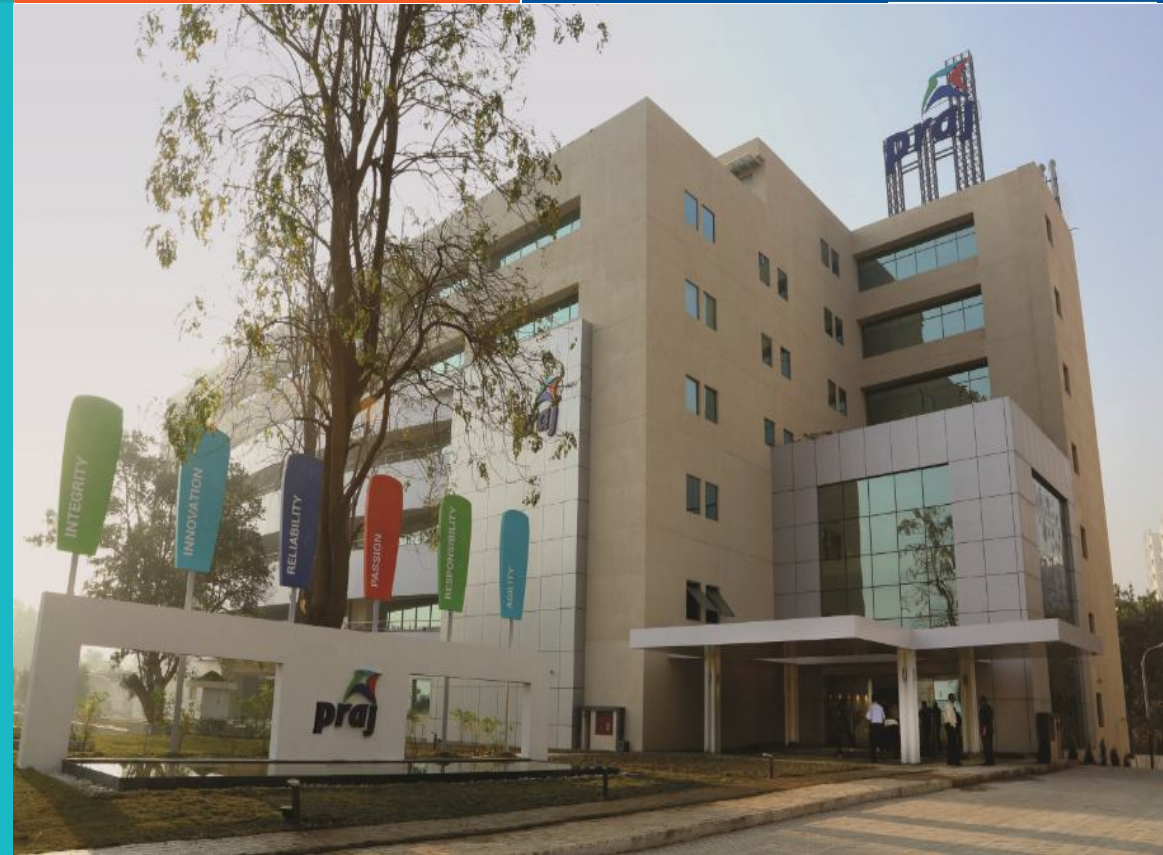


Advanced Biofuels & Beyond...

World Future Fuel Summit 2022



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Amol Nisal
February 16, 2022

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Outline

- I Praj overview
- II Bio-Mobility™ Platform – Decarbonizing Transport
- III enfinity™ – 2G Ethanol Technology
- IV Sustainable Aviation Fuel Technology
- V Summary





I. Praj Overview

Praj At A Glance



George Washington Carver Award
2020 for Innovation in Industrial
Biotechnology and Agriculture
Presented to
Dr. Pramod Chaudhari



Best Places to Work
in the advanced bioeconomy 2020



BiofuelsDigest
The world's most widely read biofuels daily



TheDailyDigest
The world's most widely read bioeconomy daily

#3
BioDesign & Engineering Organizations

TheDailyDigest
The world's most widely read bioeconomy daily



Praj Business Verticals



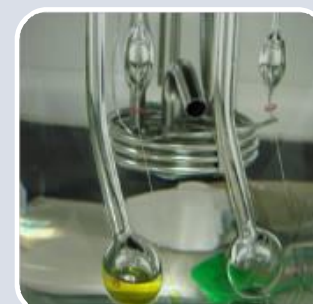
Bioenergy

Solution Provider in 1G
& 2G Bio-Ethanol
plants
Modernization &
upgradation,
Compressed Bio Gas



High Purity

High purity
applications for
pharma,
biotech,
cosmetics
industry



Engineering Businesses

Beverage
plants

Critical process
equipment &
systems,
Modular Process
Skids , Special
Projects

Effluent
Recycling & ZLD



R&D

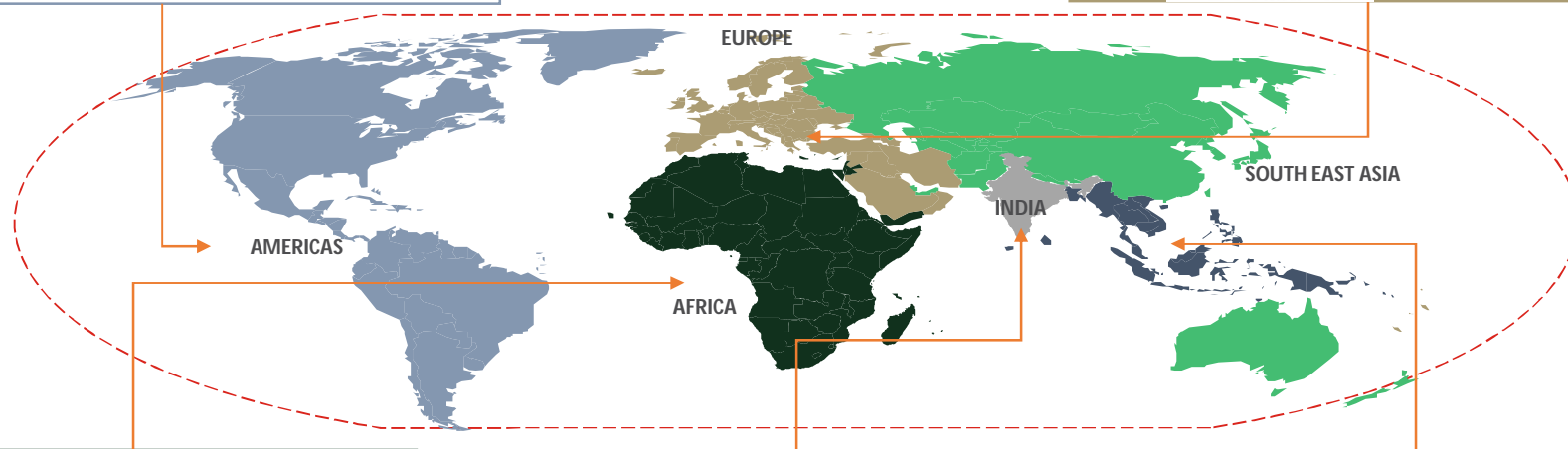
Customized
Research Services &
Solutions,

RCM

Bio-products

4 Decades of Leadership in Industrial Bio-technology Space

Praj Global Footprints



1000 ++ references in 100+ countries across all 5 continents. And still counting...

Expertise Across Value Chain



Research & Development

Technology & Engineering

Process Equipment Mfg.

Installation and Integration

Commissioning & Handover

Project Management

Life cycle Management

Competencies



Technology &
Innovation



Manufacturing &
Project Management

Development

Deployment



Engineering &
Integration



Commercialization
& Scale-up

Seamless value chain from concept to realization to life cycle management

Matrix – R&D Center

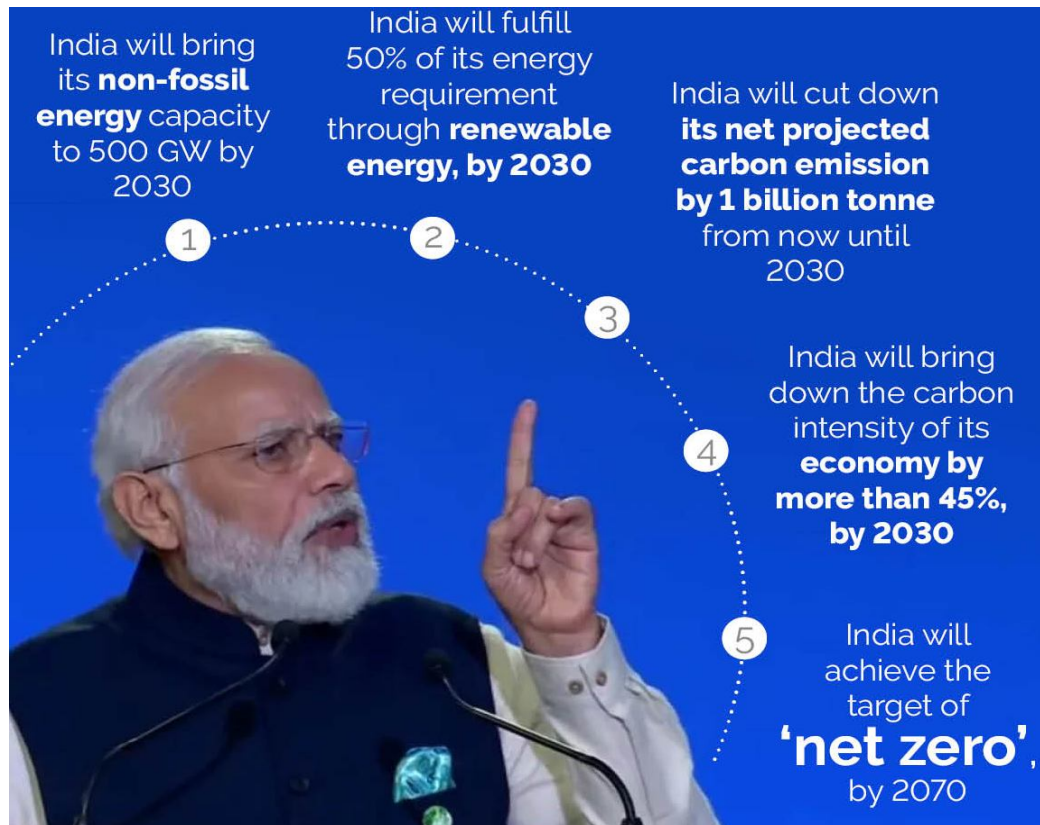
- R&D with **Bench and Pilot scale facilities** which enable validation of scientific assumptions and rapid commercialization
- **90+** technologists Biologists + Chemists + Engineers
 - **PhD: ~ 20 Nos & Postgraduates: ~65 Nos**
- **80+** patents
- Focus on **“Green technologies”** with emphasis on **sustainability**
- Continuous Design & Development (D&D) endeavor to **improve water and energy footprint**
- Devoted to developing **bio-fuels and renewable chemicals** using advanced **biotechnology** tools.



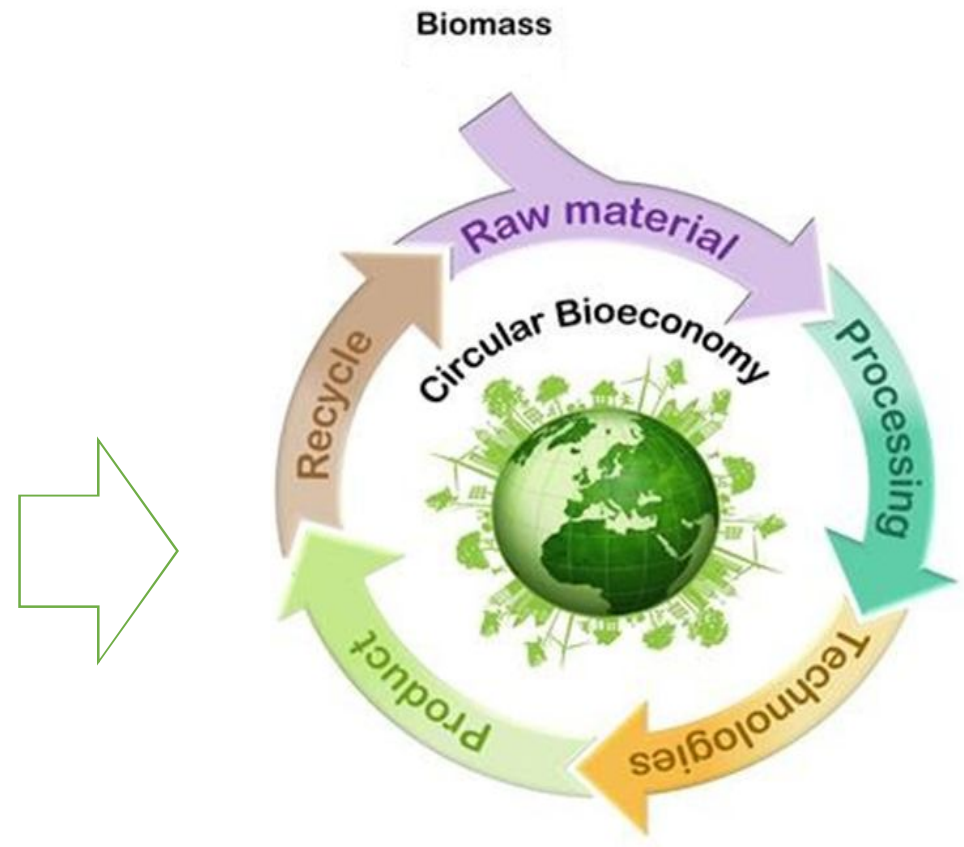


II. Bio-Mobility™ Platform

COP26 Climate Pledges – Driver for Bioeconomy



Net-Zero Countries: More than 90% of world GDP covered by Net-Zero targets by more than 100 countries



Biofuels & Circular Bioeconomy
Pillars for Energy Transition for India

Advanced Bioeconomy

Boost to development of Decarbonizing, Energy Transition Technologies & Climate Innovation

Capturing & monetizing Waste & Residues

Development of low Carbon Intensity (CI) products and services



Increased Viability of Energy Transition Projects

Price of carbon factored in capital projects

Development of carbon markets in many countries (LCFS, CDM, ETS & possibly also in India) Carbon Credit as additional revenue stream boosting project viability

Better cost of capital & finance for firms on the path of decarbonization

Sustainability aspects to play greater role in corporate operations under ESG – International Sustainability Standards being developed

Greater contribution of Bio based, Low Carbon & Sustainable Fuels, Chemicals & Materials in the global economy

Waste & Residues as preferred sustainable feedstock for bio-based products

Application of Biofuels in new areas such as in aviation & marine industry (& reduced use in road transport due to EV)

New technologies & Products –SAF, Marine Biofuels, Green Hydrogen - CCU to play crucial role for CI reduction

Increased use of renewable power at production plants

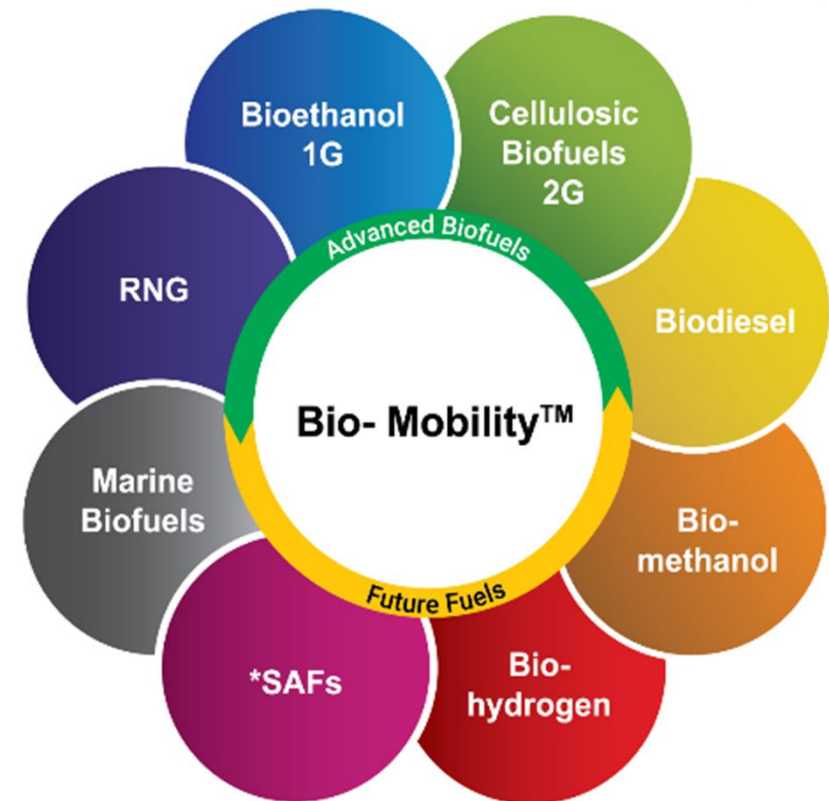
Circularity (Reduce, Reuse & Recycle) in process design

Application of Data Science for sustainability

Sustainability & C.I reduction aspects in every business decision

Bio-Mobility™: Decarbonizing the transportation

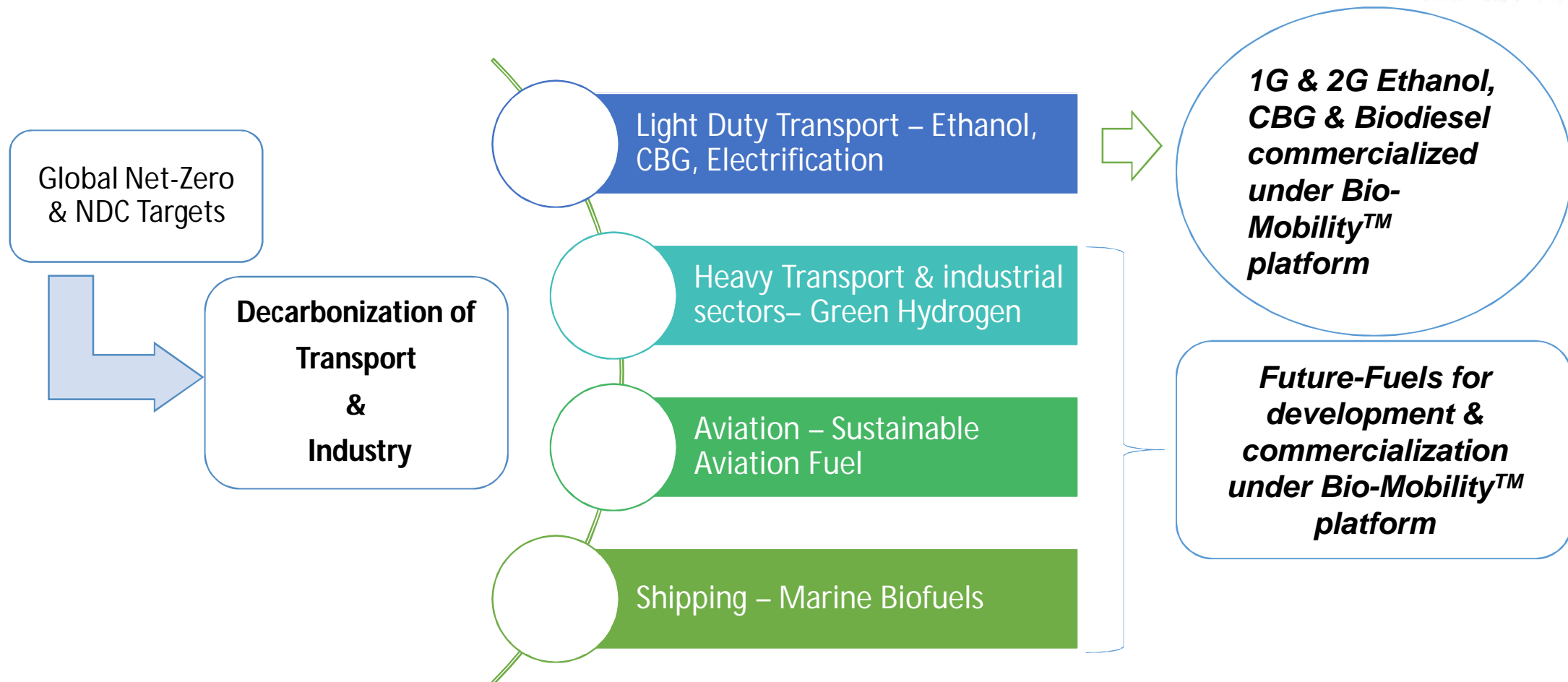
Bio-Mobility™ platform of technologies envisages utilization of Agri residues and organic waste to produce low carbon transportation fuels across all modes of mobility i.e. Surface, Air and Marine.



*SAFs- Sustainable Aviation Fuels



Future Fuels: Decarbonizing 'hard to abate' sectors



Unfurling the opportunity of \$ 100 Bn investment in next 5 Years

Feedstock

Sugary



Avg. 6 MMT Excess sugar

Starchy



Avg. 23-25 MMT*

Lignocellulosic

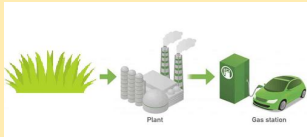


Avg. 84 MMT Agri residue

Potential - Biofuels Production



9.5 BLPA potential for
Installed Capacity



5000 CBG plants in next 4 yrs.
15 MMT Gas production



Sustainable Aviation Fuel (SAF)
With 5% blend:
~500,000 tons / year
requirement

Socio-Economical & Environmental Benefits

- GHG Emission reduction -
> 16 MMT
- Employment Generation:
> 1 Mn.
- Farmers to be progressively
benefited:
~ 30 Mn.
- Cumulative Forex Savings:
\$ 27 Bn

*Rotten, Spoiled grain, Unfit for human consumption

Source for Sugar: VSI, Industry and mathematical assumptions/ Source for Grain: FCI, <https://pib.gov.in/PressReleaseSelfFramePage.aspx?PRID=1602455>, DFPD/ Source for Biomass/Agri-residue: TIFAC report on Biomass availability.



III. enfinity™ 2G Ethanol Technology



Our technology brings infinite possibilities to the environment and energy challenges confronting mankind... by making use of nature's endless resources.

That's why we proudly call it.....enfinity.

Technology development journey.....

2009 - 16

1 BDTPD Pilot Plant Operations



2016 - 18

12 BDTPD Industrial Demo Scale Cellulosic Ethanol Biorefinery



2020 - 22

425 BDTPD Commercial Scale Cellulosic Ethanol Bio-refinery

*Process
Integration
&
Optimization*



Feedstock: Rice Straw, Wheat Straw, Cotton Stalk, Sugarcane Bagasse, Corn residues, Bagasse Pith, EFB, Bamboo etc.

enfinity™ Uniqueness

- Complex feedstock handling experience
- Straws, Corn Stover, wood, Bagasse, etc.



Multiple
Feedstock



Proven Track
Record

- Having processed agricultural feedstock – variations
- Delivering Ethanol Tech+ Engg for more than 35 years



- Best-in-class yields
- Low processing costs



High
Efficiency



Robust
Process

- No solids handling issues due to focus on parameters needed for high plant availability
- Well integrated process physically and chemistry wise

More than 600 + samples of various agri-residues have been fingerprinted

Cellunity™ – Forest residue (softwood) technology



Almost 4 decades in bioprocessing with 1000++ references in 100+ countries across all 5 continents



Sekab

Sekab is a Swedish Biochemical and cleantech company with a mission to create a better world through sustainable solutions

World's first 3 commercial scale 2G ethanol projects licensed



CelluAPP®

R & D work with ~200 patents and 15 years of hands-on experience on woody biomass



PRAJ has upgraded Sekab's CelluAPP technology for processing forest residues (softwood) to produce advanced bioethanol

Integrated 2nd Generation "Smart Bio-Refinery"



- Multi Feed stock - Rice Straw, Wheat Straw, Cotton Stalk, Sugarcane Bagasse, Corn residues, Pith
- Fully integrated : Energy and water, Biomethanation

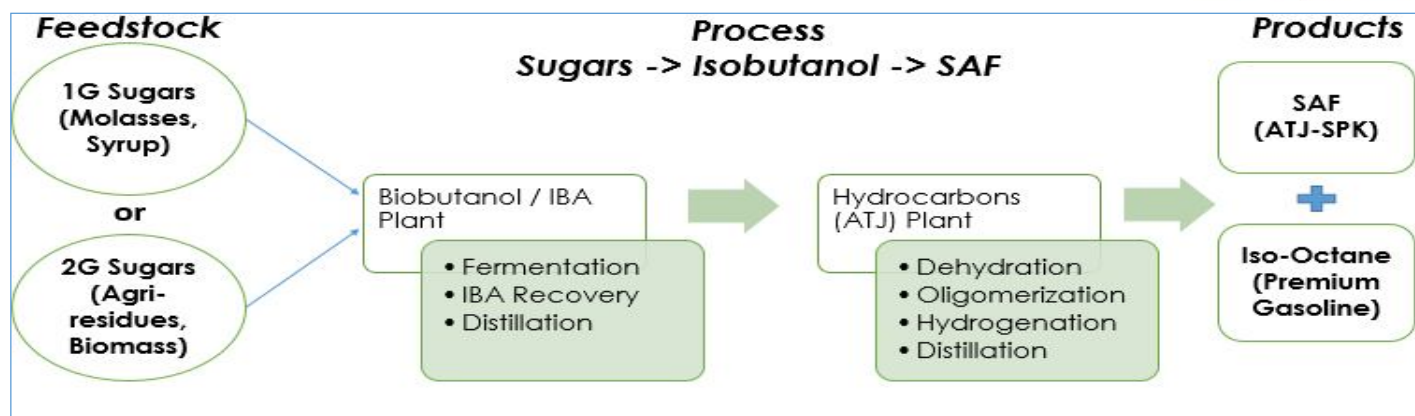


IV. Sustainable Aviation Fuel

SAF – ASTM approved pathways

Sr. No	Conversion Process	Abbreviation	feed stock	Blending % Volume
1	Fischer-Tropsch hydroprocessed synthesized paraffinic kerosene	FT- SPK	Coal, Natural gas, biomass	50%
2	Synthesized paraffinic kerosene produced from hydroprocessed esters and fatty acids	HEFA- SPK	Vegetable oils and fats, animal fat, recycled oils	50%
3	Synthesized isoparaffins produced from hydroprocessed fermented sugars	HFS-SIP	Biomass	10%
4	Synthesized kerosene with aromatics derived by alkylation of light aromatics from nonpetroleum sources	FT-SPK/A	Coal, Natural gas, Biomass	50%
5	Alcohol-to-jet synthetic paraffinic kerosene	ATJ-SPK	Sugars, Starches, Biomass	50%
6	Catalytic Hydrothermolysis Synthesized Kerosene	CH-SK/CHJ	Fatty acid esters and free fatty acids (lipids or fats, oils and greases)	50%
7	Hydroprocessed Hydrocarbons	HHC-SPK or HC-HEFA	Vegetable oils and fats, animal fat, recycled oils	50%

Praj-Gevo Collaboration



Technology Adaptation & Optimization

- Gevo's renewable Isobutanol technology adapted & optimized by Praj for :
 - **1G Feedstock** : Sugary streams (Cane Juice, Syrup & Molasses)
 - **2G Feedstock** : Agricultural residues such as Rice Straw, Wheat Straw, Bagasse, Corn Stover etc.

Praj-Gevo joint offerings of Technology, Equipment & Services for:

- 1G & 2G feedstock to Isobutanol (IBA)
- Isobutanol to Sustainable Aviation Fuel (Alcohol-to-Jet ATJ)

SAF: Feedstock Potential in India



India - Feedstock Availability

ATJ Pathway		
Feedstock	Qty	SAF Potential
Cane Syrup	Equivalent to ~6 MMT surplus sugar	~1 MMT
C-Molasses	10 MMT	~1 MMT
Surplus Grains	17 MMT	~2 MMT
Agri Residues	84 MMT	~5 MMT

SAF Production Potential in India:
~ 9 Million tons per year

Potential GHG emission savings: ~10 million tons per year

Utilization of carbon potential (Sink) of India for production of SAF

Praj signs MoU with IndianOil to produce Alcohol to Jet fuels

Synopsis

As per the MoU, IndianOil and Praj will also collaborate to set up Biofuel production facilities, including CBG, Biodiesel and Ethanol.



"Currently, Praj is executing India's first 2nd Generation ethanol plant for IndianOil at their Panipat facility.

Praj Industries (Praj) and Indian Oil Corporation Limited (IndianOil) have inked an MoU to explore opportunities such as the production of Alcohol to Jet (ATJ) fuels, 1G & 2G Ethanol, Compressed Bio-Gas (CBG) and related opportunities in the Biofuels industry, informed Praj in a press release.

"The Indian Aviation sector is at the cusp of exponential growth. At the same time, it is also identified as one of the significant sources of Green House Gas (GHG) emissions. This MOU will boost ATJ fuel production capacity and its use in India which will in turn help curb emissions emanating from the airplanes as per IATA's (The International Air Transport Association) mandate," said Praj.

Summary

Summary



Climate pledges – driver for global bioeconomy & investments in energy transition

Biofuels – Pillar of Energy Transition

India – availability of various feedstock to meet growing biofuels demand

Rapidly maturing technologies for Future Fuels such as SAF, Green Hydrogen

Strategic policy interventions – key to successful commercialization of SAF

Climate Innovation – Need of disruptive business models, value chains and technologies for achieving Net-Zero emission

THANK YOU

1000 ++ references in 100+countries across all 5 continents. And still counting...



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IOCL Panipat Plant – site photographs



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