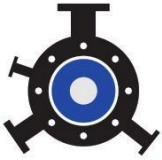


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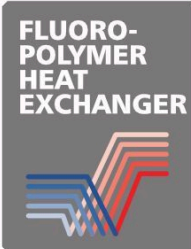
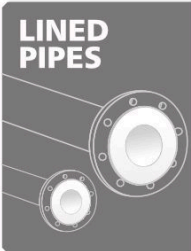
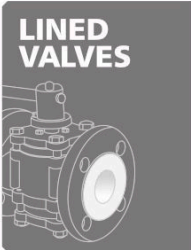
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### Harnessing the Power of Biofuels



**Atul Mulay**

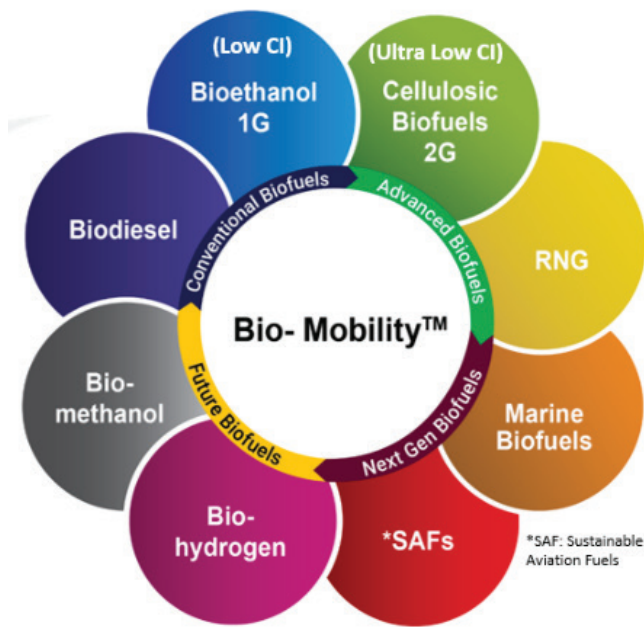
President - Bioenergy, Praj Industries and  
Chairman - Bioeconomy Committee, IFGE

Biofuels, as renewable and carbon-neutral energy sources, can reduce India's fossil fuel dependency. Biofuels emit fewer pollutants, improve air quality and public health, and stimulate rural economies by creating jobs and supporting local industries. **Atul Mulay, President - Bioenergy, Praj Industries and Chairman - Bioeconomy Committee, IFGE**, explores the challenges and impacts of climate change and how biofuels can mitigate its adverse effects.

**T**he escalating climate crisis, driven by excessive fossil fuel consumption, presents a pressing global challenge. India, heavily reliant on oil imports, faces a dual challenge of energy security and environmental sustainability. India's reliance on oil imports, amounting to 232.5 million metric tonnes in 2023-24, contributes significantly to its greenhouse gas emissions, which increased by 190 million tonnes in the same year. Biofuels, derived from renewable organic resources, offer a sustainable solution to address these challenges. By replacing fossil fuels with biofuels, India can reduce its dependence on imports, lower greenhouse gas emissions, and

promote a cleaner and healthier environment. Biofuels also contribute to rural development and job creation, providing economic opportunities for farmers and rural communities. Moreover, biofuels can be seamlessly integrated into existing energy infrastructure, making the transition from fossil fuels relatively straightforward.

They offer a climate-friendly solution by balancing the CO<sub>2</sub> emitted during combustion with the amount absorbed by plants. Investing in biofuels can reduce greenhouse gas emissions, promote economic growth, and support environmental conservation.



Bio-Mobility Technology Platform

## Bio-Mobility Platform

Praj Industries, pioneer in developing advanced biofuel technologies, has introduced Bio-Mobility™ advanced technology portfolio, with the help of which fossil fuels are replaced with the bio-based renewable fuels.

The Bio-Mobility™ platform champions the use of renewable resources to produce low-carbon transportation fuels across all modes of mobility - land, air and sea. This platform includes the following:

### Bioethanol

- Low-carbon bioethanol:** It is derived from sugar and starch-based feedstocks such as B & C molasses, sugarcane juice, cassava, grains, and sugar beet.
- Ultra-low carbon Intensity (CI) bioethanol:** Ultra low CI ethanol, also known as cellulosic ethanol (2nd generation), is produced from non-food sources like agricultural residues, forestry waste, energy crops, etc. Praj Industries has commercialized two technologies: Enfinity® and Celluniti™. Enfinity® is designed for processing agricultural residues like wheat straw, rice straw, corn stover, and bagasse, as well as energy crops, hardwood. Celluniti™, developed in collaboration with Sweden's Sekab, is optimized for non-food softwood feedstocks like pine and spruce. Both

technologies support decarbonization in road transportation and the chemical industry by serving as the foundation for biorefineries that produce advanced bioethanol, cellulosic sugars, and valuable by-products like lignin and biogenic CO<sub>2</sub> from sustainable, non-edible feedstocks.

Praj's proprietary enfinity® technology has been scaled up for commercial use, with Praj establishing three large-scale plants in collaboration with Fortune 500 companies - Indian Oil Corporation Limited (IOCL), Hindustan Petroleum Corporation Limited and Bharat Petroleum Corporation Limited. The IOCL plant is already operational, and the other two facilities are set to be commissioned within the next 6-9 months.

### Ecodiesel™

Biodiesel is produced from used cooking oil, palm fatty acid, palm stearin, tallow, and other sources using enzymatic technology.

### Compressed Biogas

Compressed Biogas (CBG), a renewable fuel produced via the anaerobic digestion of organic feedstocks, can be derived from both organized feedstocks (such as industrial byproducts like press mud and spent wash) and unorganized feedstocks (including agricultural residues like rice straw, cotton stalks, and cow dung).

CBG offers a sustainable solution for reducing CO<sub>2</sub> emissions in both transportation and industry. By switching to CBG, businesses can lower costs and contribute to a cleaner environment.

A typical 20 TPD CBG plant brings significant environmental and economic advantages such as:

- Reduced Emissions:** Slashes greenhouse gas emissions by a remarkable 70 per cent, saving an impressive 16,400 MT annually. Delhi's CNG policy signifies importance of the shift from the diesel to CNG. Delhi's annual average Particulate

Year	Delhi's annual average PM 2.5 concentration (µg/m <sup>3</sup> )
Pre-CNG-conversion era	130
Mid-2010	120
2021-22	100

# INNOVATIONS

Matter (PM) 2.5 concentration in 2021–22 was improved to 100  $\mu\text{g}/\text{m}^3$  compared to the pre-CNG-conversion era (130  $\mu\text{g}/\text{m}^3$ ).

This signifies the GHG reduction potential of the CBG.

- o **Clean Transportation:** Enables 300-420 trucks to operate daily on CBG, a cleaner-burning fuel source, potentially covering a massive 5.3 crore kilometres each year.
- o **Diesel Displacement:** Effectively replaces up to 880 diesel trucks per year, promoting cleaner transportation solutions.

In essence, CBG offers a sustainable solution for both transportation and industrial sectors, promoting a cleaner and more cost-effective future.

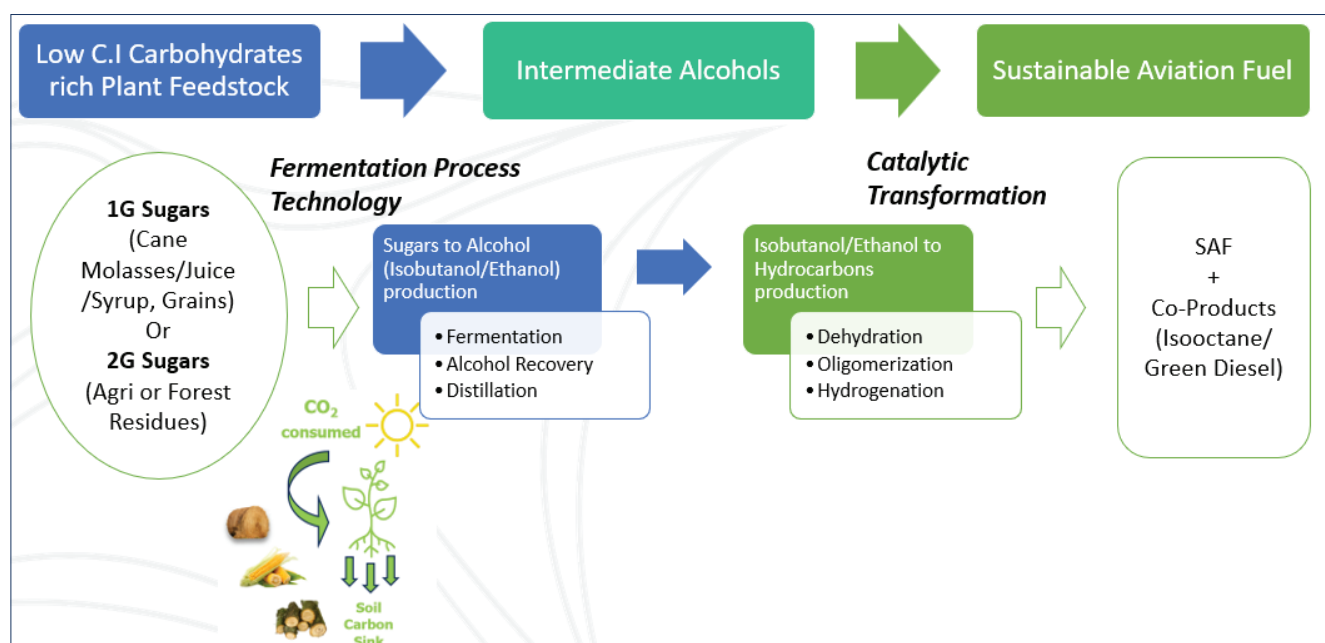
## Sustainable Aviation Fuel

The aviation industry, which relies heavily on fossil fuels like Aviation Turbine Fuel (ATF), contributes significantly to global greenhouse gas emissions, with around 1 billion tons annually. To mitigate this impact, the industry is increasingly adopting Sustainable Aviation Fuel (SAF), a renewable alternative that mimics ATF but with cleaner combustion and fewer pollutants.

Fuel	Carbon Intensity (gCO <sub>2e</sub> /MJ)
Gasoline	92
Bioethanol (1st generation - from molasses)	31
Bioethanol (2nd generation - from rice straw)	17
Jet A/A1 fuel	89
SAF [from ethanol (sugarcane)]	32.6

India's robust agricultural sector offers abundant feedstocks, such as crop residues, cane molasses, and surplus grains, for producing biofuels like ethanol and SAF, which have a lower carbon intensity than traditional fossil fuels. As aviation evolves, SAF and other biofuels provide a sustainable, eco-friendly way to reduce the industry's carbon footprint. The table below illustrates the lower carbon intensity of biofuels compared to fossil fuels.

Praj Industries has developed an Alcohol-to-Jet (ATJ) technology in collaboration with the Axens for the production of SAF using bio-based feedstock. SAF is produced from ethanol via Ethanol to Jet (ETJ) pathway using this technology. Producing and using SAF in India to reach 10 per cent blend in all domestic flights could significantly boost the economy, adding around USD 2.8 billion to GDP annually from 360,000 tons of SAF. This initiative would raise farmers' incomes,



Alcohol-to-Jet technology

strengthen energy security, create rural jobs, improve waste management, and reduce open-air burning, leading to cleaner skies.

## Next-gen Biofuels

Marine Biofuels, and future fuels such as Bio-methanol and Bio-Hydrogen are also key components of Praj's next-generation biofuels portfolio.

## Socioeconomic and Environmental Benefits of Biofuels

Biofuels, made from renewable organic resources, offer benefits that go beyond energy production, impacting social well-being, economic growth, and environmental sustainability.

### Economic Benefits:

- **Job Creation:** The biofuels industry creates jobs across the entire value chain, especially benefiting rural areas by stimulating local economies.
- **Rural Development:** Biofuel facilities attract investment in rural regions, leading to infrastructure improvements and better access to essential services.

### Environmental Benefits:

- **Reduced Emissions:** Biofuels produce significantly lower greenhouse gas emissions than fossil fuels, helping combat climate change and improve air quality.
- **Waste Management:** Converting agricultural residues and waste into biofuels reduces the need for open burning, enhancing air quality and soil health.

### Societal Benefits:

- **Energy Security:** Domestic biofuel production decreases reliance on imported fossil fuels, boosting energy independence and reducing supply risks.
- **Foreign Exchange Savings:** By cutting down on foreign oil imports, biofuels help save valuable foreign exchange.

Biofuels offer a sustainable, multifaceted solution that promotes economic growth, improves livelihoods, and reduces environmental impact, contributing to a more sustainable and equitable future.

## Challenges and Path Forward

To unlock the full potential of bioenergy, we must overcome key challenges. This necessitates a shift towards non-food feedstocks, fostering waste-to-energy solutions, and safeguarding natural habitats. Collaborative efforts among governments, industries, and research institutions are vital. Investing in research and supportive policies, coupled with a holistic approach that considers social, economic, and environmental factors, is essential for realizing a sustainable bioenergy future.

## Conclusion

In the face of escalating climate challenges and India's heavy reliance on fossil fuels, biofuels present a transformative solution. With their potential to reduce greenhouse gas emissions, enhance energy security, and drive economic growth, biofuels, especially advanced options like Sustainable Aviation Fuel (SAF) and Compressed Biogas (CBG), are pivotal in the transition to a cleaner and more sustainable energy future. By embracing biofuels, India can not only reduce its carbon footprint but also pave the way for a more resilient and equitable future. The journey towards sustainable energy is challenging, but with continued innovation, investment, and collaboration, biofuels can lead the way to a cleaner, greener world. ■