



Reliance
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Plenary Lecture

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**Sustainable Fuels & Chemicals -
RIL's Breakthru Technologies**

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Reliance Has Built Three New Mega-Growth Engines in a Single Decade

1

- Connecting Indians digitally with unprecedented reach at affordable prices with superior customer experience
- Reached 398.3 million subscribers (1Q FY21) in less than four years since inception



2

- Serving the entire spectrum of Indian society with **640 million footfalls** (FY20)
- Supplying a **diversified product portfolio** of groceries, fashion & lifestyle, consumer electronics and connectivity through **11,800+ stores across 28.7 million sq. feet** (1Q FY21)



3

- Connecting people and businesses by **providing transportation fuels** in **one of the fastest growing energy markets**
- Supplying petrochemicals to diversified end-use industries **manufacturing essential industrial and consumer goods** using polymers and polyesters

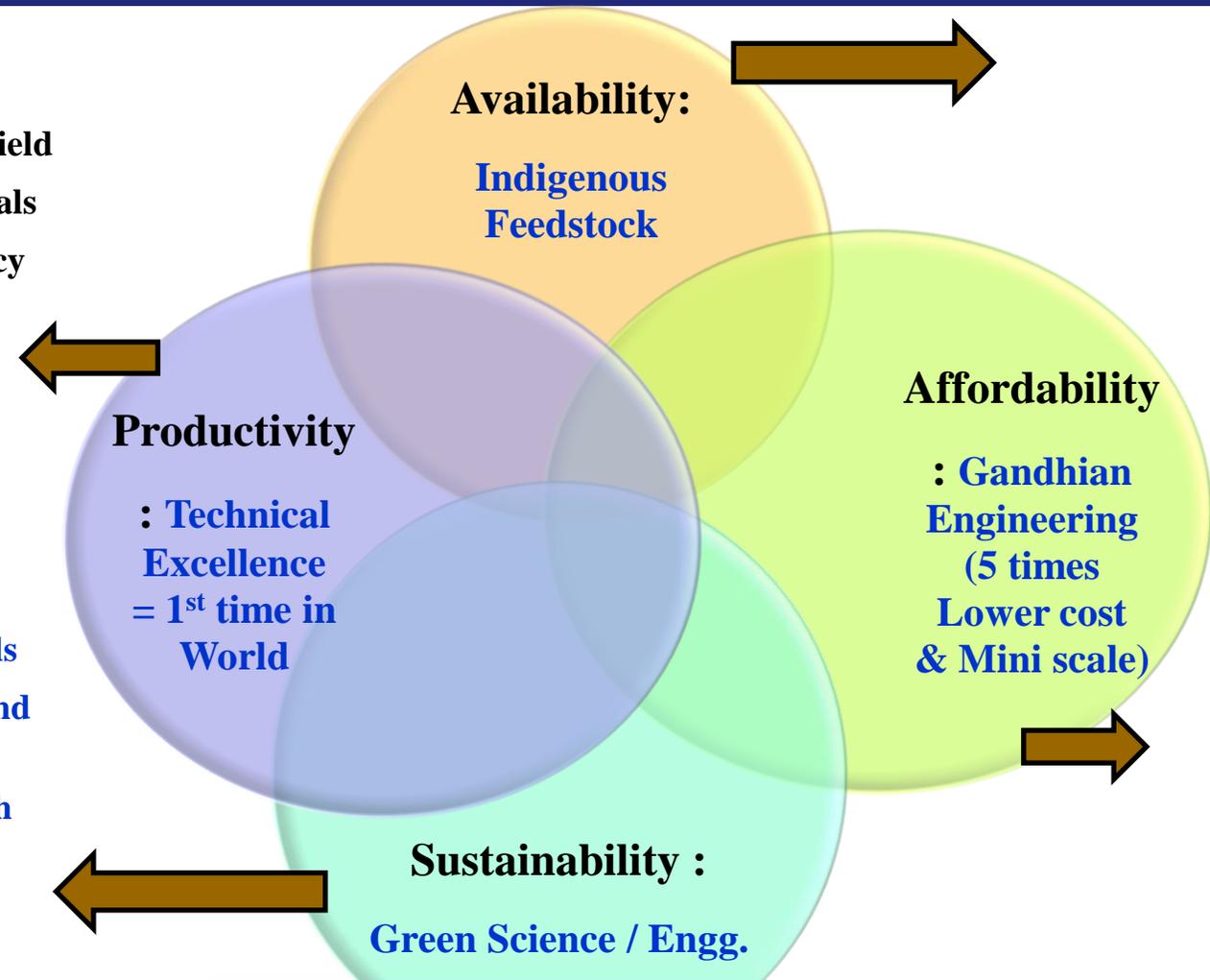


RIL caters to a significant portion of consumer spending through its digital and physical presence

- **Energy & Chemicals – Innovation Scope**
- **RIL's Innovative Technologies**
- **Biomass Cat Gasification + CO₂ Capture to Renewable Fuel & H₂**
- **Rcat HTL – Cat Hydrothermal Liquefaction of wet biomass to Liquid fuel**
- **Circular Economy : RIL's Cat Pyrolysis process for waste plastic / biomass**
- **MCC Technology : Cat Py Oil to Renewable Chemicals**
- **Future Integrated Refinery**
- **Conclusions**

RIL has declared to be NET ZERO by 2035 and recently announced an ambitious plan to build 4 Giga factories around renewable power and Green H₂

Energy & Chemicals – India Centric Innovations



- Gasoline and Diesel quality improvement @ lowest cost
- Direct Crude to chemicals > 70% yield
- Direct Syngas to high value chemicals
- Gasoline and Diesel engine efficiency
- Methanol + Ethanol economy
- Green Hydrogen for Refineries
- Improving EII: Refining & Petchem heat/mass integration
- Low cost CO₂ capture technology
- CO₂ to high value & bulk chemicals
- Conversion of waste plastic to oil and chemicals
- Refinery and Petchem waste to high value products
- Algae to oil & chemicals
- Renewables: Solar, Hydro

- High ash Indian coal
- Agro-biomass 250 MMT / yr.
- Municipal solid waste
- Waste plastics
- Lignite
- Other wastes – cooking oil
- Production of bio-ethanol
- Bio-CNG – Anaerobic digestion
- Biomass gasification
- Pipe gas availability
- Sulfur as fertilizer
- High efficiency solar panels
- Improvement of village roads
- Cheaper road & housing materials
 - Fly ash
 - Gasifier slag
 - Bio-concrete
 - Plastic waste

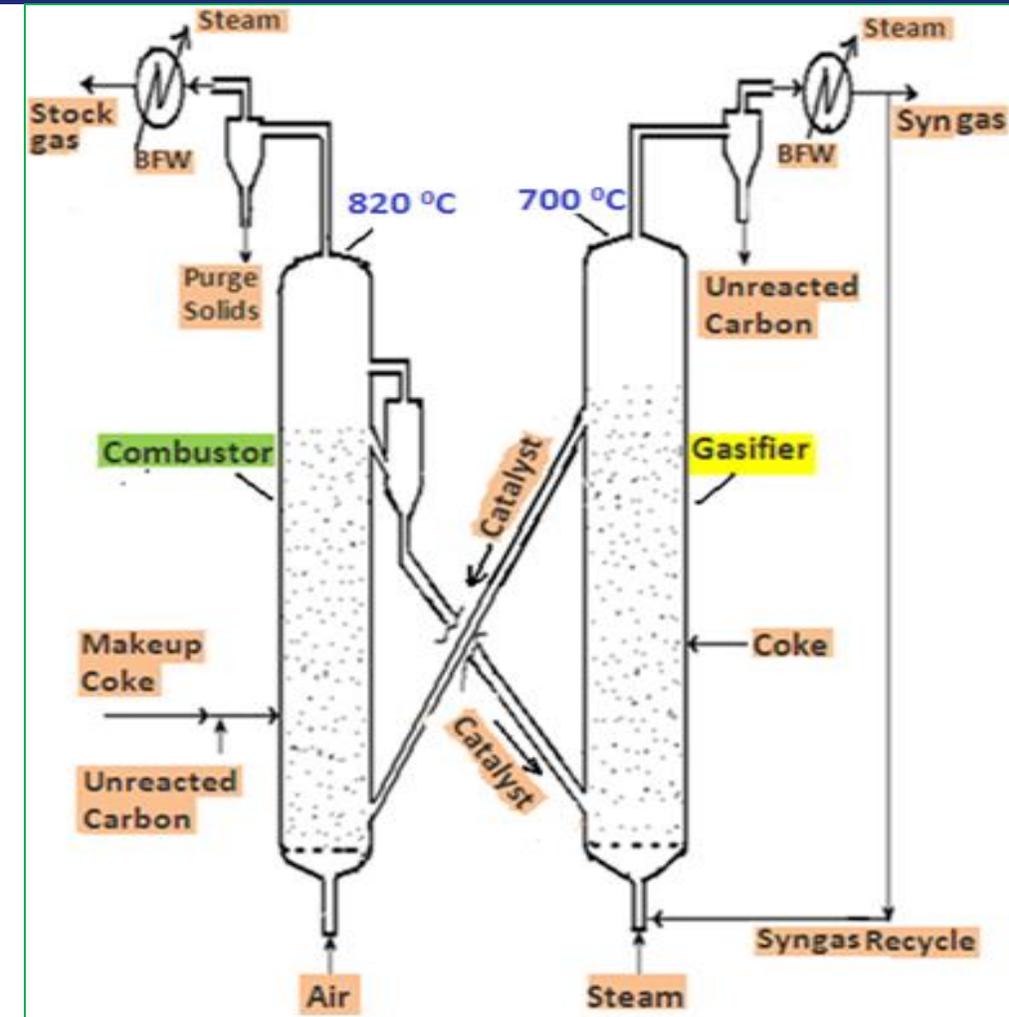
➤ We need **MISSION** oriented approach and India Centric Innovation

➤ Focus on National Mission for Demonstration and Commercialization

➤ Industry needs to fast Commercialize Innovative Developments

RIL's Low Temperature Catalytic Gasification + Integrated CO₂ Capture Technology

- ❑ **Combustion & gasification occur in two separate beds**
 - 1) No need of pure O₂
 - 2) ~ 40% reduction in CAPEX & OPEX
- ❑ **Developed a high active supported alkali catalyst**
 - 1) Good Attrition & Hydrothermal resistance
 - 2) Better metal dispersion & Excellent reusability
 - 3) Catalyze C gasification + WGS kinetics
- ❑ **Proved that external solid catalyst can gasify the coke @ <720 °C while feed is continuously consumed**
- ❑ **Large capacity single gasifier like FCC is possible, no slag, no high T issues**
- ❑ **Granted patent around the world**
- ❑ **Applications – Petcoke, Lignite, High ash Indian coal, Waste Agri biomass to tar free high quality Syn gas**
- ❑ **Suitable for high ash Indian Coal => producing low cost Syn gas and then CH₃OH to replace gasoline as fuel.**



Solid-Solid Catalysis in Fluidized Bed = Migratory Catalysis

- ❑ In biomass gasification, usually the product syngas contains substantial quantity of tar
- ❑ Catalytic biomass gasification eliminates tar formation completely while achieving high H₂ yield > 10 wt% from various waste biomass feedstock



Catalytic

Non-Catalytic

**Color comparison of unreacted water + tar of
Sugar Cane Stalk**

Gasification Economics : Catalytic vs Thermal

Feed Type	UoM	High Ash Coal (40%)		Agro-Biomass	
		Thermal	Catalytic	Thermal	Catalytic
Process	-	Thermal	Catalytic	Thermal	Catalytic
Temperature / Pressure	°C / bar	1500/45	≤ 780/≤ 4	1500/45	≤ 750/≤ 4
Feed rate (1 MMTPA)	TPH	122.2	122.2	122.2	122.2
H ₂ / CO	mole ratio	0.63	>3	0.63	>4
Syngas Calorific Value	Kcal/kg	2917	3671	2870	3630
Cold Gas Efficiency	%	<65	85.3	<60	76.6
Cash Cost for Power	\$/mmBTU	A+2	A	A+2	A
CAPEX for Power	\$M	Y1	Y1 * 0.48	Y2	Y 2* 0.48
Cash Cost (\$ / T of MeOH equivalent syngas)	\$/T MeOH	B1	B1*0.52	B2	B2*0.59
CAPEX (MeOH)	TPH	Z1	Z1*0.64	Z2	Z2*0.64
Pay back (MeOH)	Tons / T of Feed	7.5	2.6	8.1	3.3

**Catalytic Gasification Economics much better = Renewable H₂ rich Syn Gas
250 MT/yr. Biomass = 60 MT/yr of Syncrude**

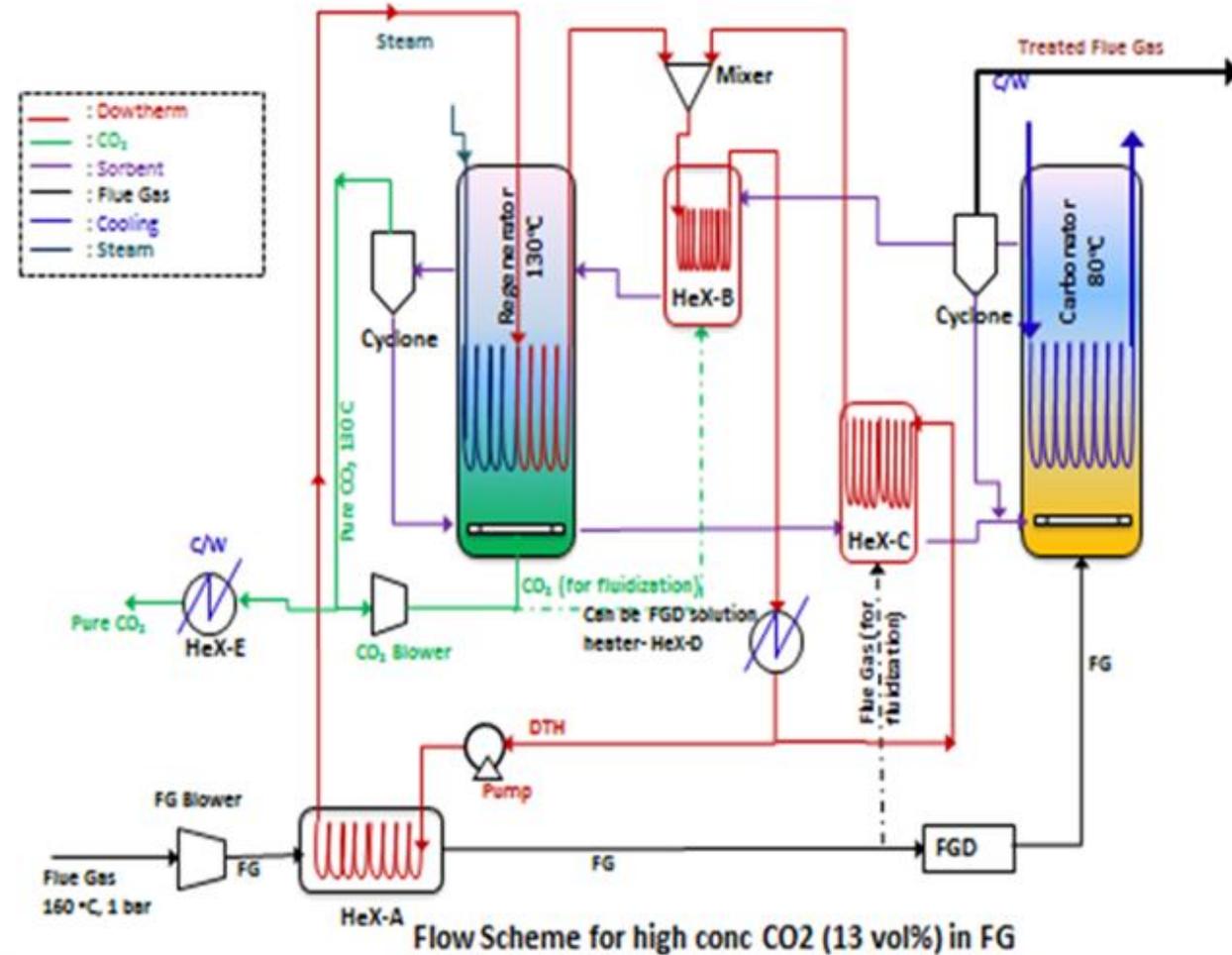
RIL Hydrated Sorbent CO₂ Capture Process

Objective:

- Development of hydrated sorbent process to capture CO₂ from refinery flue gases with min. capex and energy consumption.

Technology Description & Advantages:

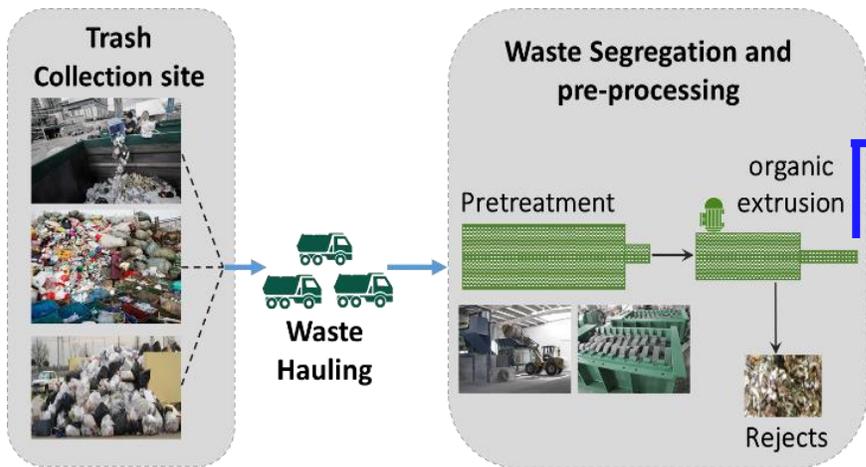
- Adsorption based technology using a novel highly stable solid sorbent in circulating fluid bed reactor.
- Completed pilot scale studies in circulating dual fluidized bed system and Achieved single pass >90% CO₂ removal efficiency.
- Filed 5 patents, completed design package and established linkage with CO₂ Utilization technologies.



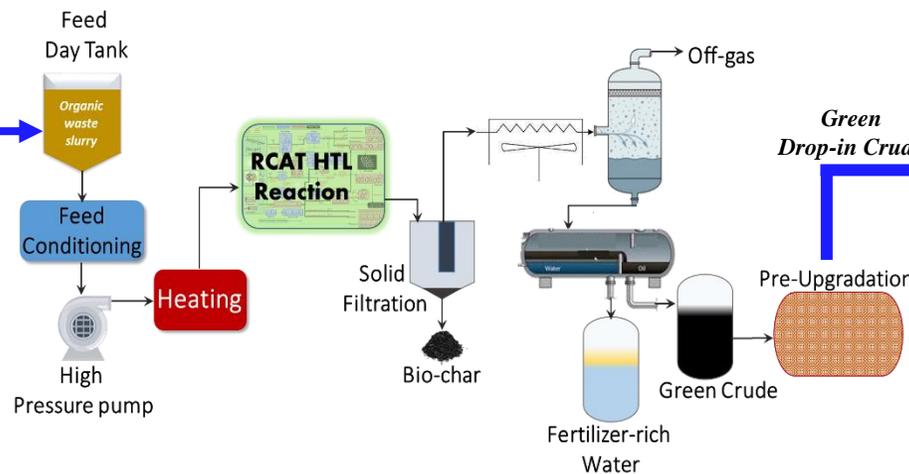
RIL Process is 70% Lower Capex and 40% Lower Opex than Conventional Amine Route

RCAT-HTL for Bio-crude & Biofuels : Waste to Wealth

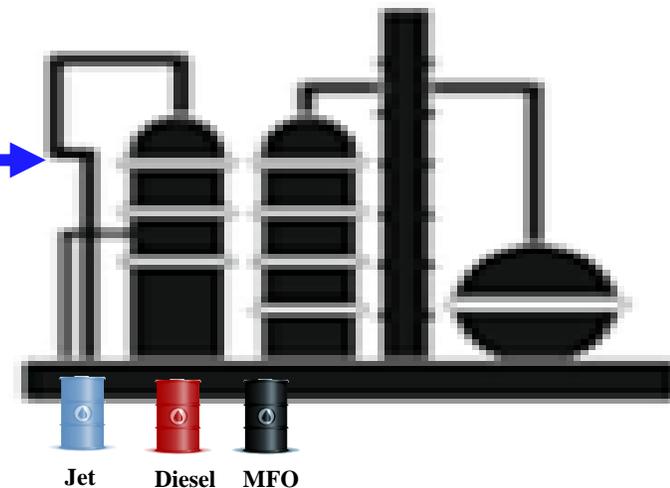
Waste Collection and Processing



RCAT-HTL



Existing Refinery Infrastructure



Handles any Organic Waste Feed Flexible Technology

(Agro waste, MSW organics, food waste, food processing waste, manure, bio-solids, ETP sludge, industrial waste, mixed non-recyclable plastics, automobile waste tyres)

❑ Energy Efficient :

Uses water in waste as a reactant and recovers fertilizer-rich water. No need of drying wet waste

❑ Drop-in Renewable Crude as Product :

Energy-dense liquid crude, compatible with petroleum crude. Can be processed in existing refining infrastructure. No change required in engine technology

Replaces fossil crude and produces climate friendly transportation fuels



❑ 70 MMTPA Bio-waste in India= 20 MMTPA Biocrude

Green Solution to World's Growing Energy Demand Using Waste as a Resource

Biomass Conversion Options

Basis : 165,000 T / Yr (500 TPD dry) Paddy Straw as feed

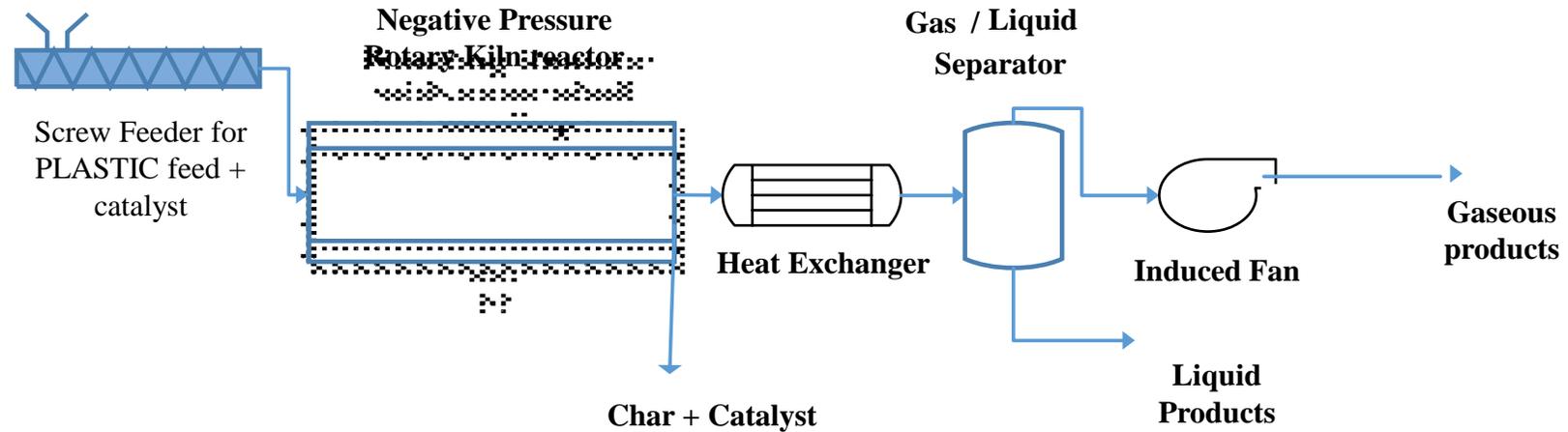
	Bio-CNG	2G Bio-Ethanol *	3G Bioethanol Cat Gasification + Syn gas conversion	RCAT-HTL
Feed	Wet	Wet	Dry	Wet / MSW
Products	BioCNG, 79% Residue	EtOH, Gas, 60% Residue	EtOH, no residue., CO₂	Bio-crude (1650 bbl/d), 75% C conv
Main product (in kg) / MT of feed	133	160-198	448	500
Capex, M\$	0.3B	B	2B	0.9B
Net Profit, M\$ / year	X	- 0.5X	4X	3X
Payback, year	2.6	subsidy	4.47	3.1

* Prelim Techno economic evaluation of 2G Ethanol with co-products from Rice straw -

+ P. Ranglanathan, Biomass Conversion and Bio-refinery 2020

Circular Economy : RIL's Continuous Catalytic Pyrolysis for Waste Plastic / Agri biomass to Stable oil to Virgin Plastic / Chemicals

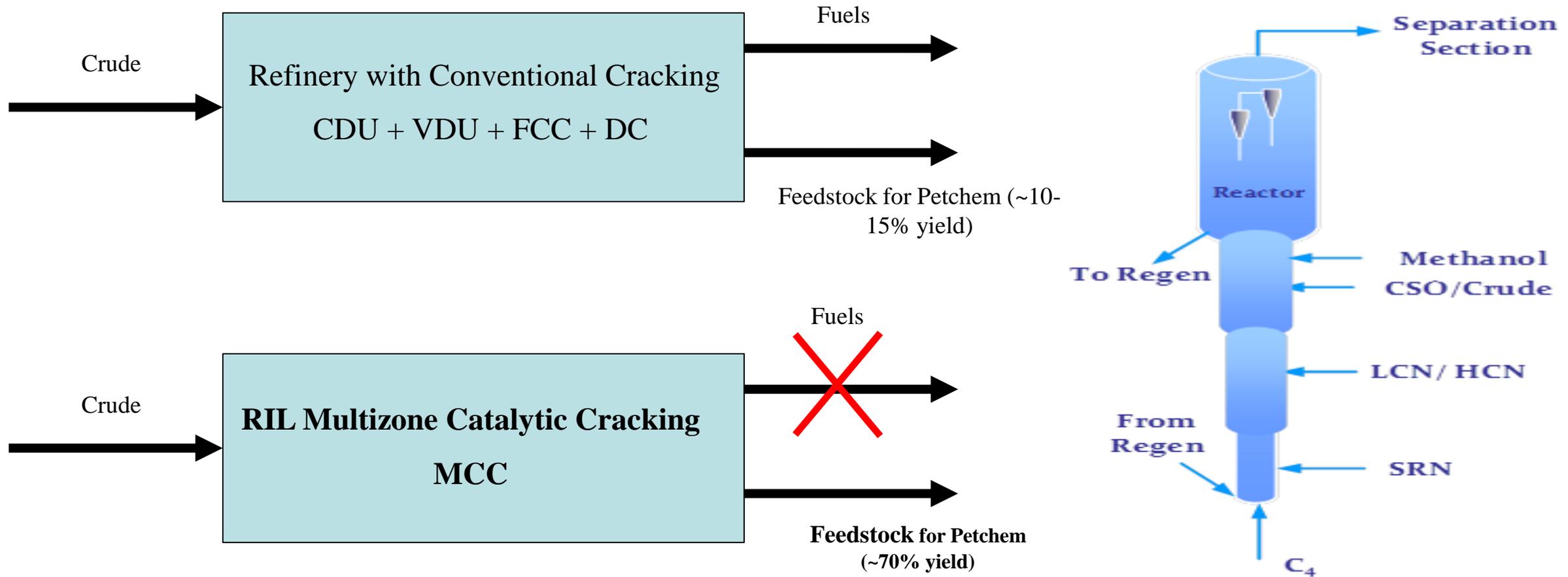
- * **Mixed plastic as feed, even wet + organics + soil**
- **25 T/D each module**
- **Stable liquid product : 80% yield**



- Mixed waste plastic feed e.g., PP, LDPE, HDPE, PS , PVC etc
- Stable liquid product with high yield(>80 wt%) and lower char+ gas yield
- Cheap, regenerable , heterogeneous catalyst helps to reduce reactor temperature by 50^o C, while maintaining smooth operation without coking/choking
- Install multiple modules near landfill, transport pyoil to nearest refinery for further processing in FCC or MCC type unit => Cyclic Plastic Economy
- 60% circularity from waste to virgin plastic

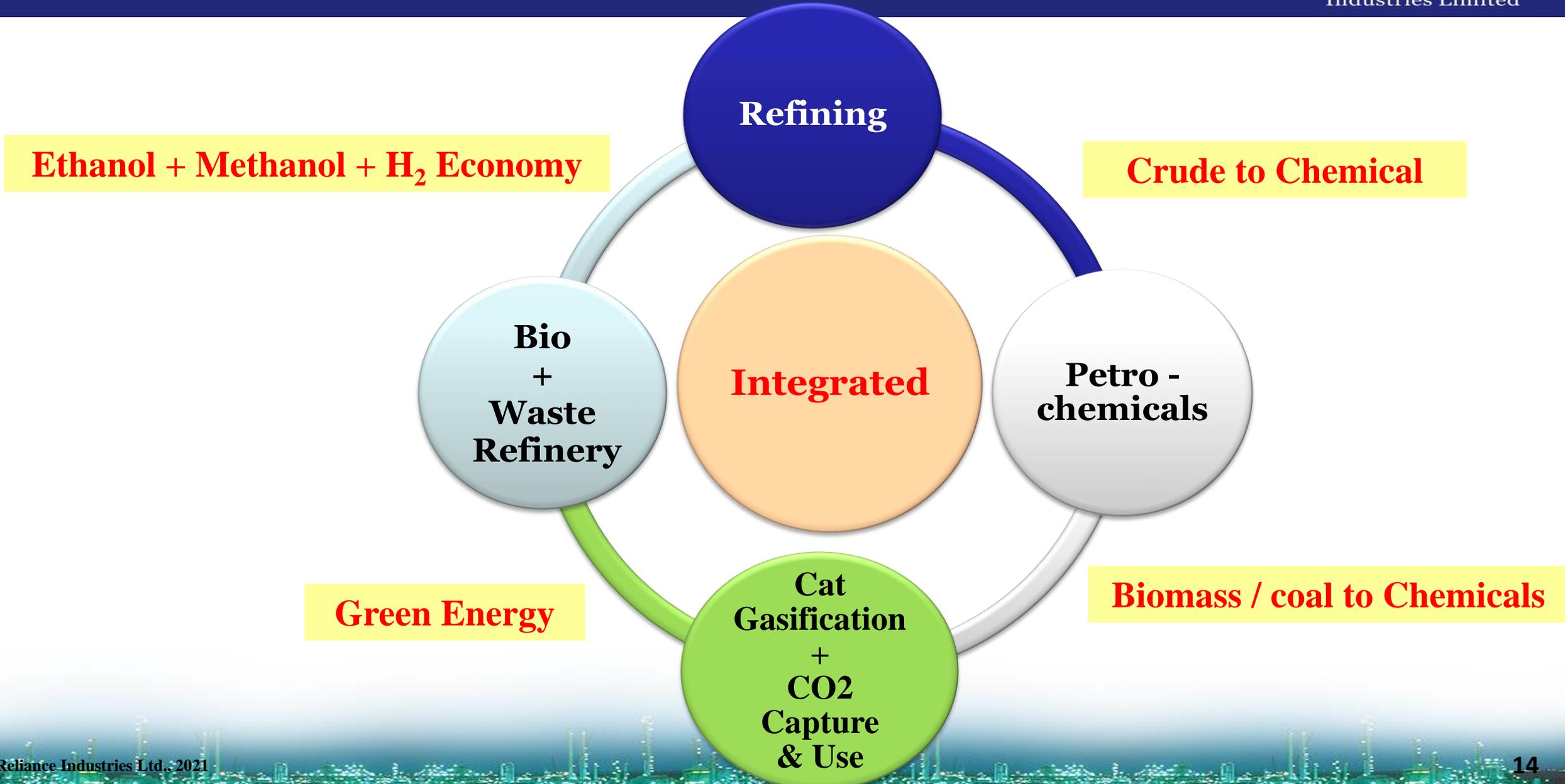
RIL's MCC + waste plastic process can produce sustainable cyclic plastic economy

RIL's Multi Zone Catalytic Cracking (MCC) – Crude / Low Value Feed, Waste Plastic / Biomass Cat Py Oil to Chemicals



MCC = Single step Crude to Chemicals, 70% yield & No Fuel
2 Zone SEZ FCC = Commercialized in 2012
Multizone MCC = First plant planned

Summary – Future Refinery



- **To establish a National Demonstration Centre for Energy & Chemicals**
- **Technology Development till pilot scale: By all R&D + Academic Inst.**
- **Faster commercialization of innovative technologies by Industry**

Mission – Sustainable Energy & Chemicals in India by 2030



THANK YOU