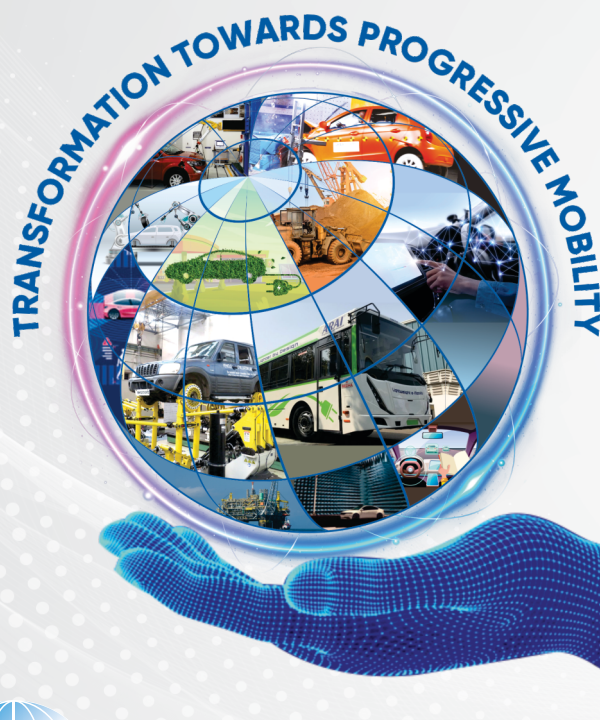
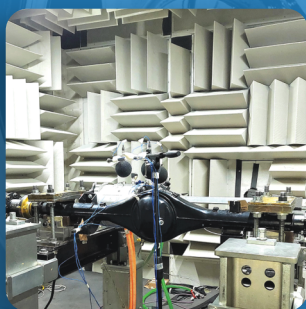
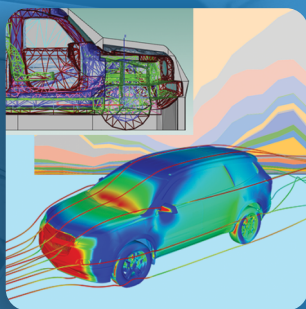




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# Reimagining Transportation with Bio-Mobility® A Praj Industries Journey

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*Praj Industries, a global leader in industrial biotechnology, drives sustainable decarbonization of the transportation sector through its innovative Bio-Mobility® platform. Bio-Mobility® platform encompasses traditional and future biofuels in all modes of transportation. Praj's strategic focus has yielded remarkable achievements, from dominating ethanol markets to pioneering advanced technologies like 2G ethanol biorefineries, and Sustainable Aviation Fuel (SAF). To complement this vision, the Global Biofuels Alliance (GBA) has emerged as a guiding torch for international cooperation, playing a vital role in the commercialization and deployment of biofuels around the globe.*

**Keywords:** Praj Industries, Bio-Mobility® platform, Global Biofuels Alliance (GBA), Decarbonization, Net Zero, Sustainable Development Goals, Climate action, Clean and Green Energy

## Executive Summary

Energy is the driving force for the industrial and economic growth of any nation. Each nation's energy mix varies based on factors like geographical location, resource availability, technological capabilities, and government policies. Although there has been a gradual change over the years, fossil resources continue to dominate the global energy landscape.

However, the mindless consumption of fossil energy in pursuit of development and growth is resulting in irrevocable damage to planet Earth. Greenhouse gas emissions due to the use of fossil resources have increased considerably in the last few decades resulting in climate change. Rising temperatures leading to more frequent and severe heatwaves, storms, droughts, melting glaciers, and polar ice caps contributing to rising sea levels are the outcomes of climate change.

The transportation sector is a significant contributor to global greenhouse gas (GHG) emissions. The global transportation sector consumed a quarter of overall energy consumption in 2022<sup>[1]</sup> and contributed to nearly 20% of the global emissions<sup>[2]</sup>. Oil was the major fuel source for transport, accounting for 90% of consumption<sup>[1]</sup>. In order to combat the evils of climate change, decarbonization of transportation is not a matter of choice but an imperative. Energy transition to alternate low-carbon energy sources has emerged as the most promising pathway.

Praj Industries, India is involved in developing and deploying innovative technology solutions in the space of biofuels. Founded by first-generation techno-entrepreneur Dr. Pramod Chaudhari in 1983, the company has become a global leader in industrial biotech over the last four decades, boasting 1000+ references in 100+ countries on five continents. The case discusses how Praj Industries successfully formulated and implemented growth strategies by leveraging Bio-Mobility® solution to decarbonize the transportation sector.



## Problem Statement

In the quest for development and industrialization, humans have created a bigger problem of deteriorating environment and irrevocable damage to planet Earth. The World Economic Forum has published the Global Risk Report 2023, highlighting that five of the top six risks are environmental-related<sup>[3]</sup>. Studies have shown that climate disasters have almost doubled in the first two decades of the 21<sup>st</sup> century as compared to the last two decades of the 20<sup>th</sup> century<sup>[4]</sup>. IEA's report on CO<sub>2</sub> emissions in 2022 has put forth the fact that CO<sub>2</sub> emissions are at a record high of over 36.8 Gt<sup>[5]</sup>. This is a clear indication of deteriorating environmental conditions and raising serious questions about sustainable development.

The dire need to curb GHG emissions has resonated prominently across various global forums such as the Conference of Parties (COP), G20, and the World Economic Forum. The landmark Paris Agreement is a legally binding international treaty on climate change. It was adopted by 196 Parties at the UN Climate Change Conference (COP21) in Paris, France, in December 2015. It entered into force on 4 November 2016. Its overarching goal is to hold "the increase in the global average temperature well below 2°C above pre-industrial levels" and pursue efforts "to limit the temperature increase to 1.5°C above pre-industrial levels"<sup>[6]</sup>. In line with this, several countries submitted their net zero targets through National Determined Contributions (NDCs) with a well-laid-out roadmap.

There are four established pathways to achieving net zero targets:

1. Energy Transition (Fossil fuels to clean and green fuels)
2. Circular Economy (Reduce, Reuse and Recycle)
3. Forestation (Increase plantation)
4. Carbon capture and storage

For the purpose of this case study, we will focus our efforts on how the Bio-mobility® platform facilitates energy transition as sustainable climate action.

The transportation sector, an important cog in the wheel of the global economy, is among the largest contributors (around 20%) to GHG emissions. If left unchecked, GHG emissions from transportation could increase by as much as 60% by 2050<sup>[7]</sup>. There are more than 1.5 billion vehicles on the road in 2023, of which more than 90% run on IC engines<sup>[8]</sup>. The aviation section, which is a hard abate sector, generates approx. 1 billion tons of GHG emissions per year, around 2 to 3% of total global emissions.

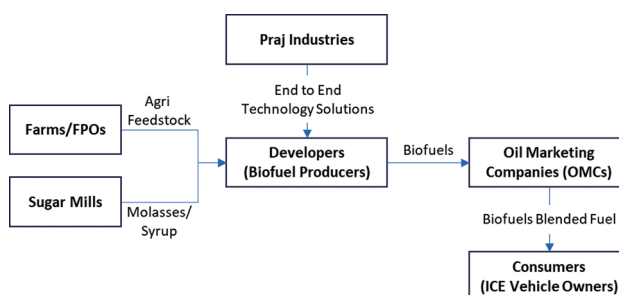
As part of sustainable climate action, it is critical to decarbonize transportation by adopting cleaner and greener low-carbon alternatives to fossil-based fuels such as biofuels.

## Solution

Praj Industries set up a state-of-the-art R&D center and has developed and deployed technology solutions for the production of biofuels from bio-based feedstock through biochemical and thermochemical processes, around the world.



The company, as a technology and EPC contractor, offers end-to-end solutions to developers for setting up biofuel production facilities. Developers source agri feedstock from farmers, Farmer Producer Organizations (FPOs), and/or sugar mills to produce biofuels. Oil Marketing Companies (OMCs) procure biofuels from developers, blend them with conventional fuels, and finally retail them to end consumers who are ICE vehicle owners.



The Bio-Mobility® platform of technologies envisages the utilization of Bio-based feedstock and organic waste for the production of low-carbon renewable transportation fuels in the liquid and gaseous state across all modes of mobility i.e. Surface, Air, and Marine.

Bio-Mobility® platform comprises technologies for the production of:

- ◆ **Conventional Biofuels** such as 1<sup>st</sup> generation/low-carbon ethanol produced from Sugary and starchy feedstock.
- ◆ **Advanced biofuels** such as 2<sup>nd</sup> generation/ ultra-low carbon ethanol and Renewable Natural Gas (RNG)/ Compressed Biogas (CBG)
- ◆ **Next-gen biofuels** such as Sustainable Aviation Fuel (SAF), bio-marine fuel
- ◆ **Future biofuels** such as bio-methanol & biohydrogen

<sup>[1]</sup> World Energy Outlook Report (International Energy Agency - IEA)

<sup>[3]</sup> The Global Risks Report 2023 (World Economic Forum)

<sup>[5]</sup> CO<sub>2</sub> Emissions in 2022 Report (IEA)

<sup>[7]</sup> Decarbonising Transport Initiative (International Transport Forum)

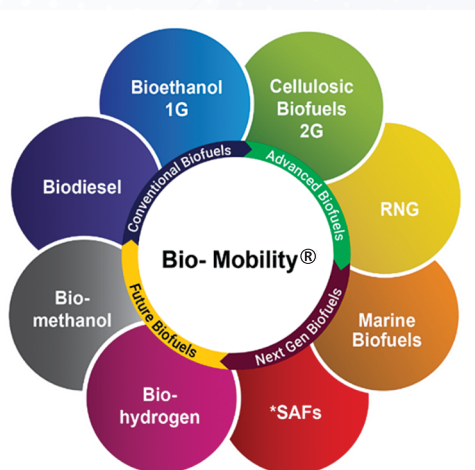
<sup>[9]</sup> G20 - Biofuels Study Report (MoPNG & BCG)

<sup>[2]</sup> World Bank/Transport

<sup>[4]</sup> Bloomberg News – January 2023

<sup>[6]</sup> <https://unfccc.int/>

<sup>[8]</sup> World Bank Estimate 2023



Praj's Bio-Mobility® Platform

### Biofuels value chain - Farm to Wheel

The value proposition of biofuels can be validated through Life Cycle Assessment (LCA) on a farm-to-wheel basis. The emissions in the life cycle of biofuel from farm to wheel are considerably less than that of fossil fuels. In the case of ethanol, studies show that there is almost a 60-65% CI reduction compared to gasoline.

### Important Role of Policy

Global and National policies play an important role in the adoption and commercialization of biofuels. CORSIA guidelines (Carbon Offsetting and Reduction Scheme for International Aviation) is a classic example of a global policy that will be applicable for international flights from 2027. Indian policies such as the National Biofuel Policy and SATAT (Sustainable Alternative Towards Affordable Transportation) have helped in the penetration of ethanol and CBG. Biofuel policies include blending mandates, special pricing, and financial support to developers for commercial viability.

### Benefits of Bio Mobility®

Biofuels can play an important role as a Socio-Economic environmental enabler for nations that are blessed with Sun, land, and agricultural activities. Bio-Mobility® supports various Sustainable Development Goals (SDGs) defined by the United Nations.

Biofuels contain carbohydrates, unlike hydrocarbons that are found in fossil fuels. Being oxygenating agents biofuels facilitate the complete combustion of fuel and resultant is very low carbon emissions and negligible particulate matter.

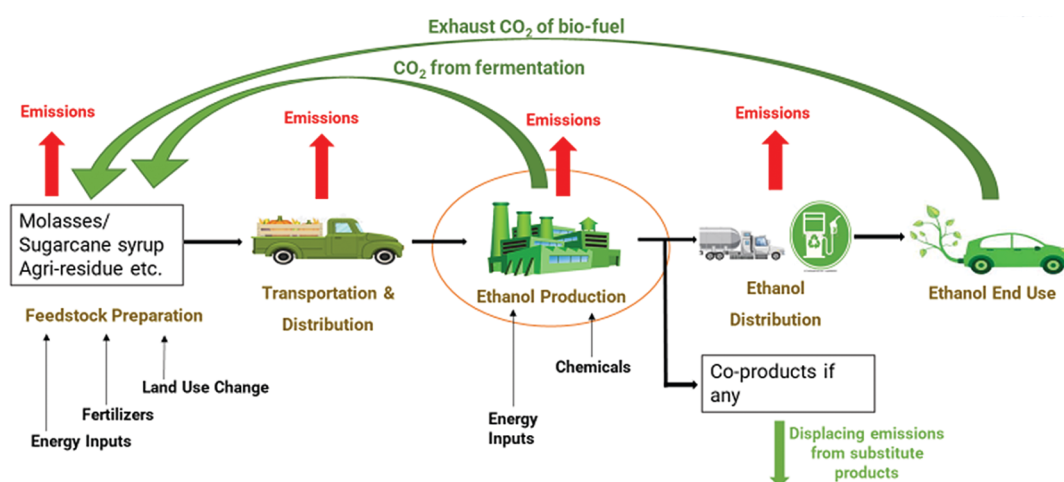
Biofuels facilitate bolstering the rural economy as they provide an additional revenue stream to farmers by way of selling agricultural residue post-harvesting. Biofuel plants are typically located near farms and create employment and entrepreneurship opportunities for rural households. This Farm-to-wheel value chain helps to reduce carbon intensity.

Being a captive resource, Biofuels help reduce the country's dependence on imported fuel and hence result in lower import bills and foreign exchange payout for crude oil.

Biofuel blending up to 20% with conventional fuels works very well in internal combustion engines and does not call for radical changes in vehicle manufacturing systems and facilities. Blending more than 20% calls for some modifications in vehicles for which technology is already established with vehicle manufacturing companies. Biofuels leverage the existing infrastructure of fuel dispensing. This eliminates any disruptions in existing jobs and industry systems. Moreover, hybrid vehicles namely flex fuel hybrid running on biofuel blended fuels and electric motors are introduced to combine the benefits of biofuels and electrification.

### Bio-Mobility® Technology Platform Advancements

1. **Global Impact on Ethanol Production:** The ethanol production capacity worldwide, of plants using Praj's ethanol technology has crossed a formidable 11 billion liters



Farm-to-Wheel Concept



annually. This translates to over 10% of global ethanol production excluding China.

2. **Dominance in the Indian Market:** The company has a 70% market share in operational fuel ethanol plants in India and contributed heavily to the realization of India's Ethanol Blending target of 10% (EBP10) ahead of schedule in August 2022. India is marching towards its EBP20 target by FY 2025-26 and has already achieved ~12% blending by the end of Q1 FY 2023.
3. **Colombia's Ethanol Blending Program:** Praj played a pivotal role in aiding Colombia, a prominent sugar producer, to implement its ethanol blending program. The company has set up seven ethanol plants across the country, further cementing its role as an enabler of sustainable solutions. With this pioneering act, it has a 100% market share in Colombia.
4. **UK's Milestone Ethanol Plant:** In 2012, the company established the largest grain-based 1200 KLPD operational ethanol plant in the UK, showcasing its global reach and technical prowess.
5. **2G ethanol biorefinery:** Praj developed proprietary Enfinity technology to process lingo-cellulosic feedstock like wheat straw, paddy straw, rice straw, Bagasse, and various other agricultural residues for the production of bioethanol. It has successfully commissioned India's first 2G ethanol biorefinery based on its proprietary Enfinity technology. This one plant will benefit more than 1 lac farmers and create around 1500 jobs for rural youth while eliminating around 3.2 lac MT of CO<sub>2</sub> every year which is equivalent to replacing nearly 63,000 cars on the road annually. Two more 2G ethanol plants are under execution in India.
6. **Compressed BioGas (CBG):** Praj has developed and commercialized technology "RenGas" for the production of Compressed Bio Gas (CBG) from a variety of agri and industry-based feedstock. CBG can be used as an alternative to fossil-based Compressed natural gas (CNG).
7. **Sustainable Aviation Fuel (SAF):** The company has reaffirmed its technology leadership in the global biofuels industry by developing technology to produce SAF from sugary feedstock in partnership with USA-based Gevo Inc. In May 2023, Praj in partnership with AirAsia India and Indian Oil, flew Indian first ever commercial passenger flight powered by indigenously produced SAF blended with Aviation jet fuel (ATJ). By collaborating with major national and international energy companies, it is helping build SAF capacities to make India the SAF hub to comply with international mandates.

## Future Prospects

BCG analysis shows that, given the right conditions, the true potential of liquid biofuels for G20 countries could be as much as 5x the current production till the year 2050, from ~ 3.41 EJ today to ~ 19.09 EJ. Realizing the full potential of Biofuels could cut global CO<sub>2</sub> emissions by 1,300-1,400 million tons, which is equivalent to the total energy consumption of Africa in 2021. 2G biofuels can generate as much as 4.5 PWh energy, equivalent to approximately 17% of global electricity demand. As of 2027, the mandatory phase of CORSIA guidelines will initiate requirements for blending Sustainable Aviation Fuel (SAF) in international flights<sup>[9]</sup>.

## Global Biofuels Alliance

The Global Biofuels Alliance (GBA) was announced at the G20 Delhi summit on 9<sup>th</sup> September 2023. 19 nations and 12 international organizations representing both members and non-members of the G-20 agreed to become part of the GBA. The GBA would promote synergies in biofuel research and development among developed and developing countries. It would facilitate transnational government interaction, industrial cooperation, and academic engagement, in order to improve the deployment, marketability, penetration, and profitability of biofuels. The alliance would coordinate a global framework of incentives to expedite cooperation among member countries to promote biofuel accessibility and sustainability. The GBA would also nurture the biofuel ecosystem through conferences, training programs, and fundraising efforts to promote new ideas and best practices.

G20 countries contribute to ~80% of the global production and consumption of biofuels. On the supply side, GBA aims to double production capacity among key biofuel suppliers. To encourage demand, the alliance would also have to encourage cost parity for 2G technology and expedite progress on the commercialization of 3G.

## Conclusion

The case of Praj's Bio-Mobility® platform serves as a testament to the profound impact that innovation can have on addressing global environmental challenges. Bio-Mobility® platform of technologies for the production of low-carbon renewable biofuels is reconfiguring the transportation fuel landscape. Biofuels act as a social-economic environmental enabler in nations' growth. Adoption of biofuels in the overall energy mix can certainly help in achieving Net Zero targets as well as Sustainable Development Goals. The Global Biofuels Alliance is poised to spearhead the widespread adoption of biofuels through knowledge transfer, policy advocacy, fostering awareness in developing nations, and strategic investments.

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