

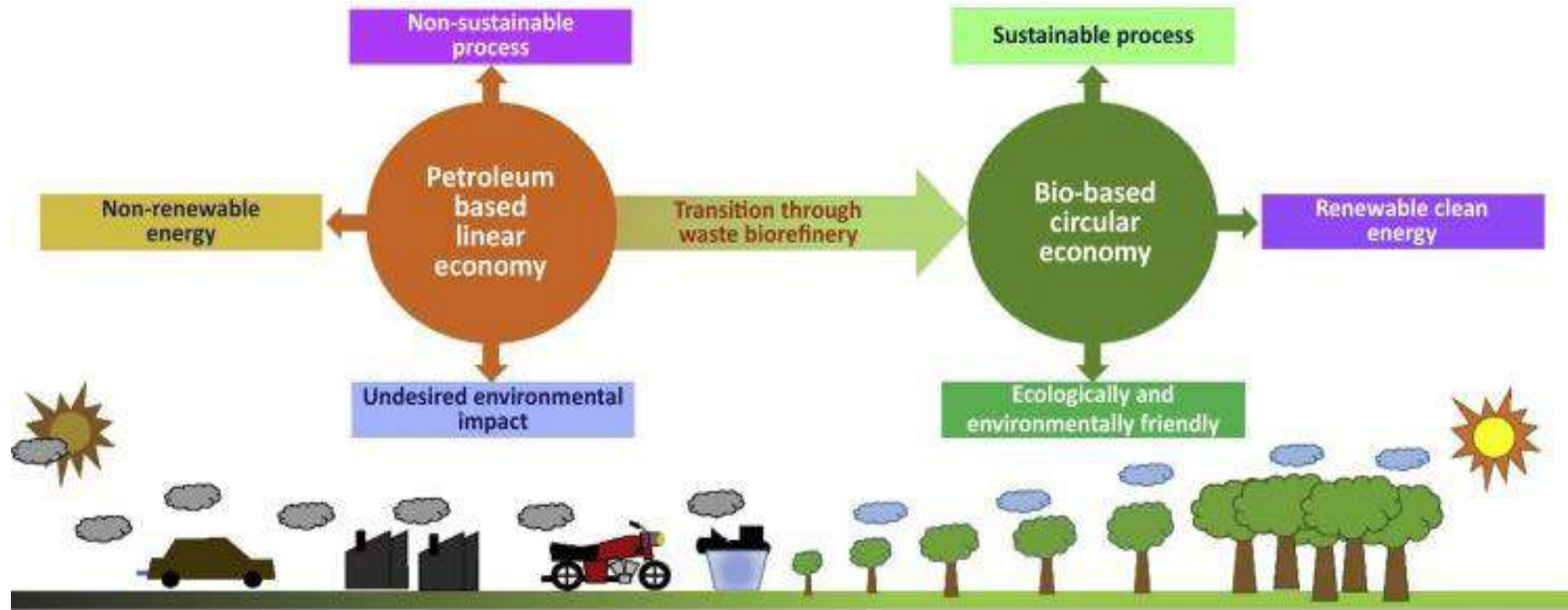
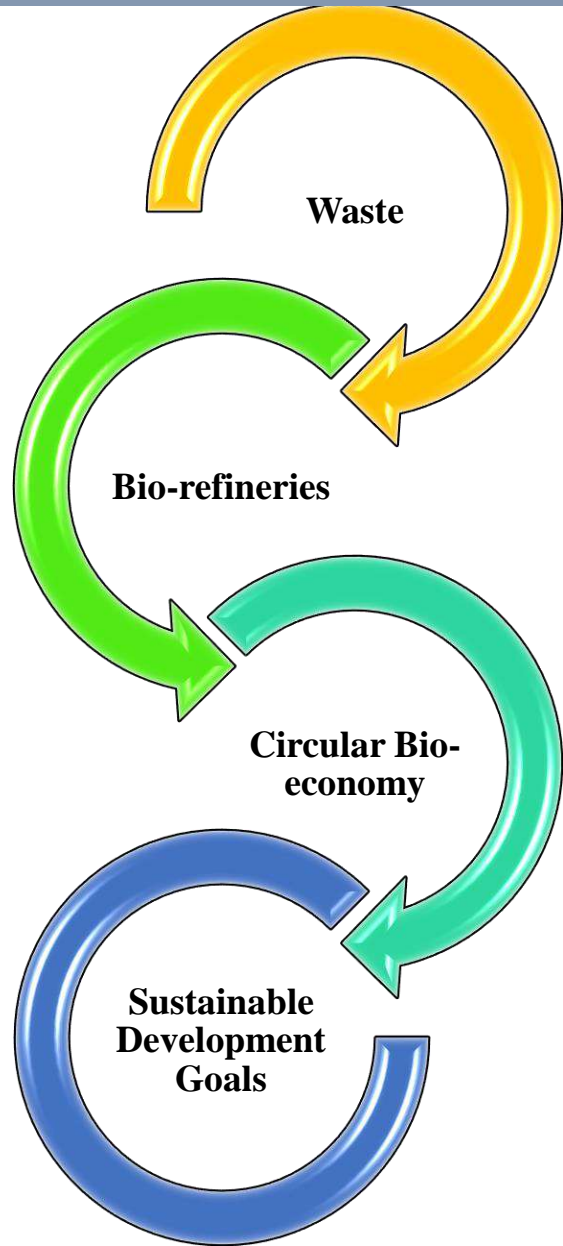


Biofuel as an alternative energy source & related technologies

Prof. Rintu Banerjee

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Agricultural and Food Engineering Department
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Technology
Ex-Chair Professor, MNRE
Founder Head, P. K. Sinha Centre for Bioenergy and Renewables
Indian Institute of Technology Kharagpur, India

Waste Bio-refinery: A Paradigm Shift For A Sustainable Bio-Economy



Indian Government's Initiatives Towards Green Energy Using Ethanol

Ethanol blending percentage



20% ethanol blending in petrol by **2030**
to provide clean energy and boost farm economy

Cabinet approves hike in Ethanol Prices to boost Ethanol Blending



Major step towards increasing farmer's income & encouraging cleaner fuel.

Ethanol price from B-Molasses/partial sugar cane juice

Prevailing price:
₹ 47.13/ltr.



Revised price:
₹ 52.43/ltr.

Ethanol price from 100% sugar cane juice

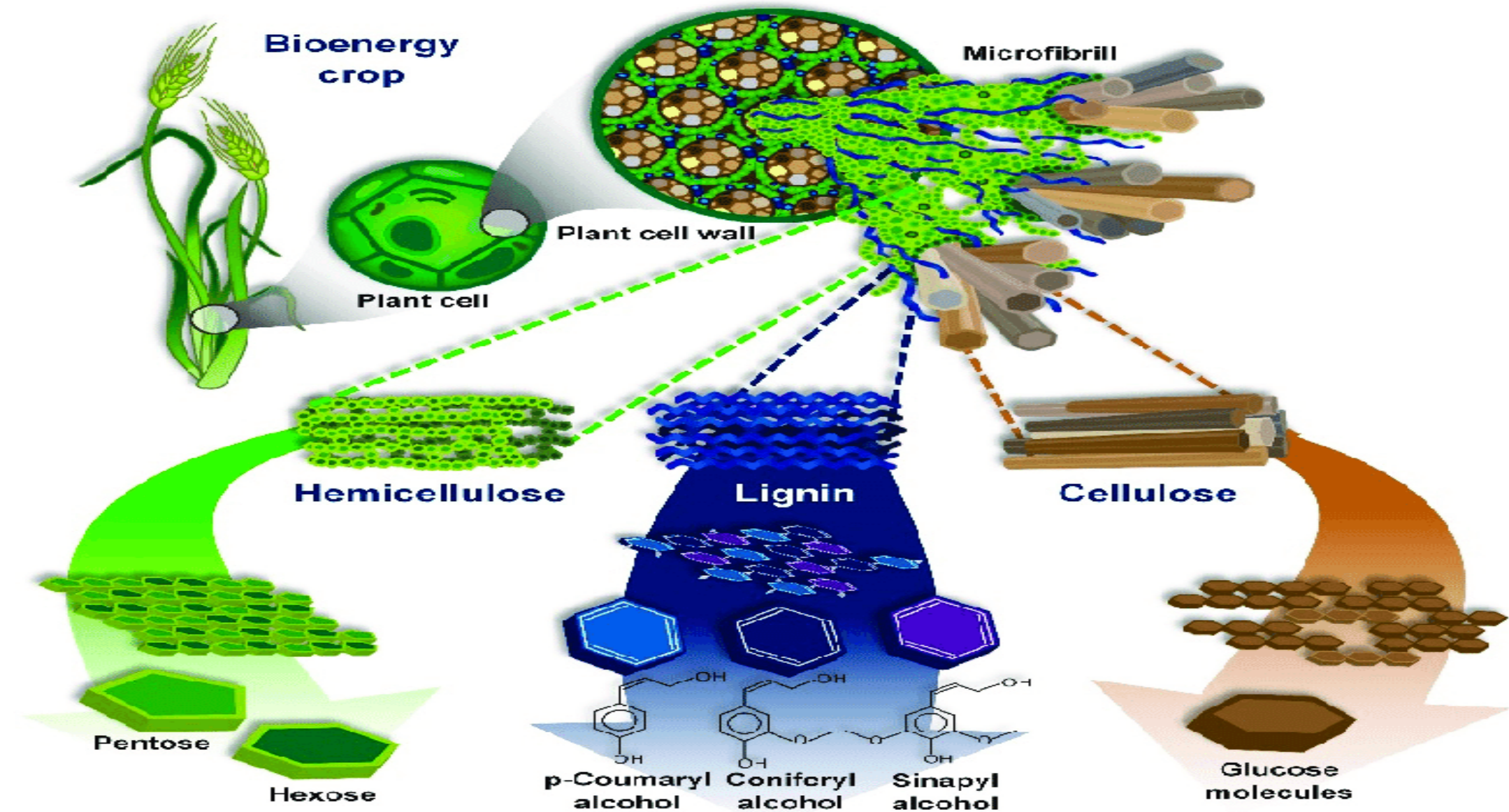
Prevailing price:
₹ 47.13/ltr.



Revised price:
₹ 59.19/ltr.



Biochemistry of lignocellulose



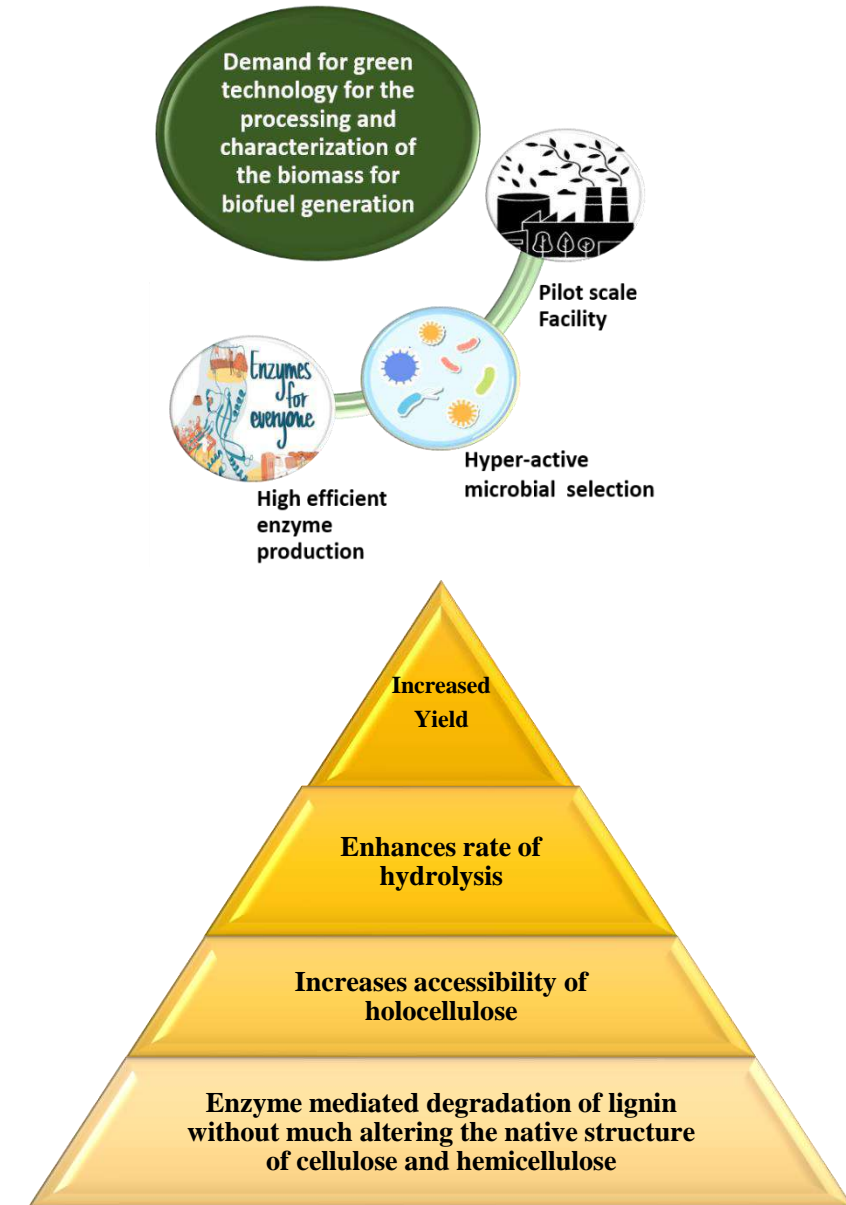
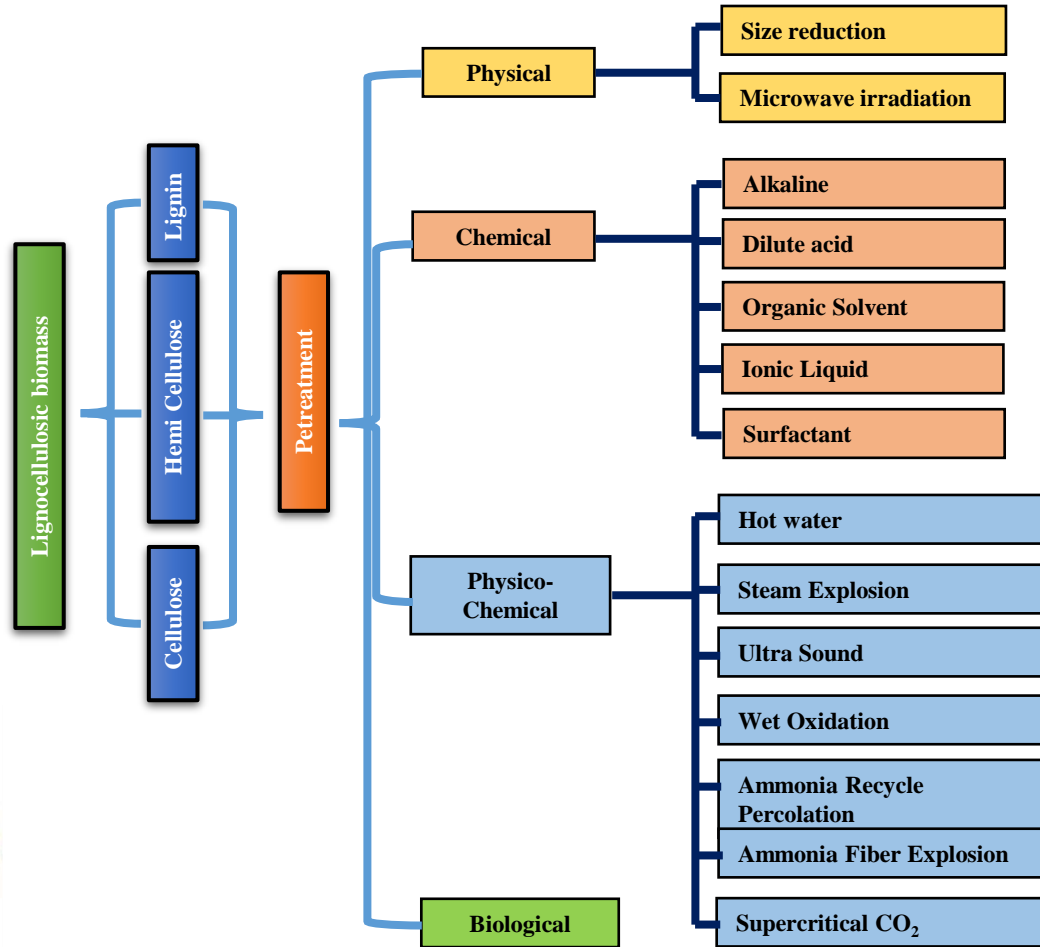
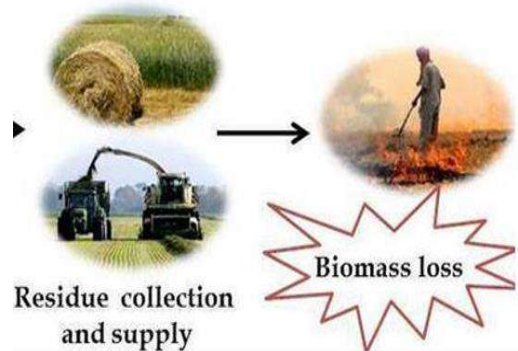
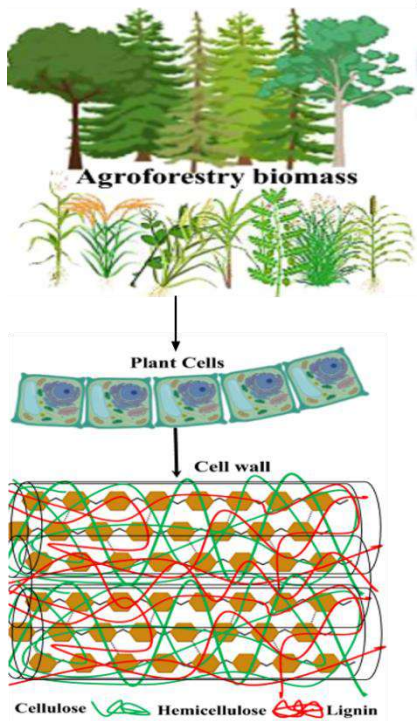
Major Bottlenecks in Lignocellulosic Bioethanol Production



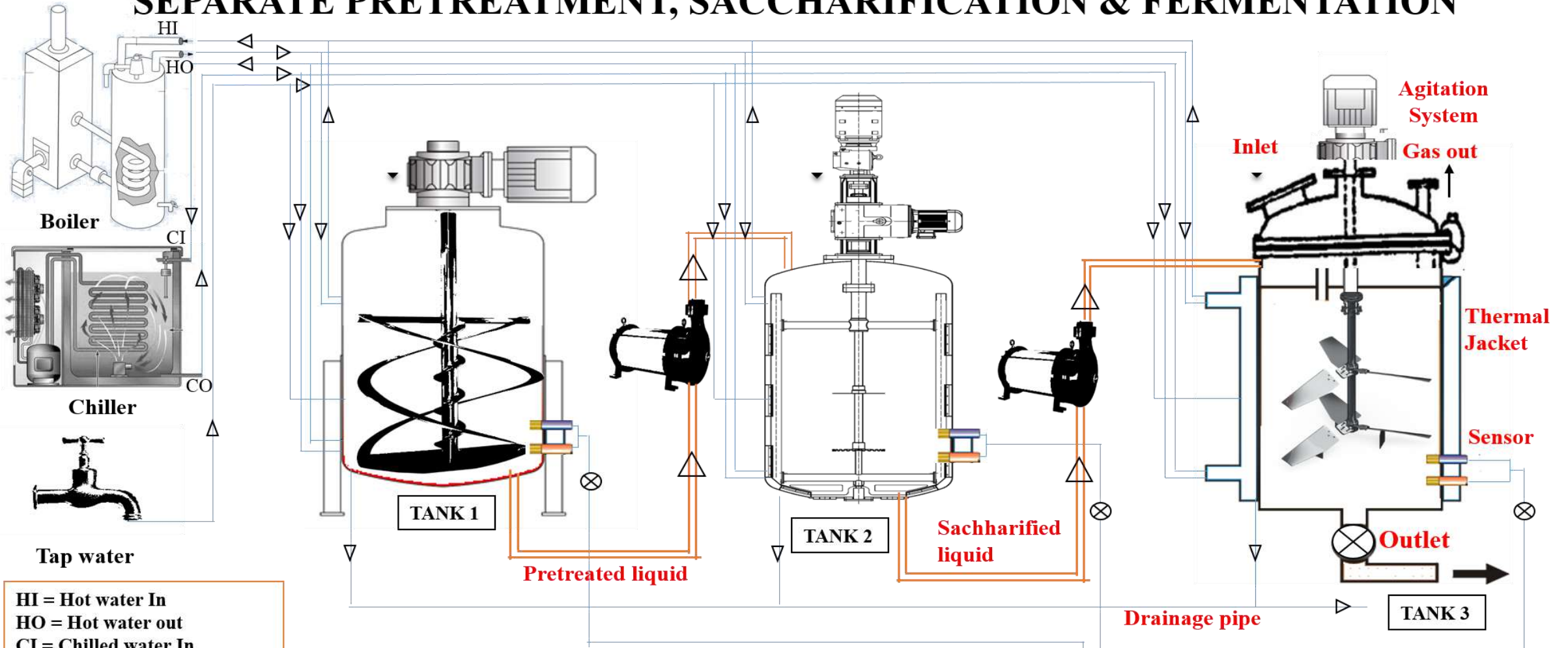
Efficient depolymerization of lignin without the production of furfurals and hydroxymethyl furfurals

Simultaneous utilization of Pentose and Hexose sugars

Need for enzyme production facility: A step to meet 20% ethanol blending program of India by 2025



SEPARATE PRETREATMENT, SACCHARIFICATION & FERMENTATION



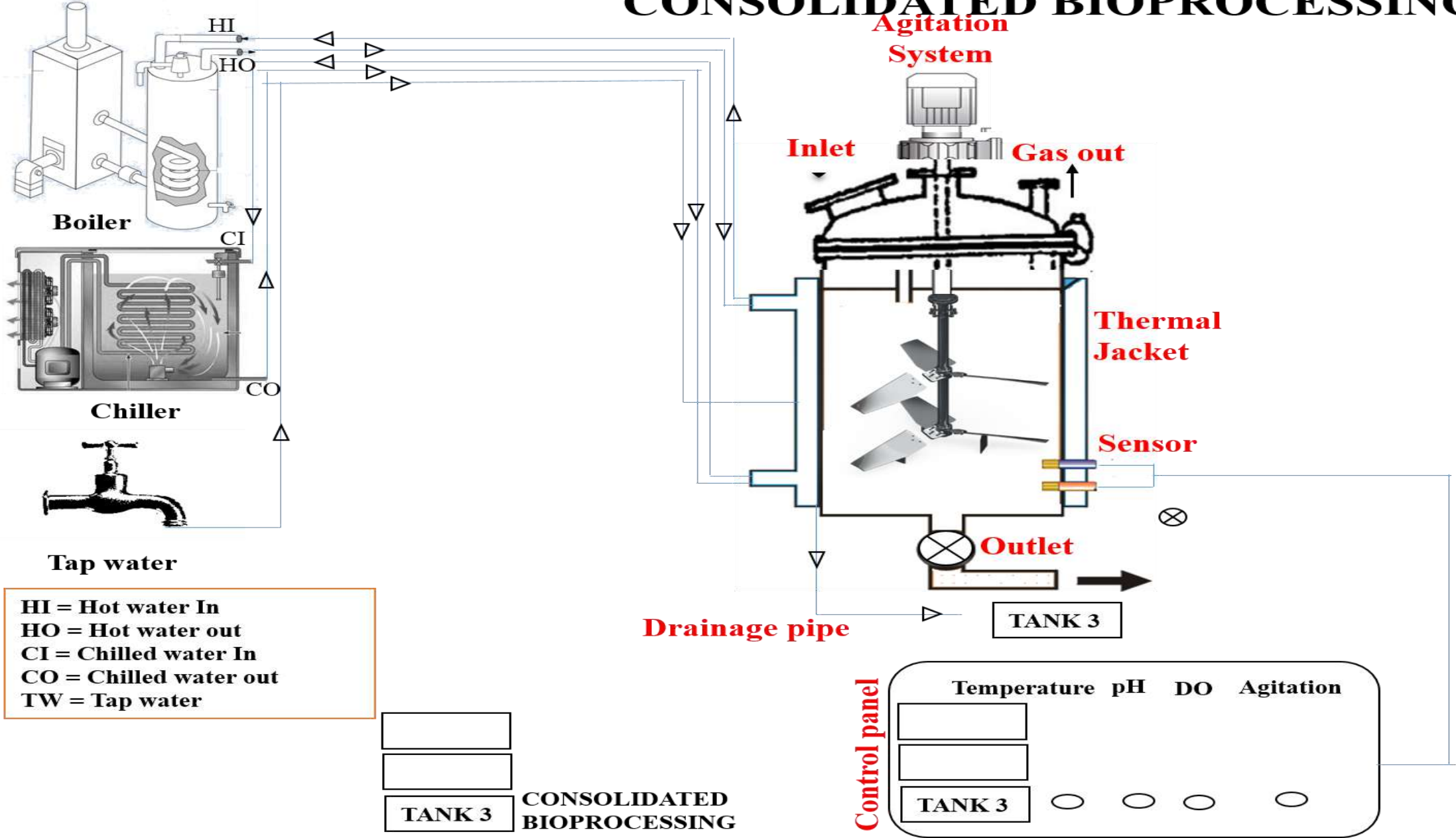
HI = Hot water In
 HO = Hot water out
 CI = Chilled water In
 CO = Chilled water out
 TW = Tap water

- TANK 1 PRETREATMENT
- TANK 2 SACCHARIFICATION
- TANK 3 FERMENTATION

Control panel

	Temperature	pH	DO	Agitation
TANK 1	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
TANK 2	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
TANK 3	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

CONSOLIDATED BIOPROCESSING



HI = Hot water In
HO = Hot water out
CI = Chilled water In
CO = Chilled water out
TW = Tap water

TANK 3
CONSOLIDATED BIOPROCESSING

Control panel
 Temperature pH DO Agitation
TANK 3 ○ ○ ○ ○

Lignocellulosics Selected for Study at IIT Kharagpur for Bioethanol Production

Ricinus communis



Lantana camara



Kans Grass



Bambusa bambos



Rice straw



Sugarcane Baggase



Pineapple leaf waste



Wheat straw



Cotton stalk



Banana plant

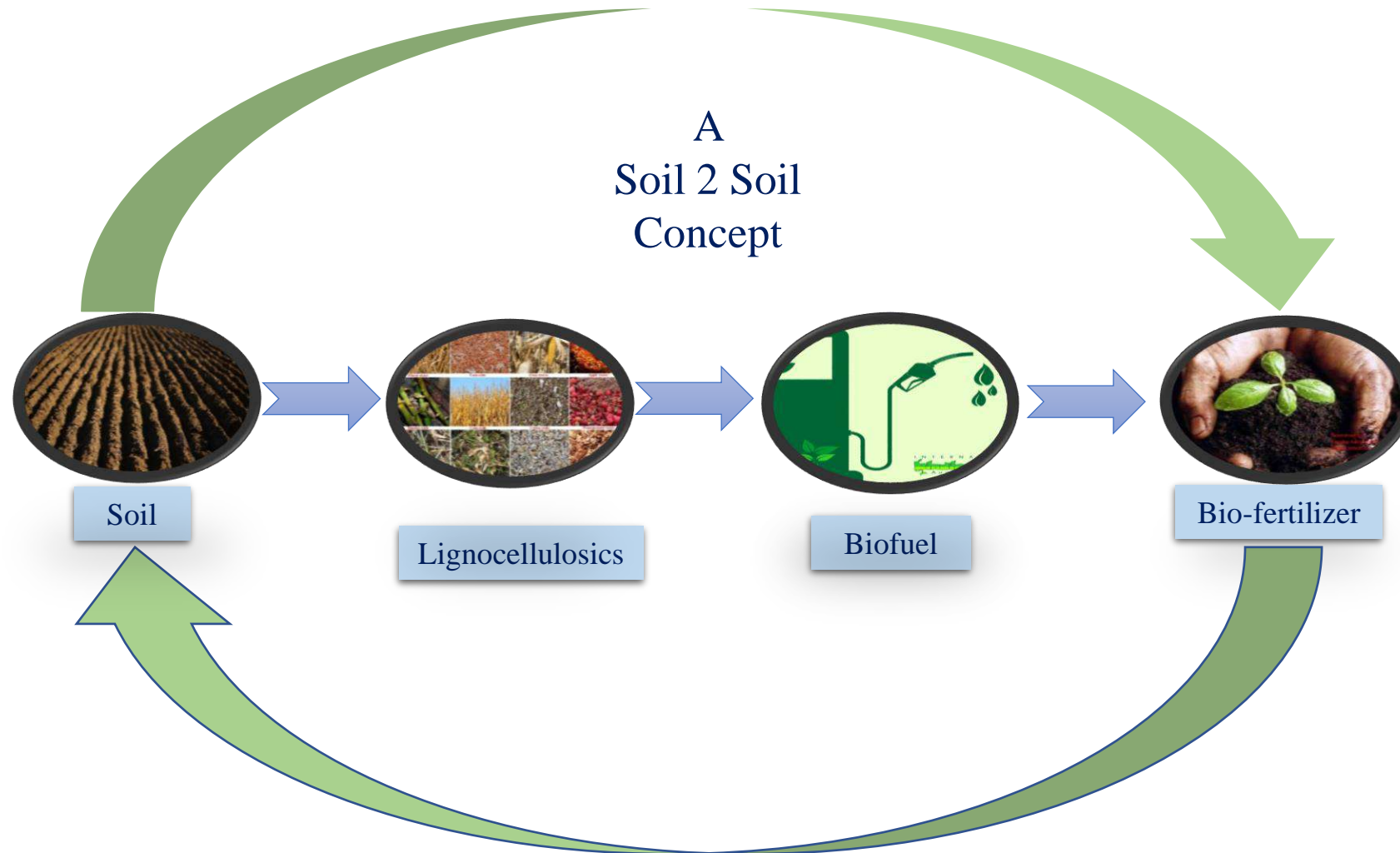


Sweet Sorghum

Pilot-scale 2G-Ethanol production using sugarcane bagasse



Soil to Soil Concept



USP of the developed Technology

- Enzyme based delignification and saccharification
- No use of chemicals/physico-chemical processes
- Reaction takes place at mild environmental conditions
- Water requirement is less compared to the other methods
- Eco-friendly and green technology
- Raw materials: Lignocellulosic biomass which includes rice straw, non-edible biomasses produced under contract farming

Versatile accomplishment of the novel technology

EXCLI J, 2011; 10: 85–96.
Published online 2011 May 27.

PMCID: PMC5109006
PMID: [27857667](#)

Production of ethanol from lignocellulosics: an enzymatic venture

[Arindam Kuila](#)¹, [Mainak Mukhopadhyay](#)¹, [D.K. Tuli](#)² and [Rintu Banerjee](#)^{1,1}

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Energy Conversion and Management
Volume 157, 1 February 2018, Pages 364-371



An eco-friendly process integration for second generation bioethanol production from laccase delignified Kans grass

[Rajiv Chandra Rajak](#)^a, [Rintu Banerjee](#)^b ✉



Waste Management
Volume 49, March 2016, Pages 320-325



Integrated bioethanol and biomanure production from potato waste

[Anjani Devi Chintagunta](#)^a, [Samuel Jacob](#)^b, [Rintu Banerjee](#)^b ✉

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Energy Conversion and Management
Volume 207, 1 March 2020, 112504



An innovative approach of mixed enzymatic venture for 2G ethanol production from lignocellulosic feedstock

[Rajiv Chandra Rajak](#)^a, [Rintu Banerjee](#)^b ✉

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THINK CHANGE INDIA 2-min Read

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NEWS

IIT KGP team develops a new technology to manufacture biofuel

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IIT - Kharagpur develops technology to make pollution-free biofuel

IANS | Kolkata
May 31, 2017 Last Updated at 17:42 IST

**Future of fuel lies in going
unconventional:
Better, Sustainable and Green**



Thank you...