Jointly Organised by

IFGE MNRE ACTIVE

Supported by

INDIA BIOENERGY & TECH EXPO

2nd International Conference & Exhibition on Bioenergy and Technologies

Theme

Transition to Net Zero:
Need to Scale up Bioenergy Initiatives

www.ibetexpo.com

24-26 September 2025 | Yashobhoomi, New Delhi

Post Event Report

- 30+ Sessions
- 175+ Speakers
- 700+ Delegates in Conference
- 100+ Exhibitors
- 5,000+ Visitors in Exhibition
- On Spot Business of Rs. 250 Crores
- Leads Generated for Rs. 1,000 Crores

Background

The major challenge in today's world is to combat from emissions, wherein industries, transport and automobile sector has bigger shares to play. The discussion at Global Platforms like Conference of Parties to United Nations Framework Convention on Climate Change (UNFCCC) under Paris Agreement has united the several countries to work on the reducing emissions. Many countries and industry Giants are working very aggressively to identify and innovate the technologies to curtail down this Global issue.

Government of India has taken various initiatives which includes promoting Bioenergy which is derived from various agro/sylvi/ Industrial, biological waste, agricultural residue and Municipal Solid Waste. The Global Biofuel Alliance announced by Shri Narendra Modi, Hon'ble Prime Minister of India at G 20 is also providing the impetus to Bioenergy Sector and creating International ties.

To promote the Bioenergy Sector in India, Indian Federation of Green Energy (IFGE) & MVI Activ Sci - Tech Communications has jointly organized 2nd Edition of India Bio Energy & Tech Expo: An International Conference and Exhibition on Bioenergy and Technologies (IBET Expo 2022) from September 24-26, 2022 at Yashobhoomi, Dwarka, New Delhi.

The Expo has sought the participation of more than 200 exhibitors and the International Conference on Bioenergy and Technologies has witnessed the participation of more than 125+ Speakers, 700+ Delegates. There were more than 20 Sessions organized at conference focusing on Compressed Biogas, Biomass pellets and briquettes, Ethanol, CCUS, Bio Mobility, Sustainable Aviation Fuel, Green Hydrogen, Bioenergy Financing, Gasifying and Farm to Fuel.

About Organizers

Indian Federation of Green Energy (IFGE)

IFGE is a dedicated trade body promoting green and bio energy since 2014 across all sectors of economic development and committed to fostering a comprehensive and integrated approach to building a sustainable energy ecosystem by collaborating with stakeholders at every level—across industries, states, and the nation. Our efforts focus on driving innovation, policy advocacy, and practical solutions that enable this transition to clean energy for a greener and more sustainable future.

MVI Activ Sci-Tech Communications

MVI activ sci-tech communications is India's leading science-oriented event management and knowledge outreach organization, specializing in large-scale tech-logic, innovation, and industry platforms. With over two decades of experience, MVIACTIV has partnered with global institutions, government bodies, and industry leaders to curate high-impact conferences and exhibitions in the field of Science, Technology, & Agriculture. The company is known for its end-to-end event management, strategic content development, and industry ecosystem building. MVIACTIV brings its expertise in delivering world-class, outcome-driven events, its commitment lies in enabling collaboration, innovation, and sustainable growth across emerging technology & agri sectors.

CONTENTS

Insights from Day 1 - September 24, 2025 5

Inaugural Session 6

International Perspective on Bioenergy: Enabling Global Energy Transition 7

CBG Panel 1: What is the CBG Investment Status Quo : Achievement and Gaps 9

CBG Cross Panel 1: Gas Offtake: Conditions, Modalities, Infrastructure Limitations & Solutions 10

Bioenergy - Creating Steam and Thermal Balance for a Just Energy Transition 12

Densification on Demand: Opportunities through Briquetting, Pelleting and Torrefaction 13

EBP of Bharat : Journey Beyond 20 Percent - Possibilities and Capabilities 14

Advanced Biofuels -2G Ethanol Technologies 15

Insights from Day 2 - September 25, 2025 16

Plenary Session 16

CBG Cross Panel 2: Technical and Commercial Expectations & Performance Management 17

CBG Panel 2: Feedstock Supply Chain & Storage 18

CBG Panel 3: Leveraging FOM and Derivatives: Challenges in Supply Chain and Opportunities for Soil Health Improvement 19

CBG Panel 4 - Establishment of Compliance-based Carbon Market Mechanism for CBG Sector in India 20

CBG Panel 5 : Optimum Performance Through Quality Enzymes, Raw Materials, Equipment and Machinery 21

Biomass - The Supply Chain Conundrum for Bioenergy, Biofuels and Biomaterials 22

Skilling the Workforce in Bioenergy Space 24

Is Bharat Aligned with Global CCUS? Policy and Management Pathways 25

Evolving Opportunities: Technology, Finance and beyond for CCUS 26

Sugar to Ethanol: Next Step, Challenges & Opportunities and Emerging Pathways 27

Grain to Ethanol : Next Step, Challenges & Opportunities and Emerging Pathways 28

Advance Biofuels - By-Product Valorization, Cost Engineering & LCA 29

Green Hydrogen - How Soon and How Much can be ? 30

Session on From Farm to Fuel: Building a Bioenergy Ecosystem 31

Insights from Day 2 - September 26, 2025 34
Financing the Bioenergy Sector 34
Partner State Session with Government of Uttar Pradesh 39
Biomobility: Policy Framework for Future & Emerging Opportunities in India 46
SAF Production Technologies 47
Policy Initiatives for SAF 50
Bioenergy Concave 59
Valedictory Session & Award Felicitation Ceremony of 9th India Green Energy Awards 61

Abbreviations:

Special Guest - (SG)

Session Chair - (SC)

Session Co- Chair - (SCC)

Moderator - (M)

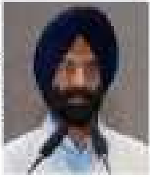
Inaugural Session

(L to R): [illegible] Kumar, Vice Chairman, [illegible]; [illegible]; Dr. [illegible], President, [illegible]; Shri Nitin Gadkari, Hon'ble Minister of Road Transport and Highways, Government of India (Chief Guest); Shri Manjinder Singh Sirsa, Hon'ble Cabinet Minister, Government of Delhi (Guest of Honour); H.E. Mr [illegible], Ambassador of [illegible] to India; [illegible], Former Member, [illegible] & Managing Director, [illegible]; [illegible], Vice President, [illegible] & former Chairman of [illegible]

Address by Shri Nitin Gadkari, Hon'ble Minister of Road Transport and Highways, Government of India

Hon'ble Minister has emphasized that 40% of India's air pollution comes from transport, calling for rapid adoption of green fuels like bioethanol, biobutanol, and green hydrogen to reduce dependence on fossil fuels and cut the ₹22 lakh crore spent annually on energy imports. He highlighted the government's biofuel initiatives, such as permitting ethanol production from corn, which raised farmer's incomes and boosted rural economies. He also showcased that India's progress in ethanol-based generators, second-generation ethanol plants using bamboo and rice straw, and bio-bitumen roads, stressing "waste-to-wealth" and "knowledge-to-wealth" innovation. He praised automakers for advancing flex-fuel and EV technologies and noted India's growing position as the world's third-largest ethanol producer. Ongoing hydrogen fuel projects with major companies signal India's shift toward becoming an energy exporter. He reiterated his vision to make India the no.1 automobile manufacturing hub within five years through renewable energy, innovation, and industry collaboration under the Atmanirbhar Bharat mission.

Address by Shri Manjinder Singh Sirsa, Hon'ble Cabinet Minister, Government of Delhi



Hon'ble Minister stated that use of clean fuels is the only solution for combating the challenge of rising pollution in cities like Delhi. He further highlighted the initiatives of Delhi Govt in addressing these issues including new electric vehicle policy which will be launched soon. He also mentioned about the efforts of Delhi Govt for adopting Bioenergy including recently inaugurated CBG plant.

Address by Dr. Pramod Chaudhari, President, IFGE & Founder Chairman, Praj Industries

Dr. Chaudhari while highlighting the success of Ethanol Blending Programme and a steady progress in CBG sector felt that the promising areas of growth for Indian Biofuel industry are in SAF, 2G Ethanol and Advanced biofuels. He further enlightened that new product development and innovation is the necessity of this sector like Bio Bitumen, LCO [illegible] bio-IBA based panel, flex fuel vehicles, etc.

Summary:

- Biofuels reduce dependence on imported fossil fuels, cut CO2 emissions, and create opportunities for rural and tribal economies.
- Surplus crops like sugar, corn, rice, wheat, and agri-residues are being used to produce ethanol, CBG, and other biofuels, boosting farmer income. Energy crops like sweet sorghum, bamboo, and non-edible oilseeds are being explored.
- Vehicles with ethanol flex engines reduce fuel costs significantly and are pollution-free. Tractor and construction equipment sectors are moving toward biofuel, CNG, and electric options.
- Research and pilot projects include ethanol, isobutanol, Bio-CNG, sustainable aviation fuel (SAF), and bio-bitumen. Rice straw and other residues are being used efficiently, generating multiple byproducts. Development of supply chains, storage, transport, offtake infrastructure, and gas grids is critical. Carbon monetization programs are being planned.
- Supportive and continuous policies are essential for growth, commercial viability, and exports. India aims to be a major exporter of biofuels, SAF, and green hydrogen.

Recommendations:

- **Promote and expand use of biofuels** across transport, agriculture, and industry to reduce pollution and fossil fuel dependence.
- **Strengthen feedstock supply chains**, including surplus crops, agri-residues, and energy crops, to ensure year-round availability.
- **Invest in technology and infrastructure** for ethanol, CBG, SAF, bio-bitumen, and other biofuel innovations.
- **Government Support for commercial viability** through subsidies, incentives, and clear policy roadmaps.
- **Develop export markets for biofuels**, SAF, and green hydrogen, including carbon credit mechanisms.
- **Foster coordination among ministries**, industry, and research institutions to accelerate bioenergy growth.

International Perspective on Bioenergy: Enabling Global Energy Transition

L to R: Mr. [illegible], Director General, ISMA; Mr. Ravi Gupta, Chairman, ISMA Sugar Bioenergy Forum & Executive Director, Shree Renuka Sugars; Mr. [illegible], ISMA; [illegible]; Managing Director & Senior Partner, Boston Consulting Group (BCG); Dr. [illegible]; H.E. Mr. Kenneth Felix Haczynski da Nóbrega, Ambassador of Brazil to India (R); Mr. [illegible]; H.E. Mr. Kimmo Lähdevirta, Ambassador of Finland to India (R); Dr. [illegible]; Mr. [illegible], Chairman, Bioenergy Committee of ISMA [illegible]

Address by H.E. Mr. Kenneth Felix Haczynski da Nóbrega, Ambassador of Brazil to India

Brazil's biofuel development began during the 1973 oil crisis, guided by consistent policies and technological innovation that built a strong ethanol industry. The introduction of flex-fuel vehicles in the 2000s enhanced energy adaptability and market resilience. Under its COP30 presidency, Brazil promotes the concept of "Multi Rao," emphasizing community-led and inclusive climate action. Through the Global Biofuels Alliance, Brazil works with partners like India to advance sustainable biofuel adoption, focusing on technology sharing, standard harmonization, and certification frameworks. The strategy balances climate goals with social inclusion, supporting rural livelihoods while minimizing food competition and promoting a just energy transition across the Global South.

Address by H.E. Mr. Kimmo Lähdevirta, Ambassador of Finland to India

Finland is advancing scalable bioenergy and circular economy solutions, including biofuels from biomass and waste, high-efficiency power plants, and municipal waste-to-energy technologies. As the first country to create a national circular economy roadmap in 2016, Finland targets full implementation by 2035. Key initiatives like the Nordic Green Gas project and Kemi bioproduct mill demonstrate leadership in renewable fuels and carbon capture. Finnish industries are transforming into biorefineries, supported by strong government policies and public-private collaboration. Finland and India are expanding cooperation in bioenergy and waste-to-energy projects, highlighting sustainability as an investment opportunity in technologies and products.

Summary:

- **Global Leadership in Bioenergy:** Bioenergy is now a global force. Brazil leads in bioethanol, Europe in biogas, and India has ambitious goals for ethanol and CBG. Finland showcases excellence through diverse biomass use, hybrid systems, and a strong circular economy backed by stable policy. Brazil's success rests on policy continuity, flex-fuel vehicles, and grassroots climate action under "Multi Rios."
- **Policy and Market Evolution:** Australia's biogas boom, driven by feed-in tariffs, collapsed when political support weakened—proving the need for stable, long-term policy. India's ethanol program is a major success, reaching 20% blending six years early. It shows that clear targets and consistent policy can rapidly transform industries.
- **Challenges in India's CBG Sector:** India's CBG sector faces weak business models, limited grid connectivity, and high investment needs—about USD 300 billion for 5,000 plants by 2030. Despite abundant feedstock, fragmented governance across ministries slows growth. A unified National CBG Mission is needed to coordinate policy and implementation.
- **Technical and Infrastructure Constraints:** Many CBG plants run below capacity due to imported technologies unsuited to Indian conditions. Localized R&D, better pipeline networks, and clear standards for bio-fertiliser and environmental benefits are vital. These steps can help monetize carbon and fertiliser credits.
- **Human Capital and Innovation Needs:** The sector faces a serious skills gap. Structured training, certification, and capacity-building programs are essential. Future progress depends on adopting advanced biotechnologies for decentralized waste-to-energy conversion.

Recommendations:

- **Strengthening the Bioenergy Ecosystem:** Long-term, stable policies and a functional global carbon market are vital to attract investment, enhance project viability, and monetize environmental benefits. Bioenergy business models must be integrated—capturing value from fuel, co-products, and waste management. Success will depend on aligning viable technologies, supportive policy and financial frameworks, and a skilled workforce.
- **Advancing a Circular and Sustainable Bioeconomy:** The next phase calls for a circular bioeconomy that captures and reuses carbon, promotes decentralized bioenergy units, and accelerates ethanol production to enter global markets such as SAF. Government support will remain crucial, but long-term growth will be driven by continuous innovation, cost efficiency, and strong public-private collaboration.

CBG Panel 1 - What is the CBG Investment Status Quo : Achievement and Gaps

L to R: [illegible]

Summary

- **Underutilized Capacity and Weak Economics:**
  Most CBG plants are operating at only 30–40% of installed capacity due to high operational costs, feedstock inconsistencies, and limited offtake. Investor confidence is low, with less than 10% of the targeted ₹1.75 lakh crore investment realized, mainly due to uncertain returns and long payback periods.
- **Feedstock Supply Chain Bottlenecks:**
  Seasonal feedstock availability, lack of aggregation and storage systems, and high transportation costs disrupt production. The absence of aggregator incentives and a price stabilization framework further limits feedstock reliability.
- **Policy, Pricing, and Financing Gaps:**
  The current CBG price remains unviable compared to ethanol, and delays in MDA/FOM disbursal along with the complex B1/B2 process affect cash flows. Financing barriers persist due to the absence of credit guarantees, limited offtake visibility, and lack of long-term pricing assurance.
- **Institutional and Operational Challenges:**
  Unclear carbon-credit mechanisms, fragmented inter-ministerial coordination, and absence of a single-window system cause procedural delays. Additionally, a disconnected value chain and inadequate skill development in plant operations hinder performance optimization.

Recommendations:

- Convert MDA into a gas production-linked incentive with simplified procedures, faster disbursal, and stable support for bio-enriched FOM linked to energy output.
- Notify a CBG-specific carbon-credit methodology and integrate it with the India Carbon Market (ICM); allow trading of Renewable Gas Certificates (RGCs).
- Establish a single-window clearance and financing portal for land allotment, approvals, and incentives; classify CBG under the 'Infrastructure Sector' to enable concessional finance.

- Introduce **generation-based CBG incentives**, recognize **biogenic CO_2 utilisation** as an additional revenue stream, and promote **indigenisation of equipment**.
- Expand **grid injection infrastructure** in coordination with GAIL and CGDs and **create a Centre of Excellence** for training, certification, and technical support.
- Conduct **capacity-building for bankers and project operators** and develop uniform **SOPs** for operations, maintenance, and safety across the CBG industry.

CBG Cross Panel 1 - Gas Offtake: Conditions, Modalities, Infrastructure Limitations & Solutions

L to R - [illegible]

Summary:

- Several CBG plants continue to face limited pipeline connectivity, particularly those located far from CGD networks or trunk pipelines.
- The absence of decentralised injection hubs or mini-grid infrastructure has increased reliance on costly cascade-based gas transportation.
- The prevailing "Take and Pay" model poses a significant challenge to project bankability; producers have recommended a shift to a "Take or Pay" arrangement to ensure payment assurance.
- **Delayed payments**, short-term MoUs, and **ambiguities in contractual obligations** are contributing to commercial uncertainty.
- The current CBG base price of Rs 54/kg (delivered) is economically unviable for many feedstocks. Industry

stakeholders have proposed reviewing pricing with additional compensation for logistics.

- **High transportation costs** and unclear **GST applicability** under various contract structures adversely affect project profitability.
- The absence of a **uniform national framework** for offtake modalities covering direct sales, pipeline injection, and CNG supply creates operational and procedural ambiguity.
- **Restricted access** to CGD infrastructure under PNGRB guidelines, coupled with limited coordination among MoP&NG, PNGRB, and CNCCL, constrains seamless gas offtake integration.
- **Variations in methane purity** (92–98%), inconsistent gas pressure, and lack of standardised metering practices create challenges in maintaining quality compliance and reconciling offtake volumes.

Recommendations:

- Establish **CBG injection hubs** and regional compression–storage facilities near major production clusters to enable efficient gas evacuation.
- Encourage **shared logistics frameworks** to minimise transportation costs and improve supply chain efficiency.
- Formulate and implement a **standardised national offtake policy** encompassing all CBG delivery modes—pipeline injection, CNG supply, and direct industrial use.
- **Simplify PNGRB access codes** and allow the consolidation of small-scale injection nodes for economically productive purposes.
- Facilitate **open access to CGD networks** through transparent and equitable tariff mechanisms.
- **Revise CBG pricing methodology** to an **ex-terminal model**, ensuring separate compensation for logistics and compression costs.
- Permit **direct industrial and institutional sales** of CBG under revised PNGRB provisions to broaden market access.
- Develop a **CBG trading platform or exchange** to enhance price transparency and market liquidity.
- Support installation of **booster compressors, calibrated flow meters, and SCADA-based systems** to ensure reliable metering and monitoring at offtake points.
- Constitute a **joint task force** comprising MoP&NG, PNGRB, and CNCL representatives to monitor gas offtake, resolve infrastructure bottlenecks, and harmonise pricing and policy frameworks.

Bioenergy - Creating Steam and Thermal Balance for a Just Energy Transition

L to R: Mr. Amrit [illegible], Director, [illegible] Agro Energy Pvt. Ltd.; Mr. Saurabh Kumar, Advisor to National Team, IFSC [illegible]

Summary

- India's biomass sector faces fragmented sourcing, logistics constraints, variable quality, and inconsistent demand.
- Lack of firm offtake agreements and limited MSME policy support weaken investment confidence and cost competitiveness.
- Sustainable growth requires stable supply chains, stronger regulations, and technological innovation in multi-fuel boilers, densification, and digital monitoring.
- Scaling a resilient bioenergy ecosystem depends on cost efficiency, skilled manpower, and collaboration among farmers, industry, and policymakers.

Recommendations:

- Strengthen biomass supply chains through farmer linkages, efficient logistics, and structured engagement.
- Secure long-term offtake agreements and policy incentives to reduce investment risk and support MSMEs.
- Drive cost reduction and efficiency through technology innovation, AI-enabled monitoring, and digital transparency tools.
- Promote multi-fuel, hydrogen-ready, and advanced tech-driven biomass systems to diversify operations.
- Expand BOOT and O&M models to ease operational burdens and enhance scalability.
- Invest in brownfield and underutilised sites to accelerate sector growth.
- Ensure cost competitiveness, policy stability, and coordination across the value chain.

Densification on Demand: Opportunities through Briquetting, Pelleting and Torrefaction

L to R: [illegible]

Summary:

- Reliable, high-quality feedstock supply requires efficient collection, storage, and seasonal planning.
- Moderate plant setup costs contrast with high operational expenses, demanding prudent budgeting and cash flow management.
- Customized, durable, and automated machinery is vital for efficiency and consistent pellet quality.
- Pellets outperform briquettes in density, efficiency, and automation potential, especially when paired with solar energy.
- Strong system engineering, organized supply chains, and policy support (carbon credits, VGF, co-firing mandates) are key to project viability and sector growth.

Recommendations:

- Ensure reliable biomass supply through robust collection, storage, and pre-processing systems.
- Deploy crop-specific, durable, and automated machinery to enhance efficiency and reduce costs.
- Adopt integrated system design for optimized, seamless operations.
- Leverage policy and financial support such as carbon credits, VGF, and government programs.
- Develop long-term operational plans covering design, sourcing, maintenance, and budgeting.
- Strengthen awareness and capacity across stakeholders to promote quality and technology adoption.

EBP of Bharat : Journey beyond 20 Percent - Possibilities and Capabilities

L to R: [illegible]

Summary:

- **Expansion and Infrastructure Growth:** India's ethanol procurement has risen from 38 crore litres in 2014 to 1,050 crore litres planned next year, supported by 1,700–2,000 crore litres of production capacity. Long-term supply agreements with 322 producers and expanded storage (from 15 to 85 crore litres) have strengthened the supply chain.
- **Vehicle Readiness and Public Awareness:** All new vehicles since April 2023 are E20 compatible, and automakers are developing flex-fuel models for higher blends. E20 performs well, though lower mileage due to ethanol's energy content must be clearly communicated. Official standards for E85 and E100 are in place, but many existing vehicles remain limited to E20.
- **Sustainability and Future Opportunities:** The shift toward grain-based ethanol reduces water use, supporting better resource management. Ethanol's potential extends to clean cooking fuel, biodegradable plastics, generators, sustainable aviation fuel, and exports. The sugar industry showcases a circular economy model where production waste becomes valuable input.

Recommendations:

- **Formulate a Long-Term Ethanol Roadmap:** Define a clear national strategy for ethanol blending beyond E20, with regional rollout of flex-fuel vehicles, transparent pricing, and stable offtake agreements.
- **Promote Sustainable & Advanced Ethanol Production:** Scale up 2G ethanol from agri-residue and non-food biomass to enhance sustainability and reduce dependence on food-based feedstocks.
- **Diversify Markets and End Uses:** Expand ethanol applications into diesel blending, aviation fuel, industrial uses, and exports driving circular economy growth and global competitiveness.

Advanced Biofuels - 2G Ethanol Technologies

L to R: Ms. [illegible], Director, [illegible]; Dr. Tushar Patil, Assistant Vice President - Corporate Strategy, Praj Industries; [illegible]; Dr. [illegible], Scientist, [illegible] Energy and Sustainable Technology Division (CEST), Department of Science & Technology (DST)

Summary :

- High Enzyme Cost and Optimization Scope: Enzyme cost remains a key challenge due to high dosage requirements. As 2G ethanol plants achieve operational stability, there is significant scope to optimize pretreatment conditions, enzyme blends, and application strategies to enhance efficiency and reduce costs.
- Evolving Enzyme Supply and Production Models: Currently, centralized enzyme production and long-distance supply remain the most reliable models. Over time, the ecosystem is expected to shift toward regional hubs and potential on-site enzyme production based on plant scale and location.
- Need for Strategic Industry Collaboration: Long-term partnerships between 2G ethanol plant developers and enzyme suppliers are critical for ensuring economic viability and investment confidence. The expanding number of 2G refineries in India underscores the need for stronger cooperation among technology providers.
- Improving Economics through Co-product Utilization: Valorization of lignin and other co-products is essential to strengthen overall plant economics. Presently, a 100 KLPD 2G ethanol plant requires an investment of approximately ₹900 crore, with potential cost reduction in private sector projects. Feedstock conversion is around 230–240 litres of ethanol per ton of dry paddy straw.
- Government Support for R&D and Innovation: The government is prioritizing R&D funding, industry–academic partnerships, and innovation in strain development and process intensification to enhance technological and commercial viability.

Recommendations:

- Develop organized feedstock logistics systems for consistent and cost-effective biomass supply.
- Strengthen R&D in enzyme efficiency, strain engineering, and region-specific enzyme cocktails.
- Invest in advanced pretreatment technologies to reduce energy consumption and enzyme dosage.
- Establish regional enzyme production hubs as more 2G ethanol plants become operational.
- Promote commercial pathways for lignin and other by-products to enhance plant sustainability and profitability.

Plenary Session

L to R: [illegible]

Hon'ble Minister highlighted that India has reached a key milestone in its energy journey with half of its installed capacity now from non-fossil sources. It leads globally in renewable energy growth and has achieved major climate targets ahead of schedule. Bioenergy plays a vital role by generating clean power, managing waste, creating rural jobs, and supporting energy security through initiatives like the National Bioenergy Programme and GOBARdhan. Over 500 new projects and 55,000 small biogas plants have been established, empowering rural communities and women. With vast untapped potential from agricultural and municipal waste, India aims to produce 42 GW of electricity or 68,000 tons of CBG daily. The Compressed Biogas (CBG) sector is gaining rapid momentum, with a current blending level of 0.73% in CNG and an overwhelming response from entrepreneurs. These efforts, supported by international alliances and policy initiatives, are transforming India into a global biofuel hub while advancing towards a cleaner, self-reliant, and sustainable future.

Summary

- India's economy grows at 6.5% with 220+ GW renewables achieving 50% non-fossil capacity ahead of 2030 targets.
- Ethanol blending rose from 1.5% to 20%, saving ₹1.4 lakh crore in imports and boosting farmer income; five 2G ethanol plants are being commissioned.
- The CBG sector is expanding fast with 113 plants commissioned and a 5% blending target by 2028-29.
- India's biomass and waste potential can generate 42 GW power or 68,000 TPD CBG.
- Strong global and institutional partnerships aim to strengthen R&D, skills, and investment in bioenergy.

Recommendations:

- Align policies between MNRE, MoPNG, and MoEFCC to fast-track biofuel projects.
- Introduce carbon-credit trading to attract private and global investment.
- Support R&D and cost reduction in 2G ethanol and CBG technologies.
- Create a biomass supply chain framework ensuring fair farmer prices and reliable feedstock.
- Expand skill development and industry-academia collaboration for innovation and workforce readiness.

CBG Cross Panel 2 - Technical and Commercial Expectations & Performance Management

L to R: Dr. Suneel Pandey, Director, Circular Economy & Waste Management Division, TERI; [illegible]

Summary:

- The CBG sector in India continues to face volatile and limited revenue streams, with gas as the only consistent income source. By-products like FOM, LFOM, and carbon credits remain underdeveloped due to policy uncertainty and weak market mechanisms. The fertilizer subsidy imbalance and royalty obligations on MSW feedstock further undermine financial viability.
- Technical and engineering inefficiencies including poor process design, inconsistent reactor sizing, and methane slippage remain major contributors to underperformance. Variations in feedstock characteristics significantly affect digestion efficiency and gas purity.
- The feedstock supply chain is fragmented and seasonal, lacking standardised contracts, aggregation infrastructure, and adequate storage facilities. Competing uses and logistical challenges increase cost and uncertainty for CBG producers.
- Persistent policy and financial barriers including limited coordination between ministries, delayed fiscal support, and lack of bank confidence have slowed sectoral growth. Current concession agreements and MCA processes do not adequately account for feedstock quality or project risk.
- The sector also faces operational challenges, such as high CAPEX pressures, limited skilled manpower, and commissioning/implementation hurdles. Weak plant monitoring and absence of SCADA systems further exacerbate performance variability.

- **Systemic gaps in standardization and monitoring**, including the lack of defined technical norms for feedstock, FOM quality, and biogas upgrading limit consistency, credibility and scalability across projects.

Recommendations:

- **Revenue and Market Diversification:** Prioritise gas as the primary revenue stream while developing policy frameworks for FOM and carbon credit monetisation. Mandate **tipping fees for MSW-based projects** and enable carbon market integration through **MoPNG and MoEFCC coordination.**
- **Technology and Engineering:** Standardise process design across feedstock types, promote **modular and multi-feedstock reactor systems**, and enhance **training programs** to minimise methane slippage and improve efficiency.
- **Feedstock and Supply Chain:** Introduce **Key Performance Indicators (KPI)-based feedstock contracts** specifying moisture, inert content, and digestibility benchmarks. Establish **regional biomass depots** for aggregation and preprocessing, and support **storage infrastructure** for seasonal residues like press mud and paddy straw.
- **Policy and Finance:** Simplify **DPR evaluation guidelines** for banks and create integrated fiscal frameworks covering feedstock, technology, and output. Introduce **credit guarantee and insurance mechanisms** to de-risk financing for developers.
- **Quality and Standardisation:** Define **national technical standards** for CBG purity (minimum 96% methane), gas injection pressure, and upgrading systems. Mandate **third-party NABL testing and methane leakage audits** to maintain performance integrity.
- **Infrastructure and Scaling Models:** Promote **hub-and-spoke and hybrid models** for regional biomass utilization, and encourage **decentralized modular plants** in cluster-rich areas. Integrate **feedstock sustainability assessments** into DPRs and feasibility studies.
- **Capacity Building:** Launch **structured training and certification programs** for CBG engineers and operators, covering plant design, feedstock management, and SCADA-based monitoring for process optimization.

CBG Panel 2 - Feedstock Supply Chain & Storage

L to R: Dr. [illegible], Managing Director, [illegible] International Consulting [illegible]; Ms. [illegible], Policy Development [illegible]; [illegible]; Mr. [illegible]; Mr. [illegible], CEO, [illegible]; Mr. [illegible], Executive Director, [illegible] Centre for Science & Technology [illegible]; Mr. [illegible], Managing Director, [illegible] Supply Pvt. Ltd.; Mr. [illegible], Director, [illegible] Energy Pvt. Ltd.; Mr. [illegible], Assistant Vice President, [illegible] Clean Energy; Mr. [illegible], Zonal Manager [illegible], ITC [illegible] Agriculture

Summary:

- **Feedstock supply and sustainability** remain critical bottlenecks. Seasonal variations, unstructured logistics, poor storage infrastructure, and competing usage have made feedstock procurement inconsistent and costly.
- **Policy and financial gaps persist**, with limited coordination between ministries and inadequate financial literacy among lending institutions. Banks remain hesitant to fund CBG projects due to technical complexities, delayed disbursal of fiscal support, and high perceived risk.

- On the operational front, high capital pressures and shortage of skilled manpower have led to quality compromises and higher OPEX. Land acquisition, licensing delays, and local community challenges further extend project timelines.

Recommendations:

- Ensure that municipal feedstock projects operate on a tipping-fee model instead of royalty payments to improve viability.
- Encourage adoption of modular, multi-feedstock plant designs for operational flexibility and scalability.
- Establish regional biomass aggregation depots and preprocessing centres to streamline supply chains.
- Support dedicated storage infrastructure for seasonal feedstocks like press mud and paddy straw.
- Develop technical evaluation guidelines for banks to improve appraisal of CBG project DPRs.
- Provide integrated fiscal incentives covering feedstock procurement, technology adoption, and product output.
- Support decentralised modular plants in high-residue regions for cost-effective scalability.
- Mandate inclusion of feedstock sustainability assessments in feasibility and DPR evaluations.

CBG Panel 3 - Leveraging FOM and Derivatives: Challenges in Supply Chain and Opportunities for Soil Health Improvement

L to R: [illegible]

Summary:

- The financial viability of CBG projects is heavily dependent on Market Development Assistance (MDA), with delays and low rates directly impacting project sustainability. The limited revenue streams primarily from CBG and FOM combined with high logistics costs for FOM and LFOM distribution, make operations financially unviable.
- Supply chain and distribution constraints remain a major barrier, with limited storage capacity, inadequate daily FOM evacuation, and unsustainable transport costs beyond a 75 km radius. Distributors' ineligibility for MDA further restricts market expansion.

- **Regulatory ambiguities** under the Fertilizer Control Order (FCO), inconsistent interpretation by state authorities, and a complex MDA disbursal process involving B1/B2 certification and repeated NABL testing have created operational uncertainty.
- **Product standardisation gaps** persist, as FOM and LFOM quality varies widely depending on feedstock type, moisture content, and microbial environment. This lack of uniformity raises concerns over heavy metal content and product reliability.
- **Low farmer awareness** about the agronomic benefits and correct application of organic fertilisers limits adoption despite their potential to improve soil fertility.
- India's soil health crisis continues to worsen, with organic carbon content falling below 0.5% in many regions, leading to nutrient imbalance and long-term degradation of soil productivity.

Recommendations:

- Liberalise FCO regulations to facilitate marketing, packaging, and distribution of FOM and LFOM, including permission for direct sales by CBG producers and retailing through oil companies and PSUs.
- Enhance MDA rates to Rs 3,000-3,500 per ton and link disbursal directly to CBG production rather than batch certification.
- Extend MDA eligibility to intermediaries and distributors to strengthen last-mile connectivity.
- Support capital investment in bagging and packaging units and mandate partnerships with PSUs, fertiliser companies, and cooperatives for large-scale offtake.
- Collaboration of ICAR and State Agriculture Universities to establish crop-specific specifications, bio-nutrient inclusion, and region-specific FOM application guidelines.
- Promote awareness and training initiatives through demonstration farms and integration of soil biology and organic manure management in agricultural curricula.
- Simplify quality certification by accepting NABL lab reports for B2 certification and streamlining testing and batch size requirements.

CBG Panel 4 - Establishment of Compliance-based Carbon Market Mechanism for CBG Sector in India

L to R: Prof. [illegible], Professor & Head, [illegible]; [illegible], Director, Bureau of Energy Efficiency, Government of India; Dr. [illegible], Additional Director, [illegible]; Mr. [illegible], MD & CEO, Indian Gas Exchange (IGX); Mr. [illegible], [illegible] Limited

Summary:

- India's carbon market ecosystem is still in a nascent stage, with no operational compliance-based carbon registry and limited readiness among CBG producers to participate in carbon credit trading. Lack of awareness and absence of a national registry are delaying market integration.
- The certification process for CBG is complex, as emission reduction depends on multiple lifecycle factors – feedstock, logistics, and utilization. This necessitates credible third-party validation to prevent double counting and ensure transparency.
- There are policy and institutional gaps, including the absence of clear penalties for non-compliance with blending obligations, lack of unified lifecycle emission standards, and weak coordination among MoPNG, MNRE, and BEE.
- The voluntary carbon market remains volatile, with depressed credit prices and undefined valuation of CBG's green attributes compared to fossil fuels. The need for transparent price discovery through exchange-based trading is critical.
- Slow policy implementation particularly delays in establishing a national carbon registry and notifying methodologies has hindered the sector's ability to capitalize on emerging carbon market opportunities.

Recommendations:

- Accelerate the launch of the Indian Carbon Market and establish a compliance-based framework with enforceable obligations and penalties.
- Finalize and notify CBG-specific carbon methodologies to standardize emission reduction validation and enable formal registration.
- Operationalize a national carbon registry to integrate voluntary and compliance markets and ensure traceability of credits.
- Implement a robust MRV (Monitoring, Reporting, and Verification) system with independent third-party audits to prevent double counting and enhance credibility.
- Encourage CBG developers to register under BEE-approved methodologies and conduct capacity-building workshops for industry participants.

CBG Panel 5 - Optimum Performance Through Quality Enzymes, Raw Materials, Equipment, and Machinery

L to R: Mr. [illegible], Director, [illegible]; Dr. Sanjukta Subudhi, Associate Director & Senior Fellow, TERI; Prof. Virendra Kumar Vijay, Professor & Head, [illegible]; Mr. [illegible] Gupta, Director, [illegible]; Mr. Vijay Kumar [illegible], General Manager, [illegible]; Mr. Prashant [illegible], Founder & CEO, [illegible]; Mr. [illegible], [illegible]

Summary

- The efficiency and sustainability of CBG plants are significantly hindered by the lack of standardization in feedstock, enzymes, and microbial cultures, leading to inconsistent gas yields and unstable digestion performance. The absence of certified suppliers and R&D-backed dosing guidelines forces developers to rely on trial-and-error approaches.
- Machinery and equipment challenges persist due to inadequate adaptation of imported technologies, poor maintenance standards, and limited quality assurance in locally manufactured components. The absence of reliable service support and performance benchmarking affects plant uptime.
- There is no unified framework for testing or certifying equipment performance, and limited adoption of SCADA systems results in weak process monitoring. Feedstock variability, enzyme inconsistency, and lack of real-time data further reduce conversion efficiency.
- The industry faces a severe technical skill gap, with inadequate training on biological process control, enzyme management, and preventive maintenance. This dependence on external experts increases operational costs.
- High input costs, import dependency, and lack of economies of scale make plant operations expensive and procurement inefficient. The absence of a centralized supplier registry leads to quality variation and delays.

Recommendations

- Establish national standards for enzymes, microbial cultures, and feedstock additives; develop BIS/ICAR-endorsed protocols for digester design and performance testing; and implement third-party certification for equipment quality and after-sales service.
- Promote local manufacturing under the 'Make in India' initiative through technology transfer partnerships. Create certified testing facilities for blowers, compressors, and upgraders, and encourage modular reactor designs suited to Indian feedstocks.
- Support targeted R&D in microbial consortia and enzyme formulations optimised for Indian biomass. Establish pilot-scale research centres and promote academia–industry collaboration to validate new process innovations.
- Launch structured training and certification programs under the Centre of Excellence for Biogas and CBG, covering process optimization, enzyme handling, and preventive maintenance for engineers and operators.
- Mandate SCADA-based monitoring for large CBG plants, introduce performance-linked service contracts for suppliers, and enable real-time tracking of methane concentration, temperature, and slurry parameters.
- Provide fiscal incentives for upfront enzyme and machinery manufacturers, establish a MoNRE/MoHUA-approved supplier registry for transparency and facilitate soft financing to promote adoption of high-efficiency technologies.

Biomass - The Supply Chain Conundrum for Bioenergy, Biofuels and Biomaterials

[illegible]

Summary:

- Biomass and bioenergy were highlighted as sustainable alternatives to coal-based power generation.
- Farmers and local communities are crucial to building a robust biomass supply chain.
- Major challenges include feedstock collection, storage, logistics, safety and price volatility.
- Gender inclusion was emphasized as essential within the biomass value chain.
- Localized solutions, digital tools, and backward integration are key to improving efficiency.
- Policy support, financial incentives, and R&D in bio-CNG, ethanol, and biomass-to-hydrogen are crucial for sectoral growth.
- Collaboration among industry, government, and farmers is essential to create a resilient bioenergy ecosystem and enable a gradual coal transition.

Recommendation:

- Localize supply chains with decentralized warehouses and strong farmer networks.
- Strengthen backward integration with quality control and safe, government-supported storage.
- Provide financial incentives, standardized offtake, and index-linked pricing for stable farmer income.
- Introduce biomass exchanges, benchmark pricing, and digital registries for market transparency.
- Deploy AI and digital tools for monitoring, planning, and optimized distribution.
- Utilize marginal and fallow lands for dedicated biomass cultivation.
- Support R&D in bio-CNG, ethanol, and biomass-to-hydrogen technologies.
- Train farmers and integrate women into biomass management and operations.
- Ensure multi-ministry coordination and clear operational guidelines.
- Promote collaboration to transition gradually from coal to biomass-based energy.

Skilling the Workforce in Bioenergy Space

L to R: [illegible] Government of India & Former ED (Fuel Management), NTPC Ltd.

Summary:

- Multiple ministries (MNRE, MoPNG, MoP) are collaborating to promote biomass, biofuels, and clean energy.
- The sector requires ~15 lakh skilled workers; focus on multi-level, industry-aligned, tech-integrated training.
- ~1.5 lakh defence veterans, with 100+ transferable skills, can support operations, logistics, and training; Agniveer/military skill credits formalize industry alignment.
- Institutions like NCSL, NTPC School of Business, [illegible], Indian Biogas Association, and BFI provide scalable, employment-linked multi-skill training.
- AI trainers, virtual/AR modules, and digital platforms are emphasized to optimize biogas operations.
- R&D and local innovation aim to reduce imports and strengthen sector capabilities.
- Training centres are strategically located in bioenergy-rich districts; PP focus on deployment, entrepreneurship, and rural engagement.
- Promote rural employment, reduce migration, support farmer adoption and regenerative farming, while creating career pathways, seasonal opportunities.

Recommendation:

- Establish a National Bioenergy Skilling Mission under Skill India with MNRE, MoPNG, and MoP.
- Develop modular, multi-level training programs covering the entire bioenergy value chain—including feedstock, conversion, by-products, operations, and entrepreneurship—while integrating technology and innovation training such as AI/IoT monitoring and R&D for indigenous solutions.
- Implement industry-recognized credentials and credit equivalence (NSQF/National Credit Framework).
- Integrate retired defence personnel into bioenergy roles via orientation and sector-specific training.

- Align training centres geographically with energy-rich districts and project fields.
- Make training employment-linked with measurable placement targets [illegible].
- Foster public-private-academic partnerships for curriculum design, trainers, and apprenticeships.

Is Bharat Aligned with Global CCUS? Policy and Management Pathways

L to R : [illegible]

Summary:

- Carbon capture costs ([illegible] per ton) are too high for industries to bear alone. Policy, fiscal incentives, and innovative financing (carbon pricing, tax benefits, multilateral funds) are essential.
- Only about 5% of captured CO_2 can be utilized and the rest 95% needs geological storage, for which India lacks detailed site data and research.
- India's energy mix still relies heavily on coal-based power plants. Decarbonizing them through CCUS is critical.
- India has potential storage sites such as depleted oil & gas fields, basalt (Deccan Traps), and saline formations (Rajasthan, Punjab).
- Multilateral funds, carbon pricing mechanisms, and tax/viability incentives can help reduce cost gaps and make CCUS commercially viable.
- Business model suggestions:
  - Cluster-based shared infrastructure for multiple industries.
  - Carbon Capture as a Service (CCaaS) model, where storage operators lease depleted fields for CO_2 injection.
- Capture technology still needs R&D – Capture accounts for 60–70% of total CCUS cost; amine-based systems dominate but are expensive. New absorbents, cryogenic and oxy-fuel methods need research support.
- India leads in utilization ("U" of CCUS) – Significant progress in CO_2 conversion to methanol, ethanol, urea, DME, soda ash, and concrete mineralization; recognized globally for utilization innovations.

- Policy & R&D Initiatives:
  - NITI Aayog, DST, ONGC, and IIT Bombay have mapped national storage capacity.
  - The upcoming ICCTS (Indian Carbon Capture, Transportation & Storage Mission) aims to identify CO_2 clusters and storage "hotspots".
  - DST supports testbeds, R&D callups, and industry partnerships to derisk technologies and build confidence.

Recommendation:

- Government needs to establish a clear national CCUS policy that defines roles, responsibilities, and operator liabilities, while integrating environmental safeguards and long-term monitoring standards.
- Need to set up a single, empowered agency to coordinate R&D, project approvals, compliance, and inter-ministerial collaboration, ensuring faster decision-making and accountability.
- Shift from office-based national plans to a resource-backed, milestone-driven roadmap, identifying regional CO_2 hubs that integrate capture sources, transport corridors, and storage basins.
- Mandate the refurbishment and testing of depleted oil and gas reservoirs through transparent PPP models, enabling private sector participation in CO_2 storage operations.
- Make geological and storage site characterization data publicly available through an open-access national CCUS database to support investors, researchers, and project developers.
- Establish an official valuation (estimated at USD 30-40 per ton) to guide fiscal incentives, carbon pricing mechanisms, and public investment decisions in CCUS infrastructure.
- Develop India-specific CO_2 pipeline, transport, and storage regulations based on global best practices, but customised for local geography, population density, and safety conditions.
- Encourage joint ventures between industries, research institutions, and government agencies for demonstration projects and shared infrastructure, reducing individual project costs.

Embed CCUS within India's broader decarbonization missions—such as Green Hydrogen, Bioenergy, and Industrial Transition—to ensure cohesive policy alignment and financing synergy.

Evolving Opportunities: Technology, Finance and beyond for CCUS

(L to R: Mr [illegible]

Summary:

- The Government of India and NITI Aayog are developing a national CCUS mission with expected policy and financial backing for technology innovation and deployment.
- The Government of India, under the Ministry of Power (earlier NITI Aayog), is finalizing the National Carbon Capture and Storage (CCS) Mission to establish regulatory, financial, and technological frameworks for CCUS deployment.
- The mission proposes a Carbon Capture Utilisation Authority for oversight and a Carbon Capture Financial Corporation to mobilise funds, with PSU participation in pilot and commercial projects.
- By 2030, India aims to operationalize CCS hubs with 4 million tonnes/year capacity, de-risk 1 gigaton of geological storage, and establish 10–15 commercial-scale and live demonstration projects.
- A regional hub model is recommended to enable shared CO_2 infrastructure, reduce costs, and facilitate collaboration among industrial emitters.
- VGF support up to 100% for early projects, is seen as essential for making CCUS commercially viable, alongside carbon credits and contracts for difference.
- India's strategy is evolving from limited CO_2 utilisation (20–40%) to long-term storage (70–80%), focusing on global best practices for safety and scalability.
- Beyond current uses (beverages, urea, soda ash), CO_2-to-fuels, chemicals, and materials will become commercially viable by 2030, aided by low-cost green hydrogen.
- Large-scale CO_2 reuse depends on clean power sources like solar, wind, nuclear, and bioenergy, aligning with India's growing non-fossil energy capacity.

Recommendations:

- India should adopt proven international CCUS technologies while also fostering domestic innovation to reduce costs and improve efficiencies.
- Recognized as transitional storage solutions, EOR and Enhanced Coal Bed Methane projects should be policy-supported for their dual climate and energy benefits.
- India must ensure carbon credit price parity (India [illegible] vs US $40), define social cost of carbon, and establish transparent carbon accounting standards for low-carbon products.

Sugar to Ethanol: Next Step, Challenges & Opportunities and Emerging Pathways

L to R: Mr. [illegible], Director General, ISMA; Mr. [illegible]; [illegible], Department of Food and Public Distribution, Ministry of Consumer Affairs, Food & Public Distribution, GoI; Mr. [illegible] Gupta, Chairman, [illegible] Sugar [illegible]; Mr. [illegible], Chief Executive Officer, Sugar Business, Triveni Engineering & Industries Ltd.; Mr. [illegible], Co-Chairperson, [illegible] Sugar [illegible]

Summary:

- India's sugar industry is transforming into a bioenergy hub, diverting 34 LMT of sugar to ethanol and utilizing press mud and bagasse for biogas.
- Surplus sugar production (340–350 LMT vs 280 LMT domestic demand) and low cane yields (70–80 t/ha vs 200 t/ha potential) remain key challenges.
- Ethanol capacity stands at ~1,800 crore litres, exceeding the 1,100 crore litres needed for E20 blending, indicating potential for higher utilization.
- Ethanol pricing has been stagnant for three years, creating a ₹10/litre gap between production cost and government rates.
- Sustainable Aviation Fuel (SAF) presents a major growth opportunity, needing 70–100 crore litres of ethanol for a 1% blend by 2027; each plant costs about ₹1,400 crore.
- Policy certainty on exports, ethanol pricing, and SAF viability is crucial for investment planning.

Recommendations:

- Announce early export and ethanol pricing policies (by October) for timely planning.
- Introduce a Minimum Support Price (MSP) for sugar to stabilize mill revenues.
- Develop a national SAF policy with mandatory procurement, price linkage, and carbon credit mechanisms.
- Provide fiscal incentives (tax benefits, VGF, interest subvention) for SAF projects.
- Enhance sugarcane productivity through better breeding and farmer training.
- Prioritize sugar diversion to ethanol and facilitate timely export to manage surplus.

Grain to Ethanol : Next Step, Challenges & Opportunities and Emerging Pathways

L to R: [illegible] Grain Ethanol Manufacturers Association (GEMA); [illegible] Federation of Indian Petroleum Industry (FIPI); [illegible]

Summary:

- The industry faces high feedstock costs due to MSP and low maize productivity (3.5–4.0 t/ha vs 5.7 t/ha global average).
- Around 60% of capacity lies with small distilleries, leading to higher operating costs and reduced competitiveness.

- Ethanol production capacity now exceeds national blending demand, creating a risk of oversupply.
- Farmers lack access to quality hybrid seeds and modern agronomic support, limiting yield improvement.
- Operational efficiency can be improved through better enzymes, reduced steam use, and energy optimization.
- By-product utilization—corn oil, DDGS, etc.—can create new revenue streams and strengthen viability.
- Long-term sustainability requires diversification into SAF, bioplastics, and diesel blending alcohols.
- Exploring alternative crops like sweet sorghum can ease dependence on maize and enhance feedstock security.

Recommendations:

- Enhance maize productivity through better hybrid seeds, agronomic support, and precision farming.
- Reduce production costs by developing local feedstock supply chains and improving plant efficiency.
- Increase profitability by valorizing by-products such as corn oil, DDGS, and other biofuels.
- Diversify output into higher-value products like SAF, bioplastics, and industrial alcohols.
- Manage oversupply by creating export pathways for ethanol and its co-products.

Advance Biofuels – By-Product Valorization, Cost Engineering & LCA

L to R : Dr. [illegible], IIT [illegible], Dept. of Chemistry; [illegible] Chairman, Steering Committee [illegible] [illegible] Thermal Engineering, [illegible] Associate Director and Senior Fellow, Advanced Biofuel Division, TERI

Summary :

- Lignin and glycerol, key by-products from biorefineries, can be converted into high-value chemicals, carbon materials, and fuel additives, enhancing refinery profitability and carbon efficiency.
- Advanced bifunctional catalysts enable selective lignin depolymerization, minimizing coke formation and maximizing monomer yield.

- Life cycle assessment (LCA) is crucial to evaluate the environmental and economic impacts of valorization routes, identifying hotspots in pretreatment, fermentation, and energy use.
- Integrating LCA into refinery design ensures balanced decisions between using lignin for energy versus producing higher-value materials.

Recommendation:

- Promote high-value conversion pathways for lignin and glycerol into chemicals and carbon materials instead of using them mainly for combustion.
- Develop and commercialise selective bifunctional catalysts and scale up pilot demonstrations for condensation and hydrogenolysis processes.
- Incorporate on-site by-product valorization units within biorefineries to improve energy efficiency and reduce waste logistics.
- Use LCA-based decision tools to identify the most sustainable and profitable valorization options.
- Introduce policy and market incentives such as green product certification and carbon credits for bio-based chemicals and materials.

Green Hydrogen - How Soon and How Much can be ?

L to R: Mr. Pankaj Bhalla, Head Strategy & Commercial Hydrogen, Reliance; Mr. Raj Kumar Singh, Business Development, Source Clean Energy Solution; Dr. B. A. Nagarjuna Reddy, Director [illegible], Business Operations, [illegible] Pvt. Ltd.; Dr. Prakash Kumar Chaturvedi, Deputy Secretary, Ministry of New and Renewable Energy, Government of India (GC); Ms. Bhagyashri [illegible], CEO, [illegible] Energy Private Limited; Dr. [illegible], Department of [illegible] Renewable Energy, Associate Professor, IIT [illegible]; Dr. [illegible], Associate Director & Centre Director, TERI [illegible]

Summary:

- India aims to produce 5 million tons of green hydrogen by 2030, supported by government subsidies for projects and electrolyser manufacturing.
- Hydrogen will be generated via water electrolysis and biomass-based methods (high-temperature gasification, hydrothermal/steam gasification, methane steam/pyrolysis), yielding byproducts like biochar and carbon black.
- Around 500 million tons of domestic biomass, optionally blended with small plastic fractions, can enhance hydrogen output.

- Emerging technologies include solar-thermochemical hydrogen production and CO_2 conversion to methanol or ethanol; pilot projects like 5 TPD green methanol at Kandla Port are underway.
- Subsidies prioritize projects with confirmed contracts; tenders from refineries, fertilizer plants, and shipping are driving demand and cost reductions.
- Current production costs are ₹270–400/kg, potentially falling below ₹200/kg using byproducts; biomass routes can achieve carbon-neutral or negative emissions.
- Focus areas include scaling TRL 5–7 technologies, managing feedstock variability, improving efficiency, and reducing hydrogen separation costs; collaboration between startups and industry is key.
- Strong international demand (Japan, Korea, Europe, Singapore) and upcoming shipping fuel regulations position India as a major green hydrogen supplier.

Recommendation:

- Focus on commercialization-ready technologies (TRL 5–7) and strengthen academia-industry collaboration.
- Scale pilot projects using biomass and blended feedstock for cost-effective hydrogen production.
- Combine thermochemical and biochemical (microbial/algal) methods to diversify production pathways.
- Leverage byproducts (biochar, carbon black) to cut costs and lower carbon emissions.
- Build green hydrogen infrastructure at major ports and promote decentralized nationwide production.
- Enhance electrolysis and gasification efficiency to make green hydrogen competitive with grey hydrogen.
- Support practical applications in green ammonia, methanol, steel, shipping fuels, electricity, and CO_2-derived chemicals.
- Ensure policy backing with subsidies, guaranteed purchase obligations, and international standard alignment to drive adoption and exports.

Session on From Farm to Fuel: Building a Bioenergy Ecosystem

Panel 1: Leveraging Potential of Agricultural Produce for Energy Security

L to R: [illegible]

Summary:

- The first session of the seminar emphasized was placed on developing rural industrial hubs linked to bioenergy, targeting over 70% of India's population living in rural areas.
- India generates around 500 million tonnes of agricultural residue annually, offering vast potential for biomass-based energy generation.
- Converting crop residue and organic waste into energy was seen as a way to promote a circular rural economy and reduce stubble burning across states like Punjab, Haryana, and Uttar Pradesh.
- Bioenergy projects can help mitigate approximately 150 million tonnes of CO_2 emissions per year, while supporting 5–6 million rural jobs.
- Decentralised bioenergy plants of 5–10 MW capacity were identified as optimal for rural industrial clusters.
- Discussions highlighted that 1 tonne of biomass can yield 250–300 kg of bio-CNG or 250–300 litres of bioethanol, depending on the feedstock.
- Participants urged for policy incentives such as capital subsidies and low-interest loans to promote local bioenergy entrepreneurs.
- Training and capacity building for rural youth were proposed to ensure operational sustainability and maintenance of bioenergy units.

Recommendation:

- Promote decentralized bioenergy hubs in rural areas to convert agricultural residues into energy and create local employment.
- Provide policy incentives and financial support to encourage private and cooperative investments in biofuel and biomass projects.
- Strengthen feedstock supply chains and logistics to ensure consistent availability for bioenergy production.
- Integrate local agro-industries with bioenergy systems to enhance economic viability and sustainability while reducing carbon emissions.

Panel 2: Economic Gain for Farmers and Industry from Bio Energy and Circular Economy

L to R: Mr. [illegible], Joint Director, Trade Promotion Council of India; Mr. [illegible], Founder & CEO, [illegible] Private Limited; Mr. [illegible] Singh [illegible], Founder & Chairman, [illegible]; Dr. [illegible] Kumar [illegible], Director General, [illegible] Association of India; Mr. [illegible] Singh, Editor-in-Chief, Rural Voice [illegible]

Summary:

- The session explored how bioenergy and circular economy models can benefit both farmers and industries.
- Declining soil organic carbon in the Indo-Gangetic plains was flagged as a key concern for agricultural productivity.
- FOM from CBG plants was highlighted as a vital tool to restore soil health and carbon.
- Speakers urged quality improvement and regulation of FOM to make it more farmer-friendly and reliable.
- Farmer Producer Organizations (FPOs) were recognized for enabling aggregation, better market access, and participation in the bioenergy value chain.
- The need for skilled manpower in rural areas for biomass operations and agri-tech was emphasized.
- Recommendations included MSP for biomass, corporate collection centers, and local processing plants to reduce logistics costs.
- Global practices like energy crops and no-till farming were shared as models for India.
- An organic GSP alternative made from agri-waste was showcased for improving soil fertility and reducing input costs.
- The session concluded by reaffirming the farmer's pivotal role in India's green energy transition.

Recommendation:

- Ensure fair farmer income by introducing an MSP for biomass, discouraging residue burning, and creating profitable supply chains through local collection centres and biomass banks.
- Strengthen farmer participation by promoting FPOs and long-term purchase agreements with industries to secure both feedstock supply and market stability.
- Enhance product quality and technology adoption through standards for FOM, promotion of no-till farming, and efficient bio-energy technologies.
- Boost sustainability and self-reliance by supporting domestic production of organic fertilizers, improving soil health, and reducing import dependence.

Financing the Bioenergy Sector

L to R: [illegible], Director, [illegible]; [illegible], Chief Operating Officer, [illegible]; [illegible], General Manager, State Bank of India; [illegible]; [illegible], Lead, Energy & Climate Partnerships, TATA Trusts; [illegible], Senior Advisor, Climate Change and Circular Economy, GIZ India

Summary

- Bioenergy projects must be commercially viable with steady cash flow.
- Key risks in Biofuel industry are feedstock supply, offtake security, and proven technology.
- CBG price rise (₹47→₹60–70/kg) has boosted viability; large plants are preferred by lenders.
- SIDBI supports green projects via 2IFT, SPICE, and a GCF-backed guarantee facility.
- A $1 billion MSME green fund is being created by SIDBI.
- Huge potential: 1 MMT biogas from 62 MMT waste under SATAT (5,000 plants, 15 MMT CBG).
- Pellet plants are low-cost (₹3–4 crore) and financed easily under SBI's Agri Infra scheme.
- Pellet demand is strong (100,000 TPD); project financing gaps persist.
- Ensure feedstock, offtake, and proven tech before seeking finance.
- Engage SIDBI/DEC early for schemes and guarantees.
- Create a structured project validation process with banks.
- Government may take small equity stakes (5–10%) in viable projects.
- Conduct training for bankers and developers to bridge knowledge gaps.

Partner State Session with Government of Uttar Pradesh

L to R: [illegible] Assistant Manager – Energy Transition, Hinduja Foundation; [illegible] Director General, ISEI; [illegible] Limited; [illegible] Vice President, IREE & former Chairman of Working Group on Biofuel, [illegible] Additional Chief Secretary, Energy & Additional Sources of Energy Department, Government of Uttar Pradesh; [illegible] Director, UPNEDA; [illegible] Scientist, [illegible] National Institute of Bio-Energy; [illegible] Director, [illegible] Energy Private Limited

Summary

- UP is endowed with abundant agricultural residues and biomass, making it a leading state in ethanol, CBG, and biomass-based energy.
- The state's bioenergy policy aligns with India's national renewable energy goals under the Panchamrit commitments and Net Zero vision.
- UP has set an ambitious target of 1000 TPD of CBG capacity under its policy. However, the state government has informally decided to raise aspirations to achieve 200% of this target.
- The government emphasized its investor-friendly approach, openness to rationalize policies, and willingness to address challenges raised by stakeholders.
- UP's bioenergy policy provides comprehensive incentives: o Subsidy of ₹75 lakh per TPD for CBG (maximum ₹20 crore). o Support for bio-coal, biodiesel, and ethanol production.
- Approvals have been granted for ~100 CBG plants, leveraging agri-residue, press mud, municipal waste, and cattle dung.
- UPNEDA is working with IIT Delhi, IIT Kanpur, and NISE for technical support and policy monitoring.
- Need to develop feedstock diversification, integrated plants, and municipal solid waste-based models.
- Encouragement to set up CBG plants in vegetable mandis to utilize urban organic waste.
- Proposal for cluster-based shared pipelines in UP to reduce offtake costs and facilitate direct injection into trunk pipelines under the new GPI policy.
- Importance of biomass banks and storage solutions to ensure year-round feedstock availability.
- Scope for energy crop cultivation (e.g., Napier grass) integrated with agri-PV models for multiple benefits.
- Potential to replicate UP's biomass assessment framework as a model for other states.

Outcomes:

- The UP Government reiterated its commitment to double its current CBG target.
- Policy rationalization is underway to address investor concerns such as multiple plant permissions per tehsil, subsidy norms, and biomass pricing.
- IFGE and industry stakeholders will continue to collaborate with UPNEDA to suggest refinements in the state policy.

Biomobility: Policy Framework for Future & Emerging Opportunities in India

[illegible]

Summary:

- The ethanol blending program has resulted in substantial crude oil import substitution of 193 lakh tonnes over the last decade, reducing India's dependence on imported fossil fuels thereby achieving a reduction of 544 lakh metric tonnes of CO2 emissions.
- The existing fleet of approximately 35 crore vehicles designed for E10 or lower blends presents compatibility challenges for higher ethanol blends.
- The automotive industry has made all new vehicles E20 material compliant since April 2023, with full E20 performance compliance achieved by April 2025.
- Manufacturers have developed and demonstrated flex-fuel vehicle prototypes capable of running on any ethanol blend from E20 to E100.
- Commercial vehicle manufacturers are actively conducting trials with advanced biofuels including isobutanol blends and methanol-diesel mixtures.
- The farm equipment sector is exploring transitioning to biofuels like CBG and [illegible] diesel to meet upcoming emission standards.
- Maintaining ethanol prices approximately 30% lower than petrol is essential to compensate for lower energy content and drive consumer adoption.

- Comprehensive public awareness campaigns are required to educate consumers about ethanol benefits and address consumer concerns about fuel efficiency through vehicle optimization.
- Implementing GST concessions and other tax benefits for flex-fuel vehicle purchases will help offset their 8-10% higher cost.

Recommendations:

- It is required to finalise and implement the draft CAFE norms in that recognize the carbon neutrality of biofuels through biogenic factors.
- A clear, time-bound roadmap for flex-fuel vehicle introduction and E100 fuel distribution must be established, potentially starting with ethanol-rich states.
- The pricing policy must establish a transparent mechanism that maintains ethanol's price advantage relative to petrol based on energy content.
- Implementing GST rationalization for flex-fuel vehicles and production equipment will accelerate adoption and manufacturing scale-up.
- Strengthening biomass supply chains through decentralized densification units and regional hubs is critical for 2G ethanol success.

SAF Production Technologies

L to R: Ms. [illegible], Joint Vice President – SAF R&D, [illegible]; Mr. [illegible], Managing Director, [illegible]; Mr. Vineet [illegible], Director, Business Development, [illegible]; Dr. [illegible], Chairperson, [illegible] Sustainable Aviation Fuel Forum (SAFF) and [illegible], Director [illegible]; Dr. [illegible] Reddy, Scientist [illegible], Energy and Sustainable Technology Division (CEST), Department of Science & Technology (DST); Ms. [illegible], Director, [illegible]; Mr. Deepak [illegible], Sr Director [illegible]

Summary

- SAF can reduce aviation carbon emissions by up to 80%.
- Commercial-scale plants are essential for faster global adoption.
- ATJ and ETJ technologies convert bioethanol into jet fuel; pilot projects and test flights are already successful.
- Methanol + captured CO_2 + green hydrogen can also produce clean jet fuel.
- Biomass and MSW can be converted into jet fuel through gasification and Fischer-Tropsch processes.
- [illegible] technology enables 100% drop-in, carbon-negative jet fuel using [illegible] feedstocks like crop residues.

- IOCL can integrate sugarcane by-products (molasses, bagasse, press mud) to produce ethanol, SAF, biogas, fertilizers, and bioplastics.
- Key challenges: high production costs, scattered feedstock supply, and need for large-scale plants.
- Diversified feedstock integration (agri-residue, MSW, used cooking oil, algae) can strengthen sustainable SAF production.

Recommendation:

- Establish commercially operating reference plants for each SAF pathway to accelerate adoption.
- Farmer cooperatives, feedstock collection systems, and strong government policies are essential for faster SAF production in India.
- Government support such as cost-based recovery mechanisms and mandates for SAF project setups required.
- Facilitate cooperative models for feedstock aggregation to reduce fragmentation and lower production costs.
- Incentivize adoption of CSAF for international markets to meet global blending mandates.
- Foster public-private partnerships for R&D, international collaboration, and technology transfer.
- Prioritize life-cycle carbon reduction by integrating 2G feedstocks and coproduct valorization.

Policy Initiatives for SAF

L to R: [illegible], Former Director, CSIR-IIP; [illegible], Project Leader, Boston Consulting Group; [illegible], Former, Energy Transition and Decarbonization, [illegible]; [illegible], Joint Vice President – SAF, Praj Industries; [illegible]

Summary:

- In the Asia-Pacific, SAF production is growing but remains largely underdeveloped due to feedstock limitations and lack of binding mandates.
- There are 11 globally certified SAF pathways, including HEFA, ATJ, PtL/FT, and IPK (ASCENT) routes. HEFA fuels are currently the most commercialized and cost-competitive, while ATJ and FT technologies require further scaling to reduce costs.
- e-SAF technologies use captured CO_2 and green hydrogen to produce synthetic jet fuels with the lowest lifecycle emissions globally.
- CORSIA (ICAO) compliance becomes mandatory by 2027, ensuring verified and traceable SAF adoption across global airlines.

Recommendation:

- Financing mechanisms like Viability Gap Funding (VGF), carbon credits, and public-private partnerships are essential for early project deployment.
- Collaborate with ICAO to set India-specific default emission factors for key feedstocks.
- Technology grants for production of Enzymes and Catalysts
- Project financing for large scale alcohol-to-jet facilities
- Launch carbon crediting aligned to CORSIA/LCA methodologies for SAF
- Establish a national book-and-claim registry for SAF certificates
- Public-private partnerships and policy incentives required for early adoption.

Bioenergy Conclave

Bioenergy Conclave was organized on [illegible] during the Indian Bioenergy & Tech Expo [illegible] held at [illegible], New Delhi. Representatives from the Government, International and Indian Bioenergy Associations, Industries, Research Institutions, Key Stakeholders [illegible] in the Bioenergy Conclave. The session was chaired by [illegible]. Eminent Guests on the dais included [illegible]. The session was [illegible] by [illegible].

Summary :

- Discussion was held regarding the growth potential of the Bioenergy Sector and government's support and initiatives to sustain the momentum.
- Discussions also encompassed the issues that are being faced by various stakeholders of the Bioenergy Sector and measures taken to address some of these concerns.
- Bioenergy Conclave involved free & frank exchange of viewpoints from both participants to identify the gap areas and possible solutions to accelerate the growth of the sector.
- Aspects of Bioenergy to include farmer inclusion, robustness of biomass supply chains, biomass aggregation & processing, government policies & incentives, market development, technology, skill development, finance, future potential areas etc. were deliberated upon.

Recommendations:

Policy & Institutional Framework

- There is a need to designate a single nodal ministry to coordinate all bioenergy-related policies and programs for better consolidation and smoother implementation
- An **Integrated National Bioenergy Policy** covering feedstock, technology, finance, manufacturing, green technology, and skill development etc. should be implemented for the rapid development of the sector
- The Government should mandate biomass co-firing policies across all States and UTs as well as promote Bio-CBG as a transport fuel equivalent to CNG

Feedstock & Infrastructure Development

- It is important to develop a **national feedstock mapping and logistics framework** which integrates agriculture, urban, and industrial sources
- **Biomass densification (including torrefaction)** should be promoted while leveraging existing logistics infrastructure (railways, CWC, etc.) for cost-effective movement.
- There should be policy support for the energy plantations.
- Logistics support should be planned across across the value chain including warehousing

Technology, R&D & Indigenous Manufacturing

- It is crucial to create support for R&D and technology incubation in feedstock aggregation, storage, and biofuels and biomaterials production systems
- **Establishment of Centres of Excellence and national testing and certification frameworks** (including LCA and audits) is an important domain for standardization in the sector
- **Indigenous manufacturing** of bioenergy equipment and integration of digital tools (IoT/SCADA) for real-time monitoring and efficiency, should be promoted under initiatives like Make in India & Digital India, etc.

Finance & Market Mechanisms

- To improve the project viability, introduction of refinancing options, VGF, low-interest green bonds, and priority sector lending are innovative financing
- Enabling the tradable green derivatives (carbon credits, RECs) with fast-track monetization under the Indian Carbon Market will provide impetus to the sector
- Financial measures like interest subsidies for MSME investing in decentralized biogas plants and promoting **direct long-tenor offtake contracts** without involvement of middleman will improve the growth of CBG sector.

Skill Development & Global Collaboration

- Strengthening **Sector Skill Councils** through industry–academia collaboration and international partnerships is crucial for long-term sustainability and growth of the sector
- Special emphasis should be given to promoting awareness and capacity-building to attract high-value investments and global expertise in the Bioenergy Space.

Valedictory Session
&
Award Felicitation Ceremony of 5th India Green Energy Awards (IGEA)

L to R : Sh. Sanjay [illegible], Commissioner of Urban Administration and Development Department, Government of Madhya Pradesh, Sh. Sanjay Bandyopadhyay, Retd. IAS, Chairman, ICC – Green Transport Mobility Committee, Smt. Rekha Gupta, Hon'ble Chief Minister of Delhi (Chief Guest of 5th IGEA), Sh. Narendra Bhooshan, Additional Chief Secretary, Energy & Additional Sources of Energy Department, Govt. of Uttar Pradesh, Mr. [illegible], Chairman, Working Committee of ICC, [illegible], Mr. [illegible], Senior Director, [illegible] at Award Felicitation Ceremony of 5th India Green Energy Awards during [illegible] 2025

Valedictory Address – Smt. Rekha Gupta, Hon'ble Chief Minister of Delhi

In the valedictory session, Smt. Rekha Gupta, Hon'ble Chief Minister of Delhi, emphasized that the event marks a new era in India's green energy journey under the visionary leadership of Hon'ble Prime Minister Shri Narendra Modi. She invited bioenergy companies to invest and collaborate in Delhi, positioning the city as a leading hub for clean and sustainable energy. The Chief Minister highlighted Delhi's initiatives in bio-energy, compressed biogas, ethanol, bio-mobility, and sustainable aviation fuel, along with upcoming biogas and waste-to-energy projects, EV infrastructure expansion, and sewage-to-energy programs for Yamuna rejuvenation.

Hon'ble Chief Minister also felicitated the awards of 5th India Green Energy Awards supported by Mission LiFE, Ministry of Environment, Forest and Climate Change, Government of India. The objective of the awards is to recognize outstanding contributions and innovations driving India's renewable energy transition. Emphasizing the "Waste to Wealth" model and the role of indigenous technology, she urged strong government-industry collaboration to accelerate Delhi's journey toward a net-zero future.

LIST OF AWARDEES

Name of Organization	Status	Category
Renew Solar Energy (Jharkhand Five) Private Limited	Winner	Solar Power Producer
Acme Solar Holdings Limited	Winner	Solar Power Producer
Clean Wind Power (Dangeri) Private Limited	Winner	Wind Power Producer
ACME Malanpur Power Private Limited	Runner-Up	Wind Power Producer
Ramsarovar Vidyut Private Limited	Winner	Hydro Power Producer
Indore Clean Energy Private Limited	Winner	Compressed Biogas – Producer
Godavari Biorefineries Limited	Winner	Bioenergy Producer
Marine Industries Limited	Winner	Bioenergy Producer
Ridhegg Dynamics Private Limited	Winner	Biomass Supplier
Sukarni Sheer Power & Fuel Limited	Winner	Sugar Ethanol Producer
Grain Processing Research & Creation (GRAC) Private Limited	Winner	Grain Ethanol Starter
INFINITY Biotech Private Limited	Runner-Up	Grain Ethanol Producer
Bangalore International Airport Limited	Winner	Solar Power Consumer
Hyderabad Airport Private Limited	Winner	Renewable Energy Consumer
National Thermal Power Corporation Limited (NTPC)	Winner	Largest Biomass Consumer
EE CAS Ltd Asia Private Limited	Winner	Innovative Projects in CCUS
Tata Capital Limited	Winner	Electric Vehicle Financing

GLIMPSES

GLIMPSES

praj

UPNEDA

Reliance

verbio

am green TVS novoness HERO TOYOTA

giz

TheDigest

GEMA

www.ibetexpo.com