing all type of feed stocks, either it is MSW, paddy straw, Press mud and the animal waste.

With MSW the CBG production varies between 3-4%. But the important part is how you segregate the waste, because the MSW is a mix of inorganic and the organic waste. So, the first thing is you must have to provide the training to the team which will help in segregation of the waste at source. That is the first step and foremost requirement for getting the segregated organic waste. The second step is to get it transported at the sites in the quickest possible time. Because if you will delay in supply, then certainly the gas production will be impacted. Ensure the continuous uninterrupted supply make a long-term contract with the municipality's corporation. If you will not do the long-term contract, you cannot sustain the production at plant for a longer period. At all projects, initial troubles are so much which needs to be rectified with proper solutions to make your plant sustainable. So basically, the municipalities will play a very important role in providing the segregated material, and they can train their team for segregation and how this material could reach at the site. Manage organic

waste, municipal committees and environmental organisations are coordinating to segregate the waste and transport it to the processing plants. For example, in Indore, we currently receive 500 tons of organic solid waste daily, generating approximately, 15 ton of compressed biogas on daily basis. This requires numerous vehicles due to the mix of waste materials, including non-organic material like polythene and organic hard coconut shells. Despite a target of 90% segregated organic content some of the impurities remains, so trommels are used to remove them before the waste enters the digester through pre-treatment area. Here, materials are mixed and directed to digesters, after biogas production, the undigested waste is passed through solid-liquid separation (SLS) process. The solid waste, which has about 70% moisture content has to be composted in the windrows, but it often has an odour that needs to be managed. To mitigate

odour, we partner with the organisations having microbial consortium of beneficial bacteria and fungi. This microbial mix is added to the compost during fermentation taking around 35-50 days to complete, after which the odour is removed, and the product comply all the FCO specifications. The finished organic manure is sold in bulk to farmers and packaged for distribution to dealers. Due to government mandates, companies like NFL, KRIBHCO, and HURL are required to source such materials from biogas producers.

For Liquid Fermented organic manure, a batch size of 2,000 kilolitres is required. This requires a separate mixing tank with proper agitation and the addition of specific cultures to manage odour. To meet FCO norms, careful attention is paid to electrical conductivity, dilution, and other quality parameters.

Paddy straw is little bit more challenging feedstock for biogas production than MSW and press mud. The paddy straw processing begins with the collection and shredding, followed by pre-treatment and anaerobic digestion in the digester, the output raw biogas is processed and compressed for the dispatches. To reduce the straw burning, collection of paddy straw is a pre-requisite, and we've trained local village-level entrepreneurs, supporting them with necessary equipment such as harvesters and balers to manage the straw. A plant processing 100 tons of straw per day, for example, requires about 40,000 tons annually, needing roughly 40 acres of land for storage. Paddy straw requires more intensive processing than other feedstocks, as it must be finely shredded to be effectively digested. These measures are crucial to transforming agricultural waste into a sustainable resource.

Press mud presents unique challenges, although EverEnviro has secured partnerships with major sugar mills, such as Bajaj sugar mill and Balrampur Chini mill, which produce around 54% of Uttar Pradesh's sugar. These partnerships ensure a consistent feedstock supply at the plant.

Moving forward, it's essential to educate farmers on the benefits of using Fermented Organic Manure (FOM) and Liquid Fermented Organic Manure (LFOM).

Currently, the Indian Council of Agricultural Research has provided FOM recommendations for only 10 crops, including rice, wheat, maize, and, more recently added sugarcane. For LFOM, a recommendation exists solely for paddy, however, other crops could also be tested with the application of LFOM and farmers may be benefitted with the increased production and higher returns with sustainable soil health.

To maximize the benefits of FOM and LFOM, ICAR should expand its recommendations to cover additional crops, specifying application stages, methods, and expected benefits. This guidance would encourage broader adoption and help farmers better understanding about the value proposition of these organic fertilizers.

Dr. Sachin Kumar: ICAR and State Agricultural Universities are working on it and how it could be popularized among the farmers, basically so far in Punjab, PAU is there who is extensively working on the impact of FOM application on the soil health and its benefits in increasing the yield of different crops.

With this we come to the end of this Panel Discussion. A lot of useful experiences and thoughts have been shared and I am sure they will be equally useful for industry, researchers and policy makers.

Thank you everyone for participation.