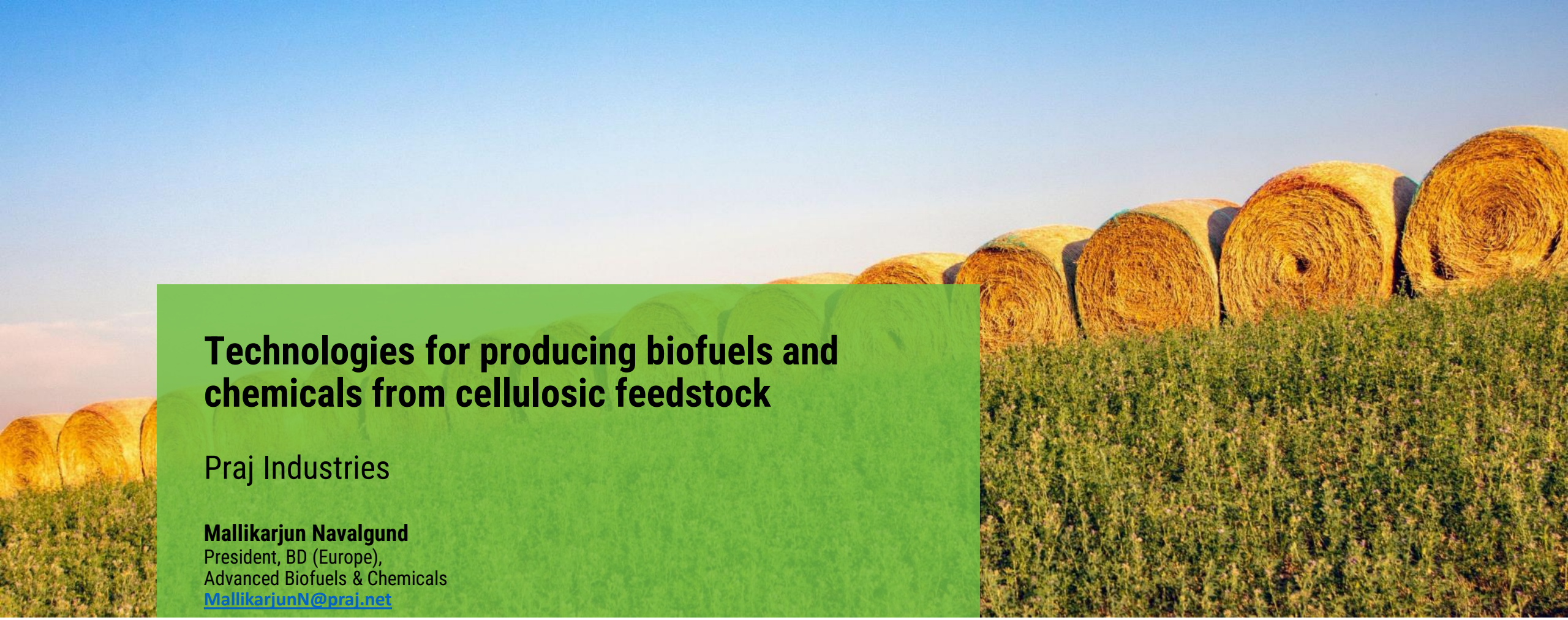


Technologies for producing biofuels and chemicals from cellulosic feedstock

Praj Industries

Mallikarjun Navalgund
President, BD (Europe),
Advanced Biofuels & Chemicals
MallikarjunN@praj.net

17th October 2022, Vienna

IEA Bioenergy
Technology Collaboration Programme

praj
Innovate • Integrate • Deliver

We are aiming high

I. Introduction - Praj

II. Technology platforms for advanced liquid fuels

III. Biogas technology

IV. Out-licensed projects

March 2022

IOCL advanced ethanol project, Panipat, India

Capacity - 100 m^3/day (~8 MGPY / 25 KTA)

Introduction Praj

IOCL advanced bio-ethanol plant in Panipat in March 2022

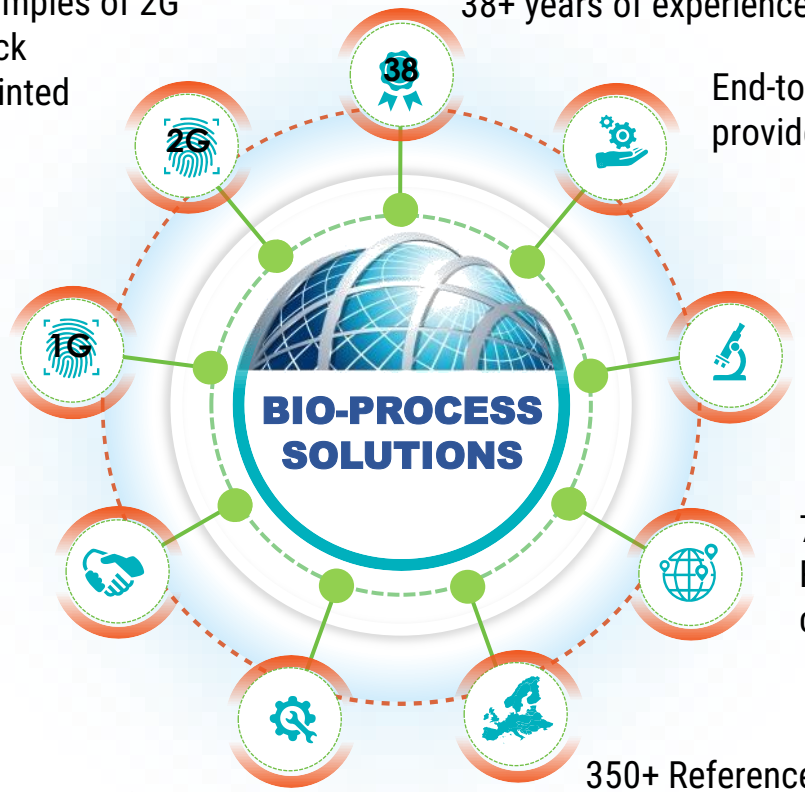
Praj at a glance

600+ Samples of 2G feedstock fingerprinted

38+ years of experience

End-to-End solutions provider

9000+ Samples of 1G feedstock fingerprinted



Praj Matrix: World class R&D centre

Experience of handling complex feedstocks e.g. cassava, molasses,

750 + (1000+ overall) References (40 % repeat customer)

References in 75+ countries across 5 continents

350+ References overseas (20+ in Europe)

In the EU over 1 billion liters are produced based on Praj's technologies, being present in Europe for over 16 years

BritishSugar

56.000
tpy bio EtOH

Beet thick juice based
Wissington

cropenergies

235.000
tpy bio EtOH

Sugar beet, wheat based
Wanze

vivergofuels
An AB Sugar company

410.000
tpy bio EtOH

Wheat based
Hull

Our customers in EU

Excerpt

HUNGRANA

32.000
tpy bio EtOH

Corn based
Szabadegyháza

Cosun Beet COMPANY

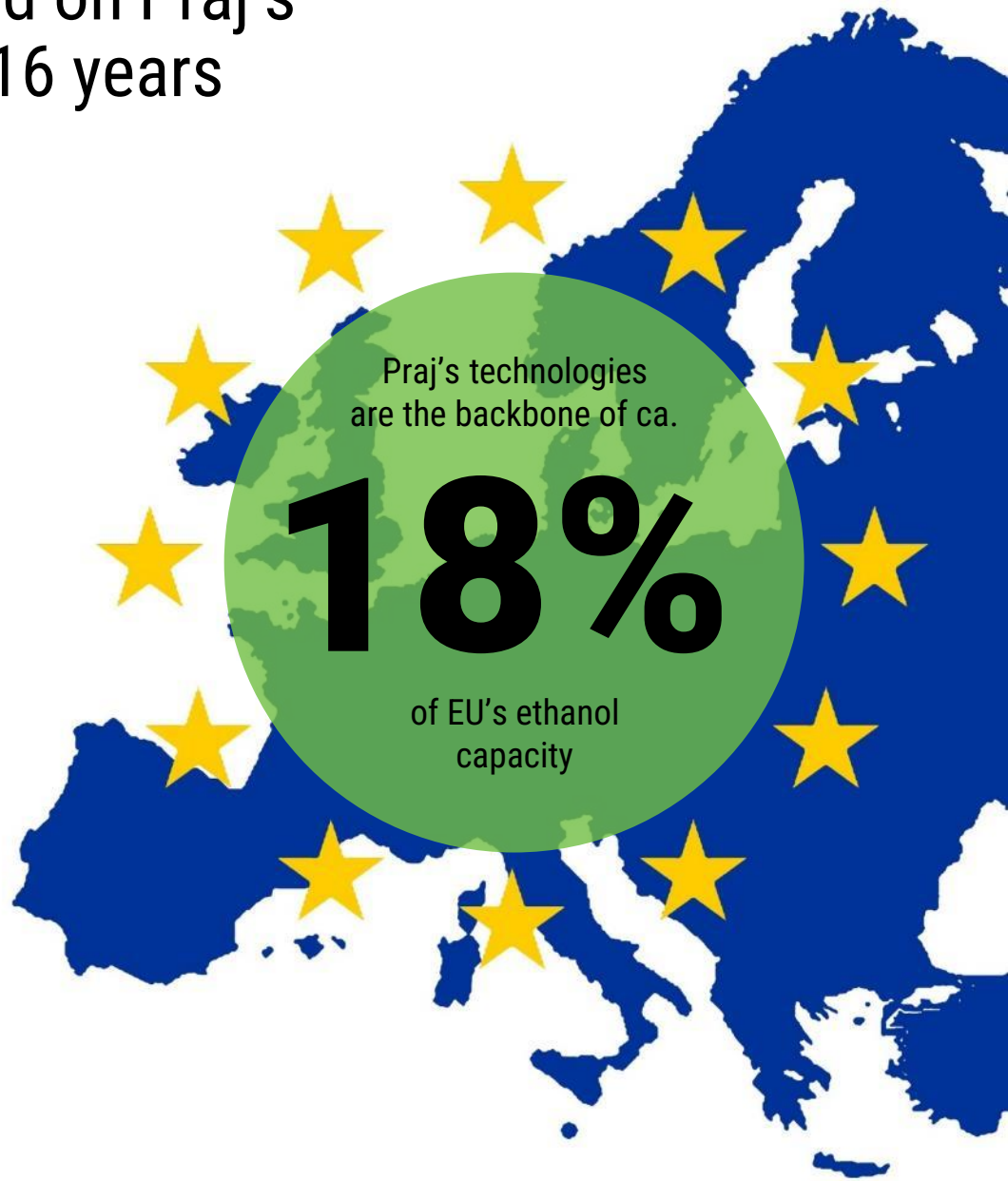
47.000
tpy bio EtOH

Sugar beet based
Anklam

BGW

55.000
tpy bio EtOH

Cereals / grains based
Rąbczyn



Technology platforms for advanced liquid fuels

The “Enfinity” technology converts lignocellulosic biomass into climate-friendly biofuels & biochemicals using the industry’s leading pre-treatment

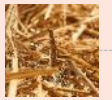
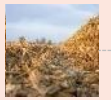
Praj
Innovate • Integrate • Deliver

enfinity™

Sugar/ starch

- Wheat
- Corn
- Sugarcane /molasses
- Cassava
- Sugar beet

Ligno-cellulose

- Wheat/rice straw 
- Corn stover 
- Bagasse
- Hard- & softwood
- MSW*

Advanced 2G

Feedstock handling & preparation

Pre-treatment

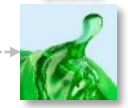
Enzymatic hydrolysis

Fermen-tation

Product separation

Waste water treatment

End-to-End integrated process

- Bio-fertilizer
- Bio-chemicals
- Fuel grade alcohol 
- Power export
- Bio-CNG
- Liquid CO2

* Municipal household waste (organic part)

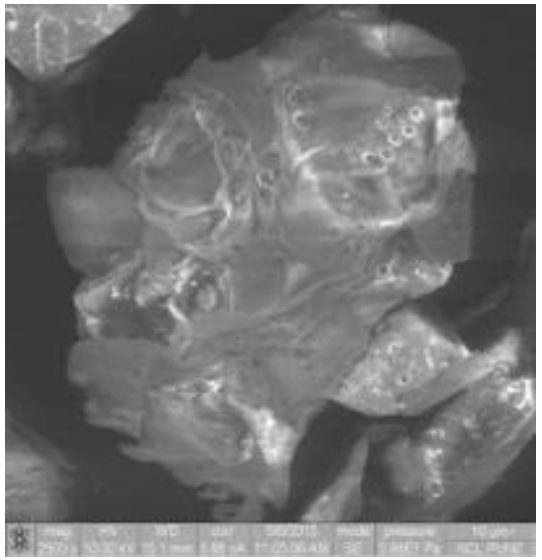
Praj 1G process

Praj Enfinity & Celluniti

The crux is pre-treatment

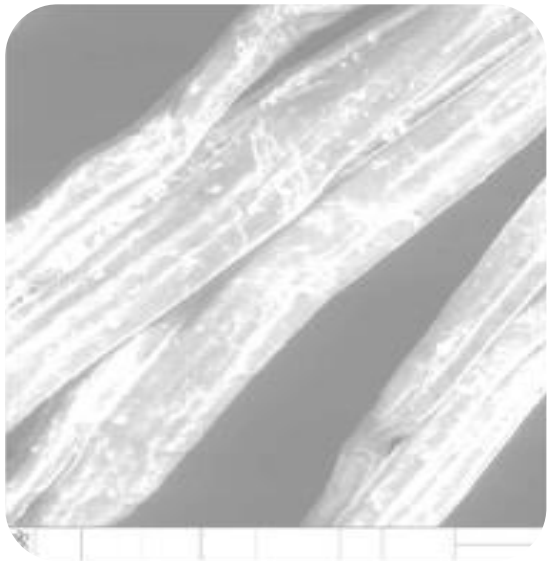
Untreated biomass

- Compact and rigid morphology
- Porosity – 30 to 35%



After pre-treatment (steam explosion without catalyst)

- Separation of bundles and fibers
- Fiber swelling
- Porosity – 70 to 75%

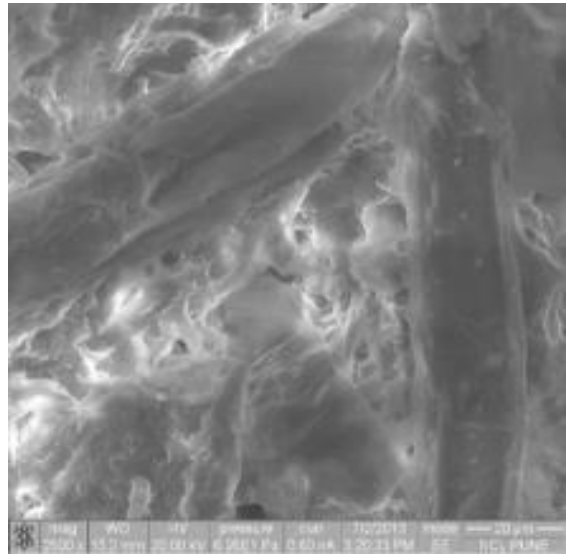


After pre-treatment (steam explosion with catalyst)

- Disorganized fibers
- Punctured-like holes and an open structure .
- Better penetration of catalyst in the fibers.
- Porosity- 80 to 85%

Next step (with additive)

- Further improvement in porosity



Photos of scanning electron microscope showing surface topography

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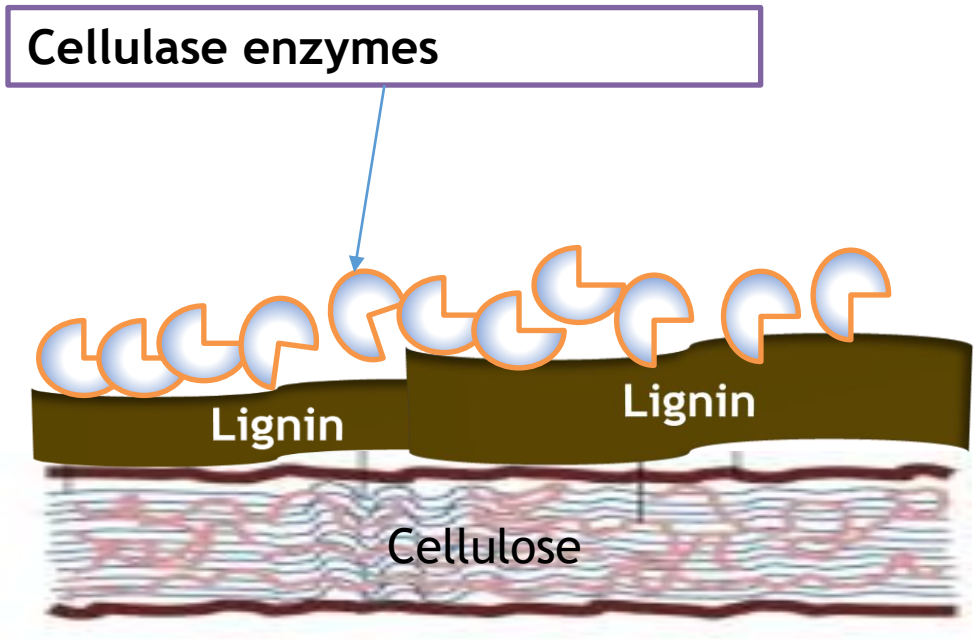
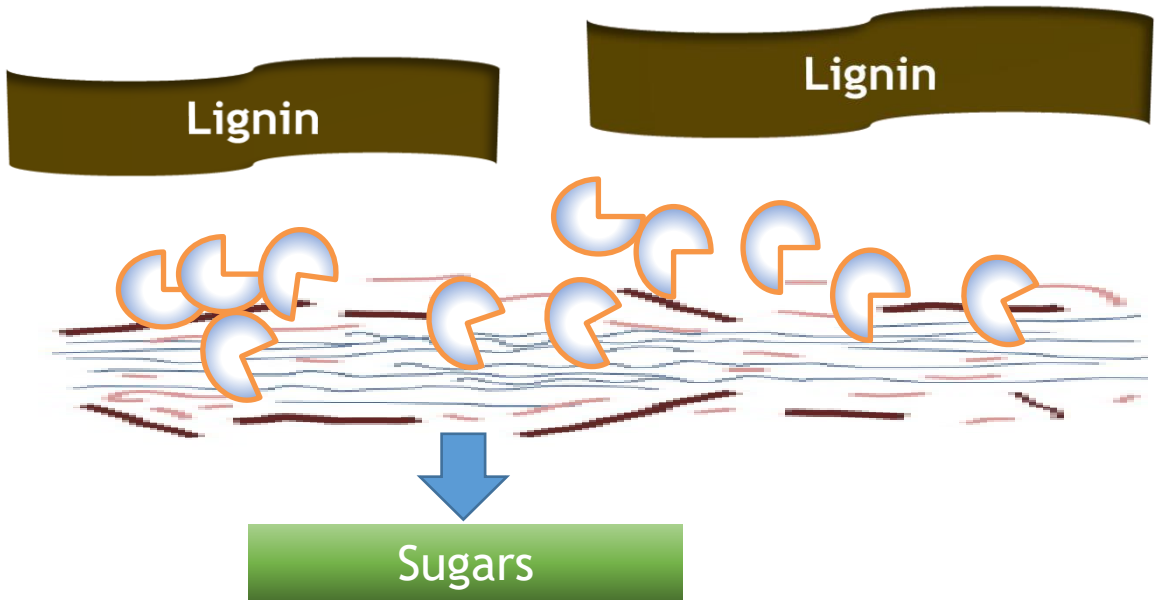
Praj's catalyst treatment –

Enhancement of enzymatic action

Before Treatment



After Treatment

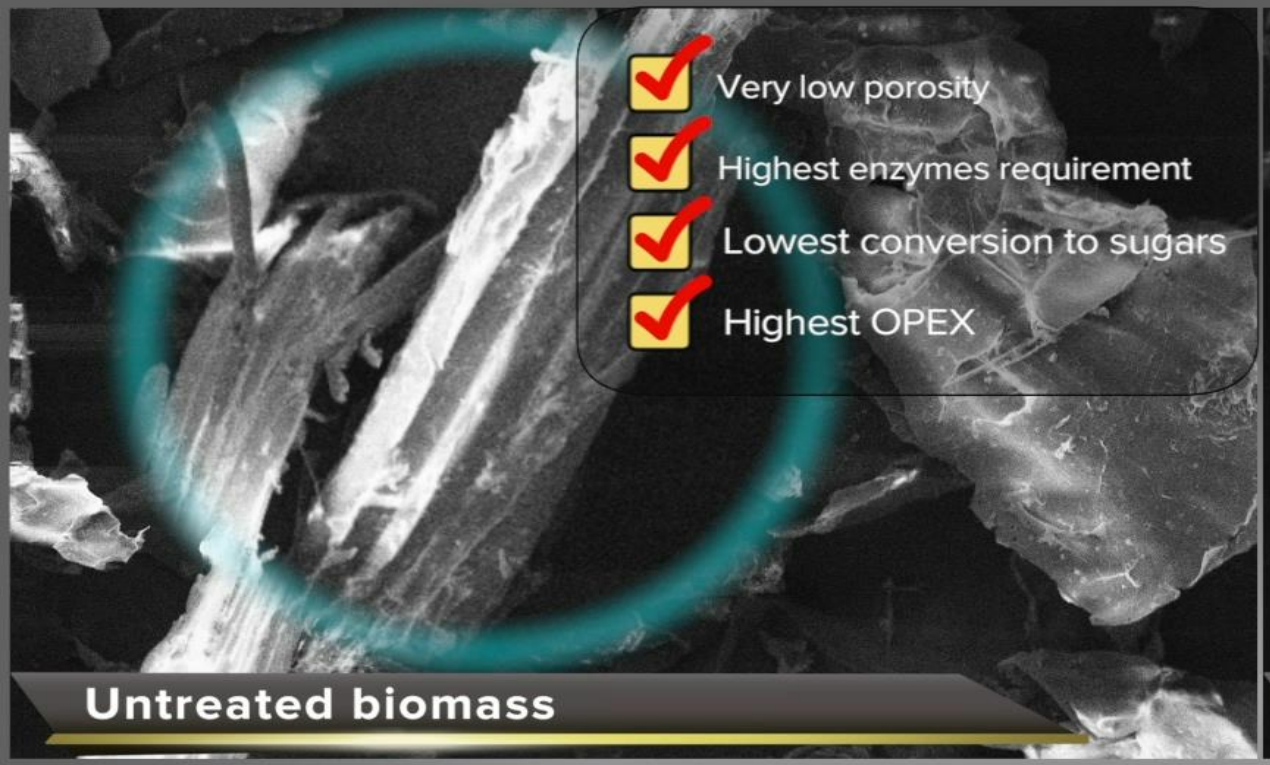


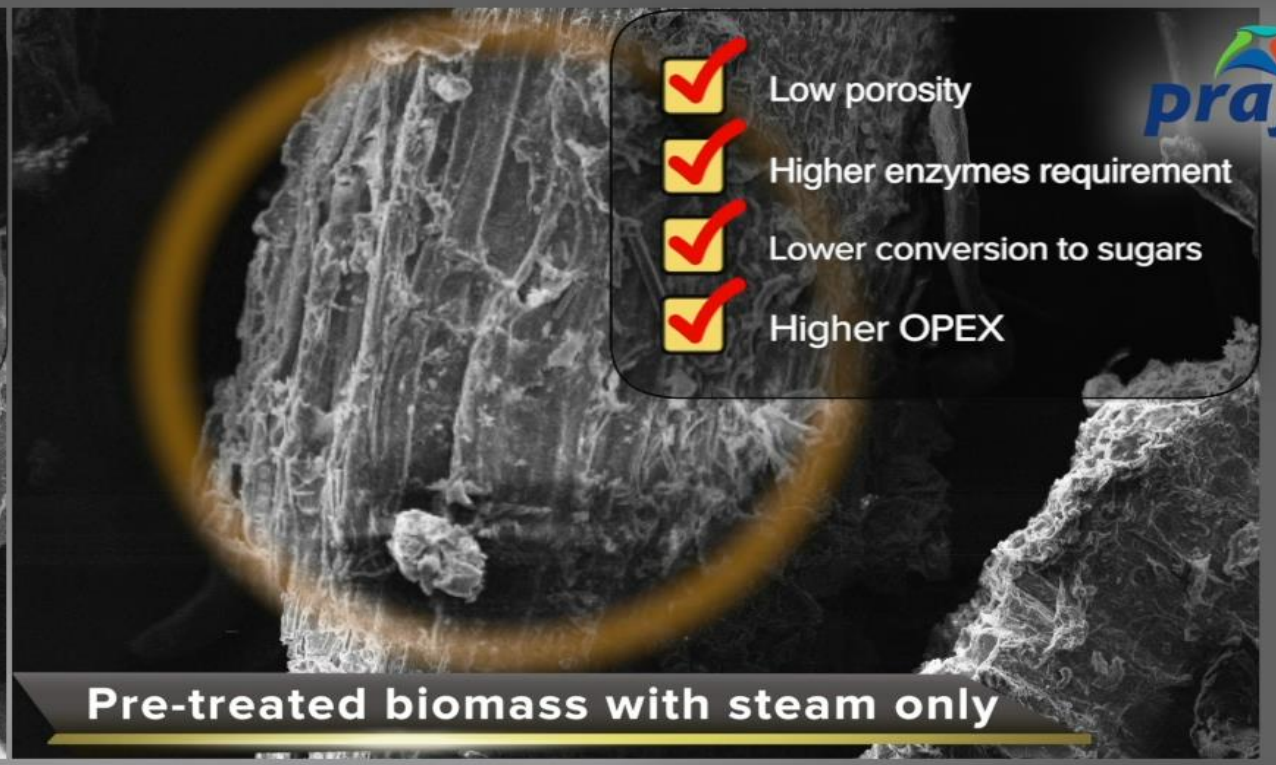
- Catalyst enhance enzymatic hydrolysis efficiency through the mitigation of lignin-cellulase enzymes interactions (Increased porosity and S/G ratio)
- Catalyst introduces charge in the lignin to make it more hydrophilic

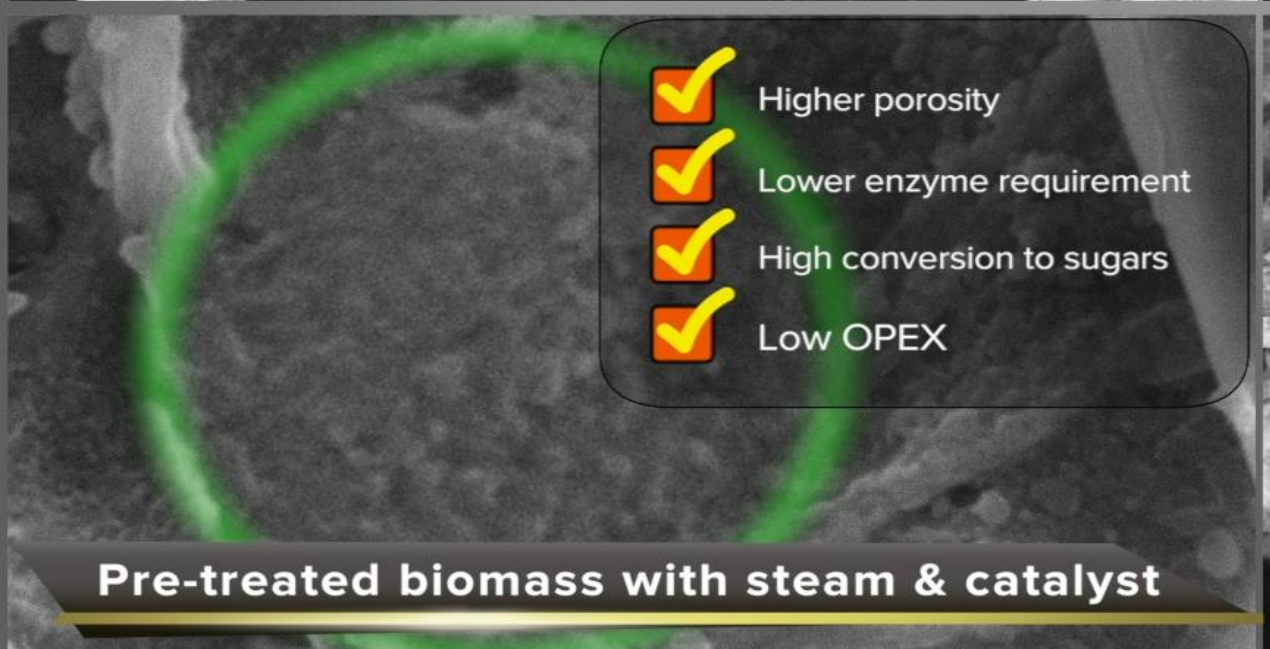
Cellulose

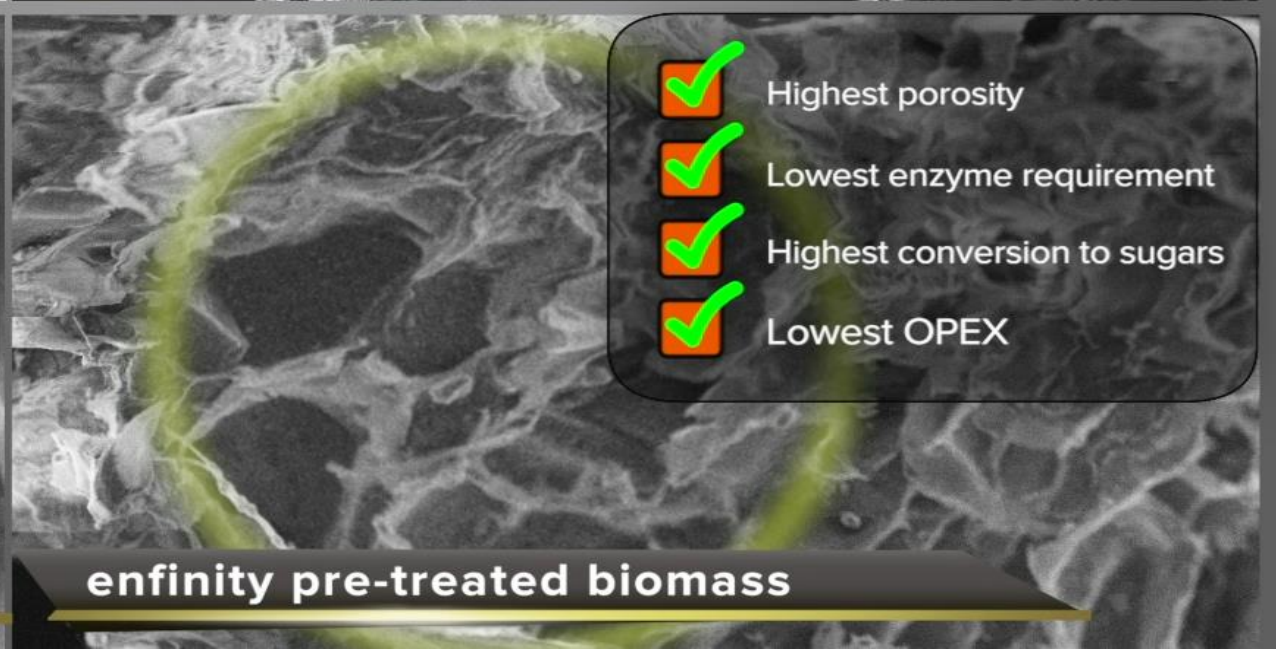
Feedstock type	S/G ratio
Native	0.83
Pretreated	0.98
Additive treated	1.06

High S/G ratio → **Better accessibility to enzymes results into lowest cost sugars**


Very low porosity
Highest enzymes requirement
Lowest conversion to sugars
Highest OPEX
Untreated biomass


Low porosity
Higher enzymes requirement
Lower conversion to sugars
Higher OPEX
Pre-treated biomass with steam only


Higher porosity
Lower enzyme requirement
High conversion to sugars
Low OPEX
Pre-treated biomass with steam & catalyst


Highest porosity
Lowest enzyme requirement
Highest conversion to sugars
Lowest OPEX
enfinity pre-treated biomass

Our pre-commercial plant has proven robustness, high yield of operations & predictability of scale up

Commercial deployment evaluation of demo plant by oil major in 2019

1. Observed **continuity** & **reliability of operations** on wheat straw for 60 days / 1094 hours of operations.
2. **Monitored** unit **performance**, evaluate technology for performance & scale up capability
3. Observed operations at **stressed conditions**

Up-time factor

96%

Yield
[Litres AA / BDMT biomass]

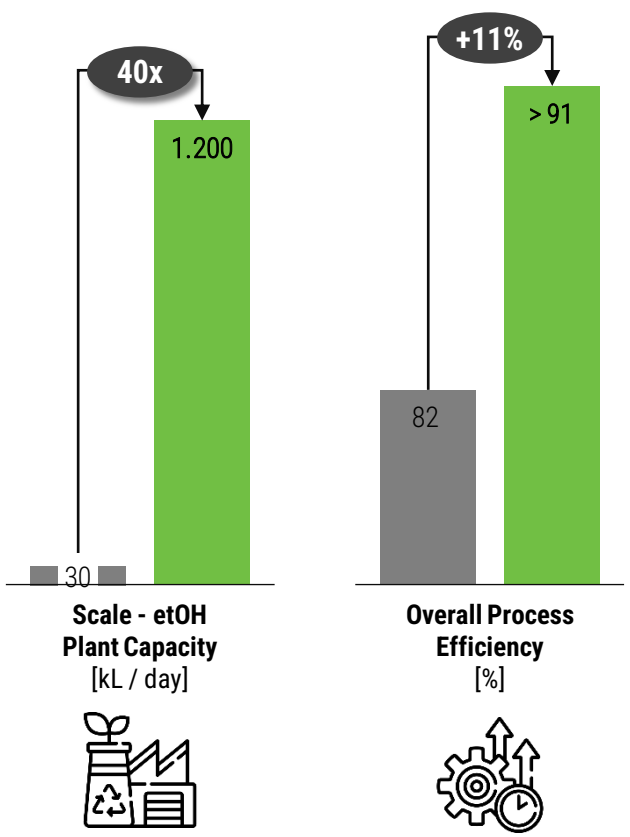
258

Operating capacity

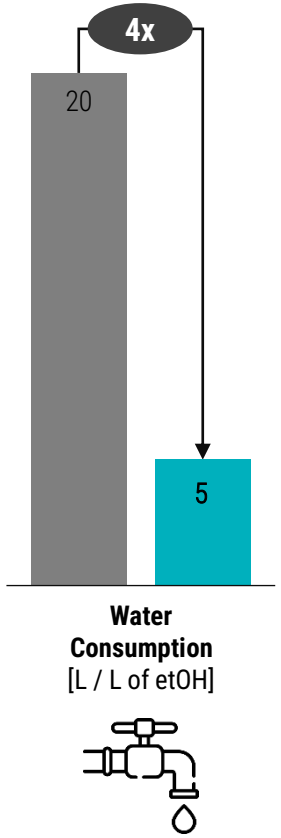
87%

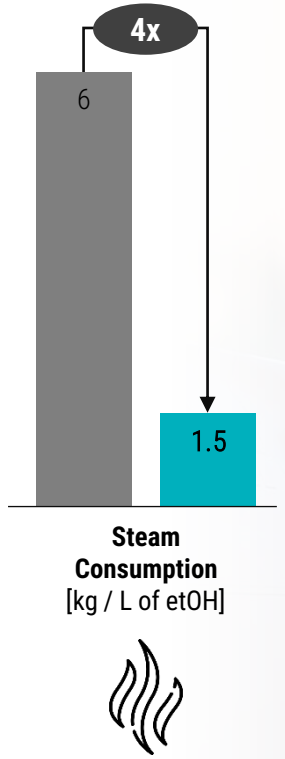
Praj's continuous improvements have boosted the commercial performance of 1G biorefineries. We will repeat this success story with 2G.

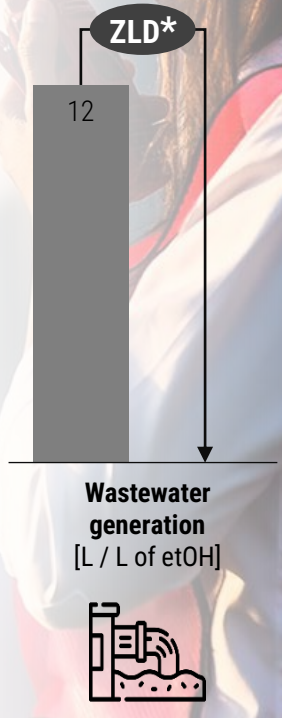
Output increased



Input Decreased







1984 today

*Praj Zero Liquid Discharge

Celluniti is a unique technology platform converting forest residues into climate-friendly biofuels and chemicals

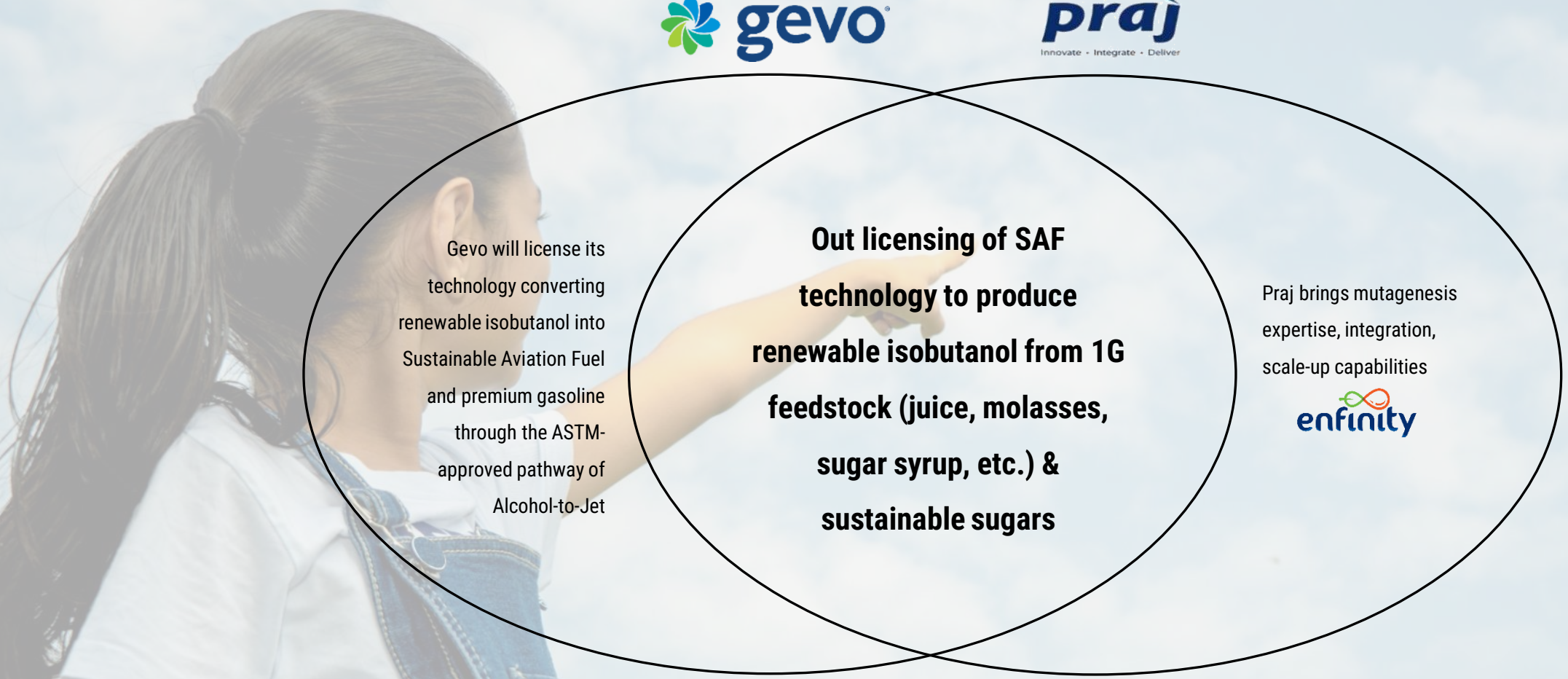
„ A Nordic, groundbreaking forestry based conversion technology complemented by the leading biorefinery engineering company to integrate, scale up, improve and commercialize.“

Celluniti benefits

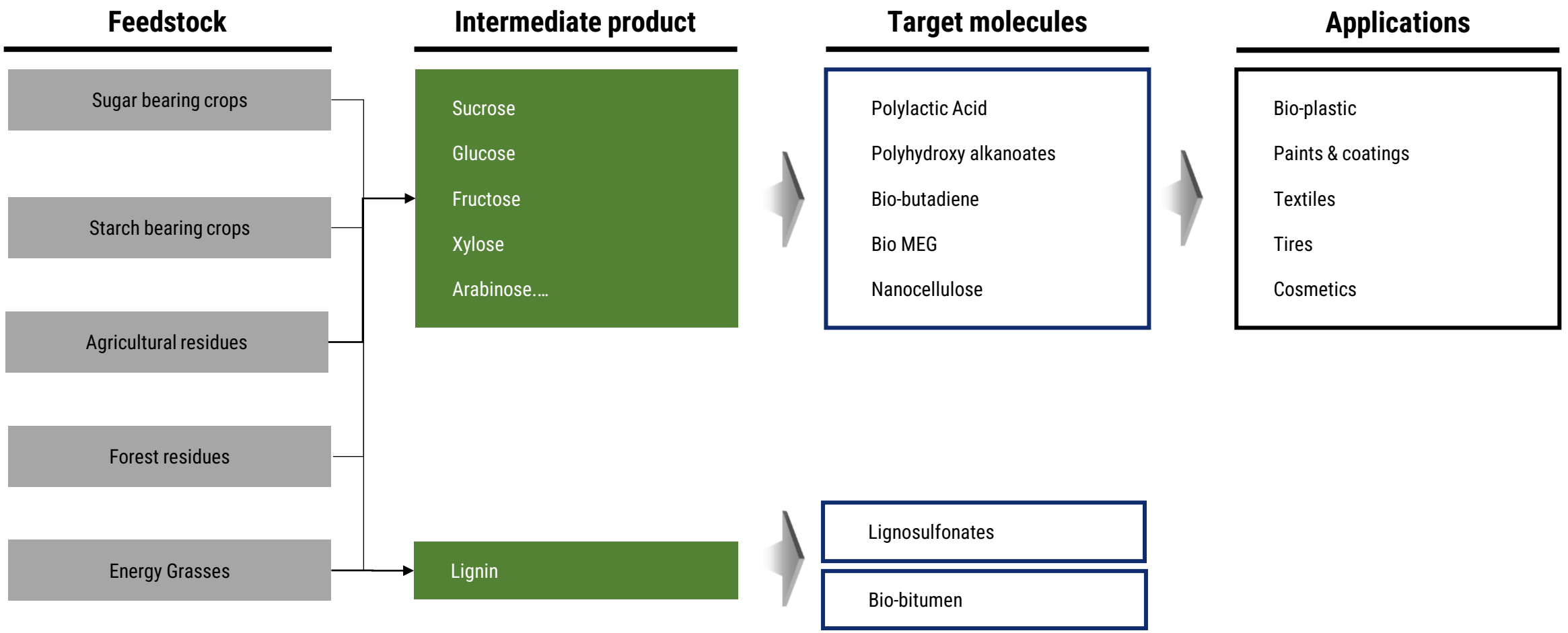
- **Leading technology** to convert forestry biomass like **softwood** into cellulosic sugars and lignin
- **Pre-commercial** plant:
  - Unique know how through **50.000 hours** of **operation** on different forestry feedstocks
  - **Capacity**: 2 tons per day dry biomass
  - Located in biorefinery cluster outside Örnsköldsvik in **Sweden**
- Technology covered by **>200 patents**
- Currently developing **Biorefineries** in the Nordics based on Celluniti.

* www.sekab.com is a Swedish green chemical company with solid experience of producing biofuels and chemicals from residual biomass products.

Praj commercializes a production technology for Isobutanol as Sustainable Aviation Fuels in cooperation with Gevo US, using renewable feedstocks



We have commercialized multiple RCM* platforms & numerous are in the development pipeline (1/2)



Biogas technology

PRAJ Demo Plant… Pune

PRAJ Rice straw / Bagasse Demo Plant (Pune)

Out-licensed projects

HPCL CBG Project

BIRDS EYE VIEW

Reference Project in India

Pressmud feeding

Compression Cascade filling

Decanter

Biogas Gas Purification

PM Stab treated Pressmud storage

CBG Cascade Filling

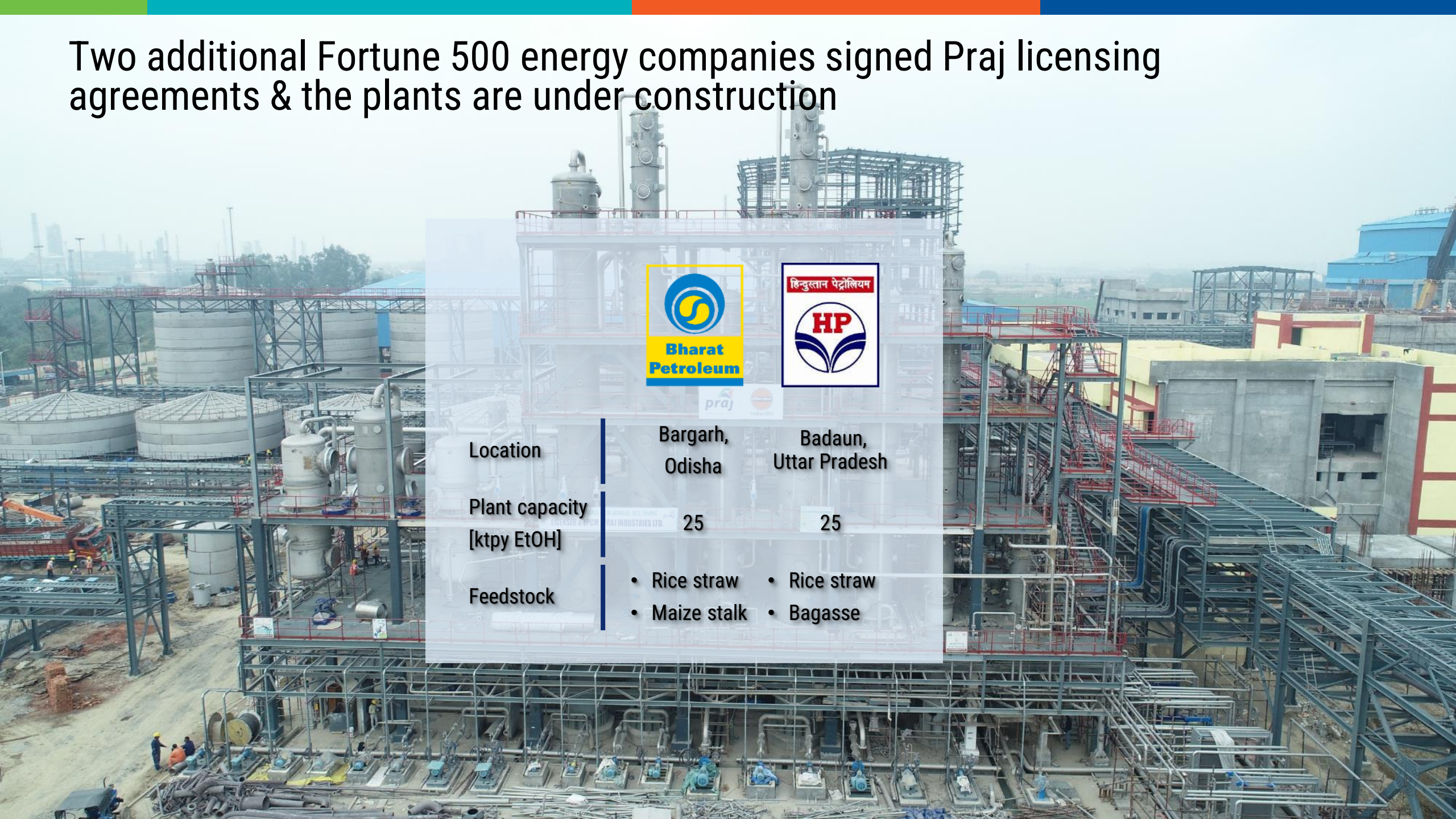
One of the world's first licensed commercial scale advanced EtOH projects is based on Praj's "enfinity" technology for a Fortune 500 Co.

Capacity	26.400 tpy 2G EtOH	**Feedstock**	115.000 tpy Rice straw	**Expected start-up**	December 2022	**Location**	Panipat / India

Structural steel	*4.500 MT*	*Piping installed*	*6,5 km*	*Electrical cabling*	*550 km*	*Feedstock trucks*	*130 per day*

Roll-out: further out licensed commercial projects

Two additional Fortune 500 energy companies signed Praj licensing agreements & the plants are under construction



	Bharat Petroleum	हिन्दुस्तान पेट्रोलियम HP
Location	Bargarh, Odisha	Badaun, Uttar Pradesh
Plant capacity [ktpy EtOH]	25	25
Feedstock	• Rice straw • Maize stalk	• Rice straw • Bagasse

Thank you

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