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**Redefining
Future Mobility**



Ushering An Era of Bio-Mobility™ in India

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We studying the evolving landscape of Transportation industry looking for low carbon fuels to contain tail pipe emissions. We are working closely with the stakeholders to address these challenges through our innovative process solutions.



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THE EVOLVING ENERGY LANDSCAPE IN INDIA

Our dependence on fossil fuels is creating a world-wide turmoil in regards to the sustainability of the human race. Fossils are the primary source of energy and resources, and this is having a detrimental effect on our planet. As a result, we are witnessing major geo-political issues and energy security concerns due to the scarcity of our finite resources. India is a leading consumer of fossil fuels due to its population size. We as humans need to acknowledge the worry-some issue that our way of life revolves primarily around the exploitation of fossil fuels.

India has been seeing rapid industrialization as one of the world's fastest growing economies. The migration of people from villages to cities for employment and education opportunities, coupled with rapid industrialization and urbanization, have put a strain on the country's ever-growing energy needs. All this has contributed in making India the world's third largest primary energy consumer. The country's energy mix today is dominated by conventional sources,

mainly derived from fossil fuels. India is dependent on external resources, importing 80 percent of crude oil, while incurring high foreign expenditure.

MOBILITY CHALLENGES IN INDIA

Transportation fuel is a large part of our total energy consumption. These fuels namely petrol and diesel come from the mineral source and are highly polluting in nature. However, in the absence of easily accessible alternatives, the world has been inclined to use it liberally over the years. The 60% increase in consumption of fossil fuels in the last three decades in India, as compared to the previous two decades is proof of this. The foreign exchange payout towards these imports in financial year 2019-2020 was three times our Defence outlay and 1.75 times the provision for annual interest payment on debt. From the geo-political perspective too, this scenario can prove perilous since India relies on the Gulf and West Asian countries for 65% of the imports of fuel. In light of the political instability in this region, we might face severe

irregularities in supply.

We at Praj are mindful that as a nation, we need to strongly adopt the idea of relying on an alternate source for our resources and energy. This is the need of the hour and this is the way forward for the Indian economy.

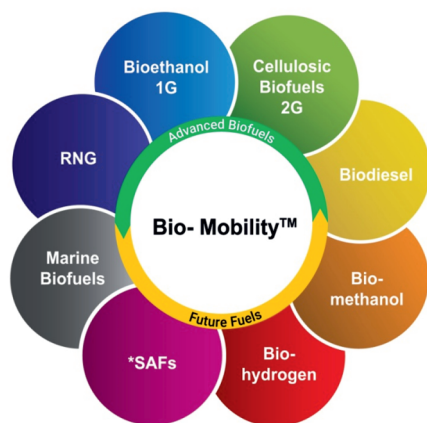
SUSTAINABLE SOLUTIONS FOR MOBILITY CHALLENGES

The issue of finding sustainable alternatives to conventional fuel sources was underlined when fuel prices went through the roof in the 70s. After some lull it picked up again at the Rio Earth Summit in 1992 when concrete goals were set towards environment protection. However, the problem of environmental pollution continued unbridled over years until 2015, when the issue was brought to the table at the United Nations led Paris Convention. The prime goal set during this meet was to bring down carbon emissions all over the world as early as possible and to keep the global temperature rise less than 2 degrees celcius. Country wise goals were determined. India accepted the 'Nationally Determined Contribution' of reducing carbon emissions by 33 to 35% and to create green cover adequate to absorb 2.5 to 3 crore tons of carbon dioxide, by the year 2030.

Praj's proprietary Bio-Mobility™ platform refers to utilizing captive renewable biological resources such as feedstock to produce low carbon transportation fuel that can be used across all modes of mobility namely, land, air and water. Bio-Mobility™ platform envisages utilization of Agri residues and organic waste derived both gaseous and liquid bio fuels in

the form of 1st generation Bioethanol, 2nd Generation cellulosic biofuels, renewable/bio diesel, renewable biogas, Bio-methanol, Bio-hydrogen, Sustainable Aviation Fuel (SAF) and Marine biofuel as primary energy source for driving mobility while retaining basic ICE technology.

Praj Matrix, DSIR certified R&D centre is world class facility for innovation in industrial biotechnology. It has 5 Centre of Excellence (COE) that work in specialized areas and develop solutions using cross disciplinary research. Praj Matrix has developed technologies to convert biomass to biofuels both in liquid and gaseous forms through biochemical and thermochemical processes.



*Sustainable Aviation fuels

BENEFITS OF BIO-MOBILITY™

In terms of economy, Biofuels helps reduce the country's high import bill and foreign exchange payout for crude oil. To that extent, it also helps mitigate spikes in volatile crude oil pricing.

• As an environmental enabler

Climate change is affecting monsoon patterns, and

consequently, the agriculture economy. Uninhibited industrialization is having a detrimental impact on ecological balance. Increasing traffic and associated rise in pollution levels, and the burning of agricultural waste are adversely affecting air quality and is a health hazard. Biofuels are carbon neutral and therefore combat these issues. Moreover, biofuels are renewable, cleaner in nature, are available as a captive feedstock in farms, and emit lesser toxic greenhouse gases.

• As an economic enabler

Being captive in nature, biofuels facilitate energy security. They also help reduce the country's high import bill and foreign exchange payout for crude oil. To that extent, they also help mitigate the spikes in pricing of crude oil in volatile situations caused by a mismatch in demand and supply.

• As a social enabler

The exodus from rural areas in the pursuit of education and employment is putting additional stress on already stretched urban infrastructure. India has to strive for inclusive growth especially in the rural sector for it to realise its ambition of reaching a five trillion dollar economy mark in five years. This is where biofuels can play a vital role in stepping up the rural economy.

Bio-Mobility™ will provide India the opportunity to create a new frontier in building and defining the new sustainable energy eco system and model specifically suited to address the challenges faced by India. It will comprehensively address the new

population of transport modes as also have the potential to address the entire existing fleet (Air, Surface and Marine) of fossil fuel driven ICE vehicles by making suitable modifications at fraction of a cost.

Additionally, Bio-mobility has the all-important farmer inclusion element, that creates entrepreneurship and employment opportunities for the rural community in India. This solution to address the future direction of mobility must therefore be capable of addressing following challenges.

1. Fight pollution & Minimize GHG emissions
2. Combat Climate change; Help meet Cop21 Obligations
3. Facilitate energy security & save valuable foreign exchange
4. Carbon neutral no environmental issue of waste disposal
5. Inclusive growth- Boost rural economy by job creation
6. Stop farmers from torching the residues.
7. Uses existing infrastructure

PRAJ'S BIO-MOBILITY™ PLATFORM OF TECHNOLOGIES

Over the past four decades, Praj has focused on the environment, energy, and Agri-process industry, with over 750 customer references spanning 75 countries across 5 continents. Biofuels can be derived from sugar and starch-based feedstock; and various technologies are available based on them.

A. 1G Technologies

Praj continues to hold market

leadership position in the Indian biofuel's industry by leveraging its innovative technologies and strong customer relationships. 1G biofuels, also known as conventional biofuels, are made from sugary feedstock (sugarcane juice, syrup, BIOSYRUP, B heavy molasses, C molasses), starchy feedstock (grains like sweet sorghum, corn, etc.) or vegetable oil. First generation biofuels are produced through well-established technologies and processes like fermentation, distillation, and trans-esterification.

B. 2G Technologies

Praj is presently executing three commercial scale advanced biorefineries based on its proprietary 2G Enfinity technology for oil marketing companies. Enfinity is Praj's 2G technology for processing lingo-cellulosic feedstock like wheat straw, paddy straw, rice straw, Bagasse and various other agricultural residue to produce bioethanol. This technology converts agri-waste into fuel grade ethanol. They produce fuel grade ethanol, bio chemicals, bio CNG, liquid CO₂, bio fertilizers, and power that are exported to the grid.

C. Compressed Biogas (CBG)

Agro-waste can be used as a raw material or feedstock to produce not just for biofuel such as ethanol, but also for compressed bio-gas (CBG) which can complement compressed natural gas (CNG). Praj has developed proprietary RenGas™ technology to produce CBG.

This technology solutions that help convert agrowaste into CBG which - unlike fossil fuels - emit very low carbon and therefore do not

contribute to GHG emissions.

D. Sustainable Aviation Fuels (SAF)

Praj has made significant progress on developing technology for Sustainable Aviation Fuel in partnership with Gevo Inc, USA. SAF is produced from sustainable feedstocks and is very similar in its chemistry to traditional fossil jet fuel. Use of SAF results in a reduction in carbon emissions compared to the traditional jet fuel it replaces over the lifecycle of the fuel. SAF has applications in commercial aviation as well as in the defence sector. The technology developed under partnership of Praj and Gevo is now ready for commercialization.

Praj Matrix is also engaged in actively pursuing development of technologies for processing biobased feedstock for producing future fuels.

E. Bio-methanol

Biomethanol is one of such biochemicals, which can be produced from biomass and biogenic wastes through thermochemical and biological routes.

F. Biohydrogen

The biological H₂ (biohydrogen) production process is an H₂ production technology that utilizes renewable energy resources, such as biomass.

G. Marine Biofuels

Marine Biofuels produced from lignin-based feedstock.

BIO-REFINERIES- HOW WILL IT HELP?

Just like a petrochemical refinery transforms and refines crude oil into more useful products such as petroleum naphtha, gasoline, diesel fuel, jet fuel, etc, a Biorefinery converts biomass to biofuels, biochemicals, and other beneficial products.

CONCLUSION

Praj's Bio-Mobility™ platform comprising of low carbon renewable biofuels is reconfiguring India's transportation fuel landscape where biofuels are poised to play a bigger

role. Being an economic, social, and environmental enabler, biofuels have the potential to make definitive contribution in ushering sustainable decarbonization through a circular bio-economy.

SUMMARY

Mobility refers to the ability to move or be moved freely and easily. While transportation was the word used for getting people from point A to B, mobility is currently the term being adopted by policymakers and governments to describe the movement of people that is cheap, efficient, and most importantly

sustainable. According to a report by the Centre for Automotive Research, "Mobility is a user-centric concept-recognizing that transportation products and services must be responsive to the needs, habits, and preferences of travellers and society."

We at Praj have been studying the evolving landscape of Transportation industry and the challenges it is facing. We understand that the sector is looking for low carbon fuels to contain tail pipe emissions. We have been working closely with the stakeholders to address these challenges through our innovative process solutions.



Our contribution to a more sustainable world centers on our products and services in the areas of

Clean mobility: Umicore's automotive and fuel cell catalysts provide solutions to stricter worldwide emissions standards, while our cathode materials in rechargeable lithium-ion batteries provide answers to vehicle electrification.

Resource stewardship: Umicore's recycling capabilities recover more than 20 precious and other valuable metals closing the loop.

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