

Biotechnology and Renewable Chemicals: The Future is Now

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Critical Observations.....



- **Over 98 % of all Compounds in nature are Carbon Based**
- **Developments in Organic Chemistry, Catalysis & Chemical Engg has invented newer ways for producing Chemicals**
- **Petroleum Refining has enabled various cost competitive routes to produce Bulk & Specialty Chemicals over last 100 yrs**
- **Over 70,000 Chemicals are produced each year**

However,

- **Petroleum Raw material resources are limited**
- **Human Needs and Environmental issues are Colliding**
- **Planet Earth Challenged by Critical Risks like Climate Change**

Is it time to look into future and revisit Biobased products ?



1. Overdependence on Fossil Raw Materials

- Feed Stock prices are volatile
- Inability to pass price hike to customers
- Contracting Margins

2. Shift from Naptha to Natural Gas

- Cheaper C2 Chemicals
- Challenge is to run Naptha Crackers Cost effectively for C3/C4 Chemicals



3. Upcoming Regulatory Challenges

- Improvement of Carbon, Energy & Water Footprint to meet emerging Environmental mandates
- RFS 2 mandate (???)

4. Changing Customer Needs

- Novel Products
- Green Ecofriendly Products
- No Green Premium

Rise of Biobased Economy

Non Renewable

Renewable



Coal



Oil

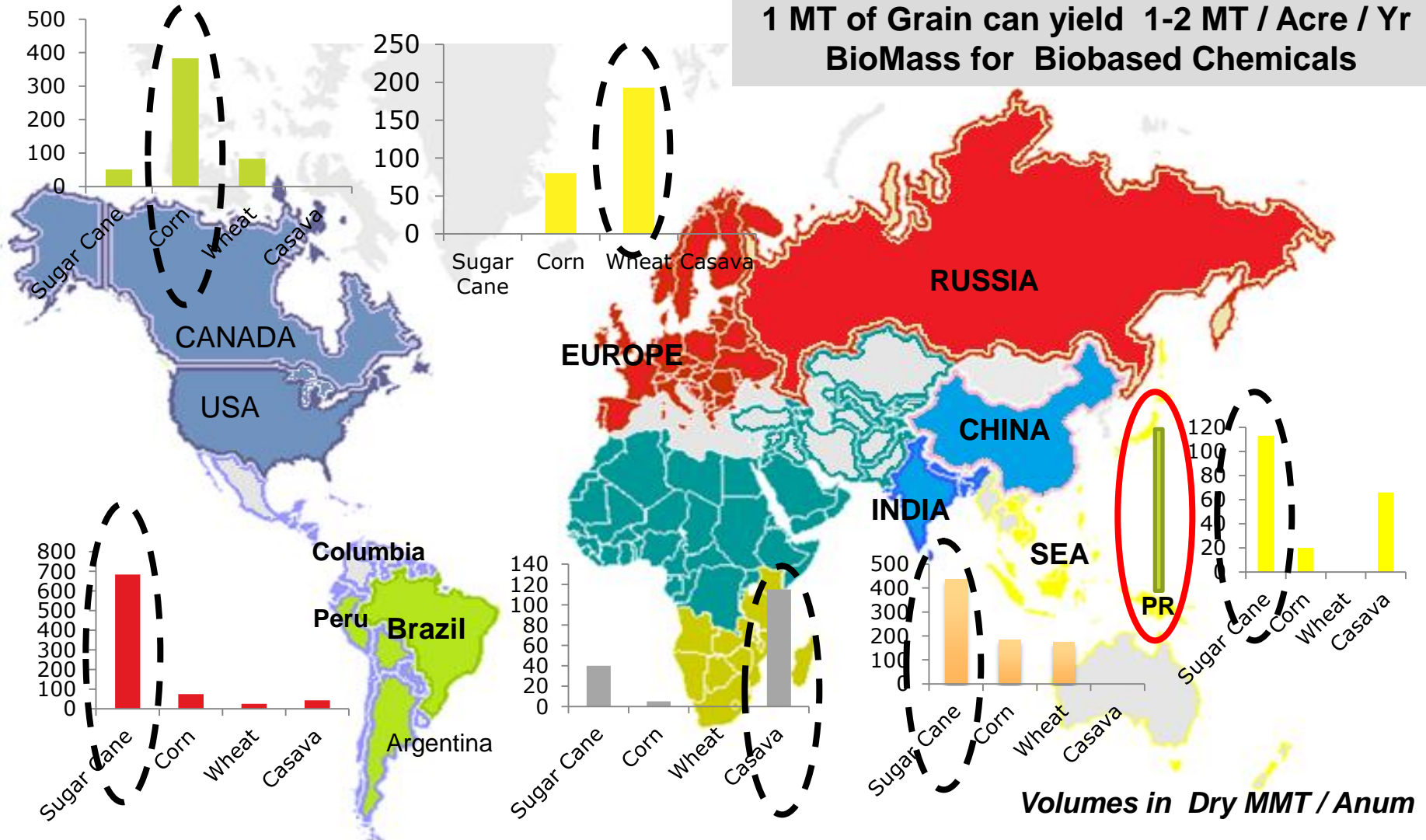


Biomass

**Witnessing Shift in Feed stocks
from Hydrocarbons to Carbohydrates**

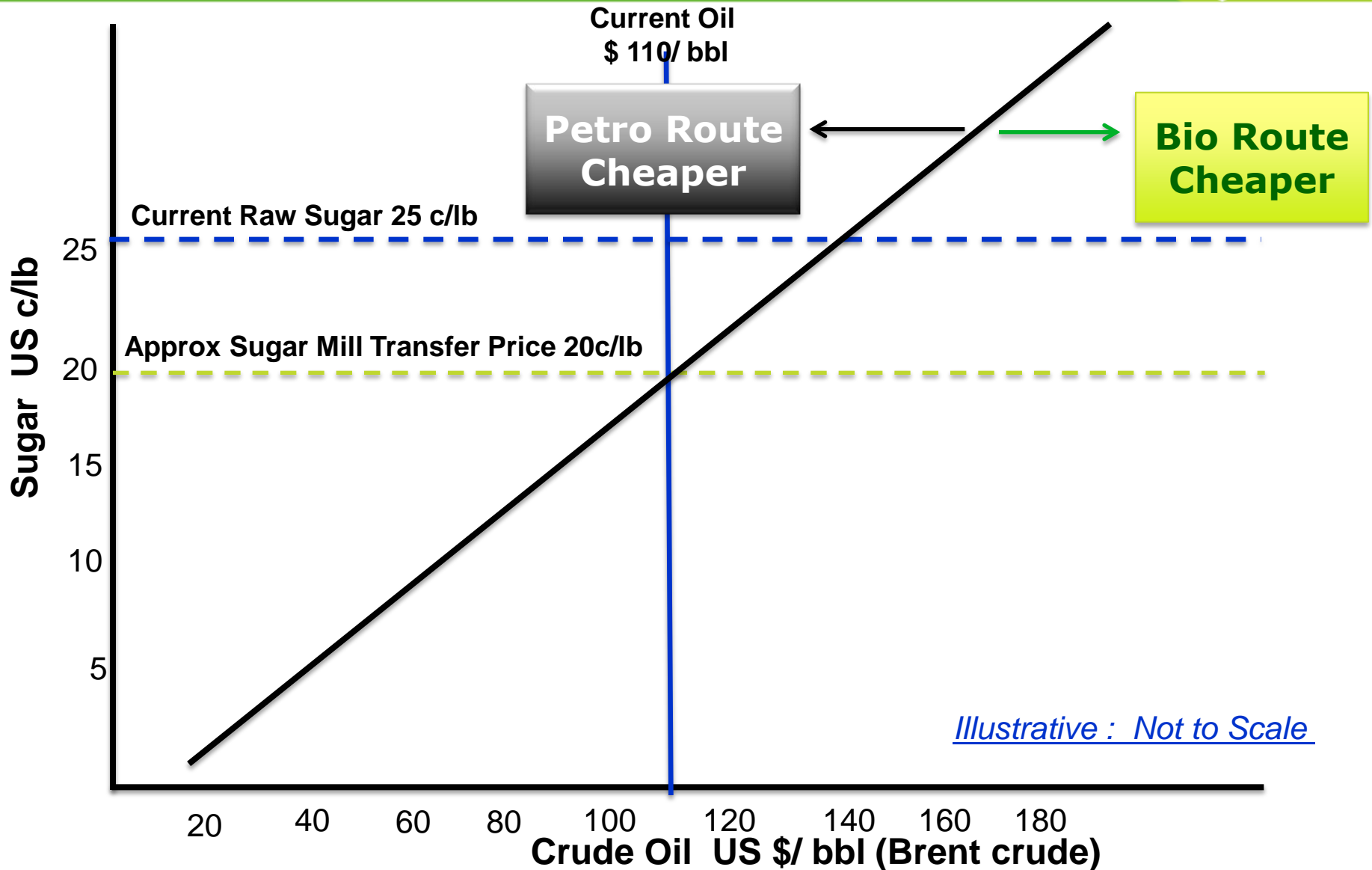
Carbohydrate Feed Stock Availability

1 MT of Grain can yield 1-2 MT / Acre / Yr
BioMass for Biobased Chemicals



Carbohydrate Feedstock is Abundant Globally

Oil Price Vs Sugar Price



Renewable Chemicals - Why Now ?



1. Rising Prices of Fossil Feedstock

Crude Oil > 100 US \$/bbl

2. Uncertainties of Supply

Geo Political Unrest

3. Cleaner Less Expensive Process

1,3-Propane Diol

4. New Products

PLA, PHA, Ketals Commercial

5. New Value Chain Players

Enzyme, Microbes, Process

6. Market Pull from FMCG Players

Coke, Pepsi, Toyota, P&G

7. Environmental Awareness

High Effort to Reduce CO₂

8. Government Support

Country wise Mandates

BioRefining: The Concept

Feedstock

Sugar

- Cane Juice / Syrup
- Molasses

Starch

- Corn, Wheat
- Sorghum
- Cassava

Cellulosic

- C5 Sugars
- C6 Sugars

Oils

- Veg / Castor Oil

Algae

- Carbohydrates
- Oils

Processing

BioChemical

- Yeast, Bacterial, Fungal
- Aerobic, Anaerobic
- Solid State/ Submerged
- Enzymatic
- Downstream Processing

Chemical

- Extraction
- Catalytic
- Downstream Processing

Products

Fuels

- EtOH, BuOH
- Drop-In Fuels
- Next Gen

Chemicals

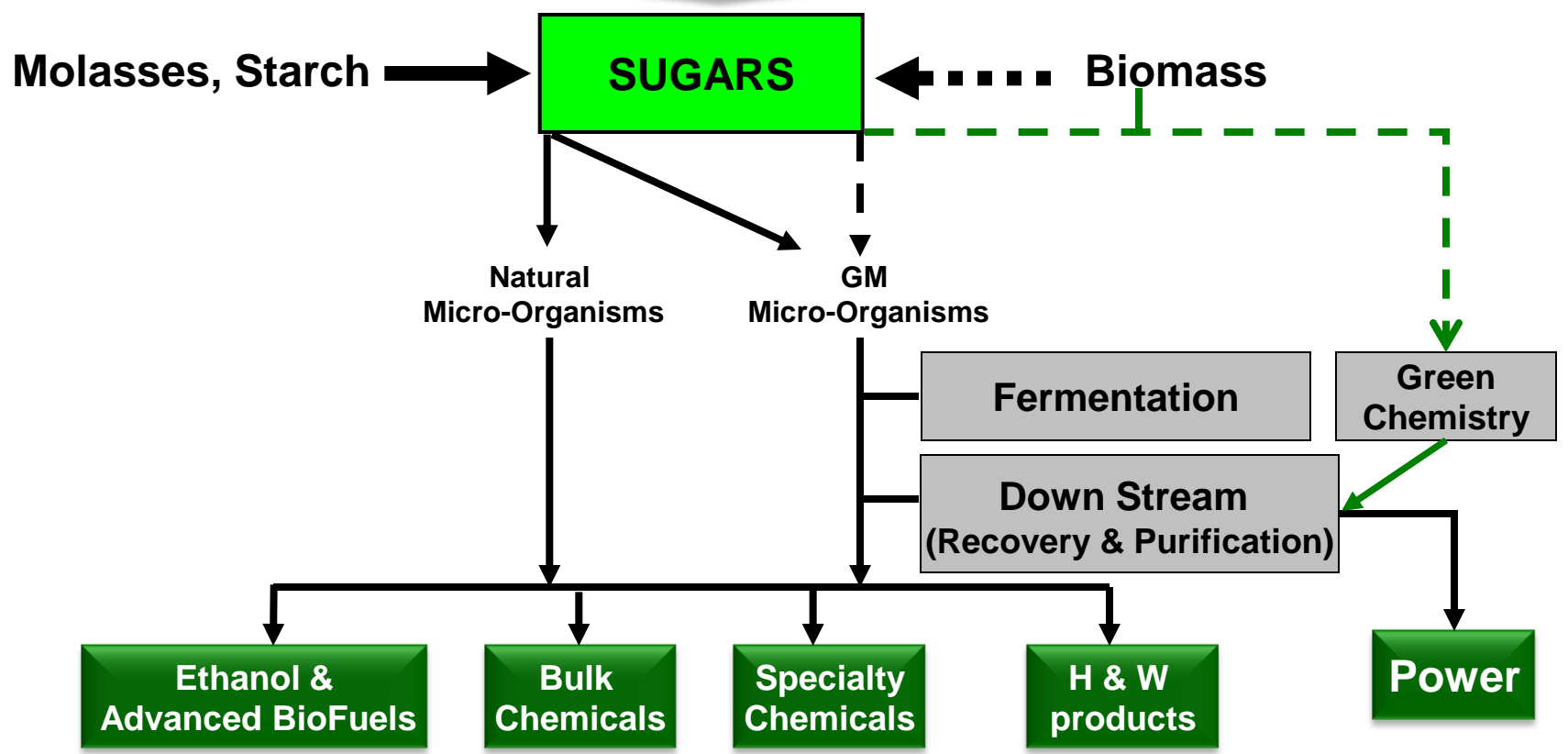
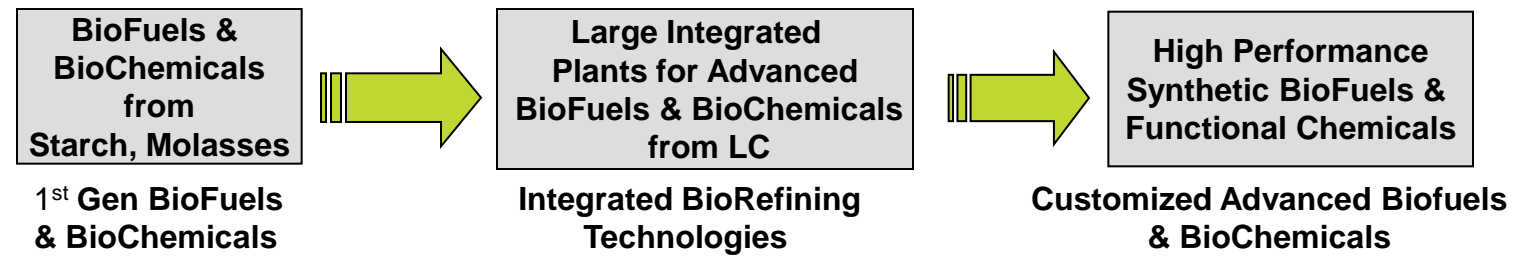
- Furfural / Derivative
- Organic Acids
- Furanics
- PG, BDO, PDO,
- MEK, Isoprene
- Specialty Chem.
- Oleochemicals
- Polymers

- Human Food
- Animal Feed

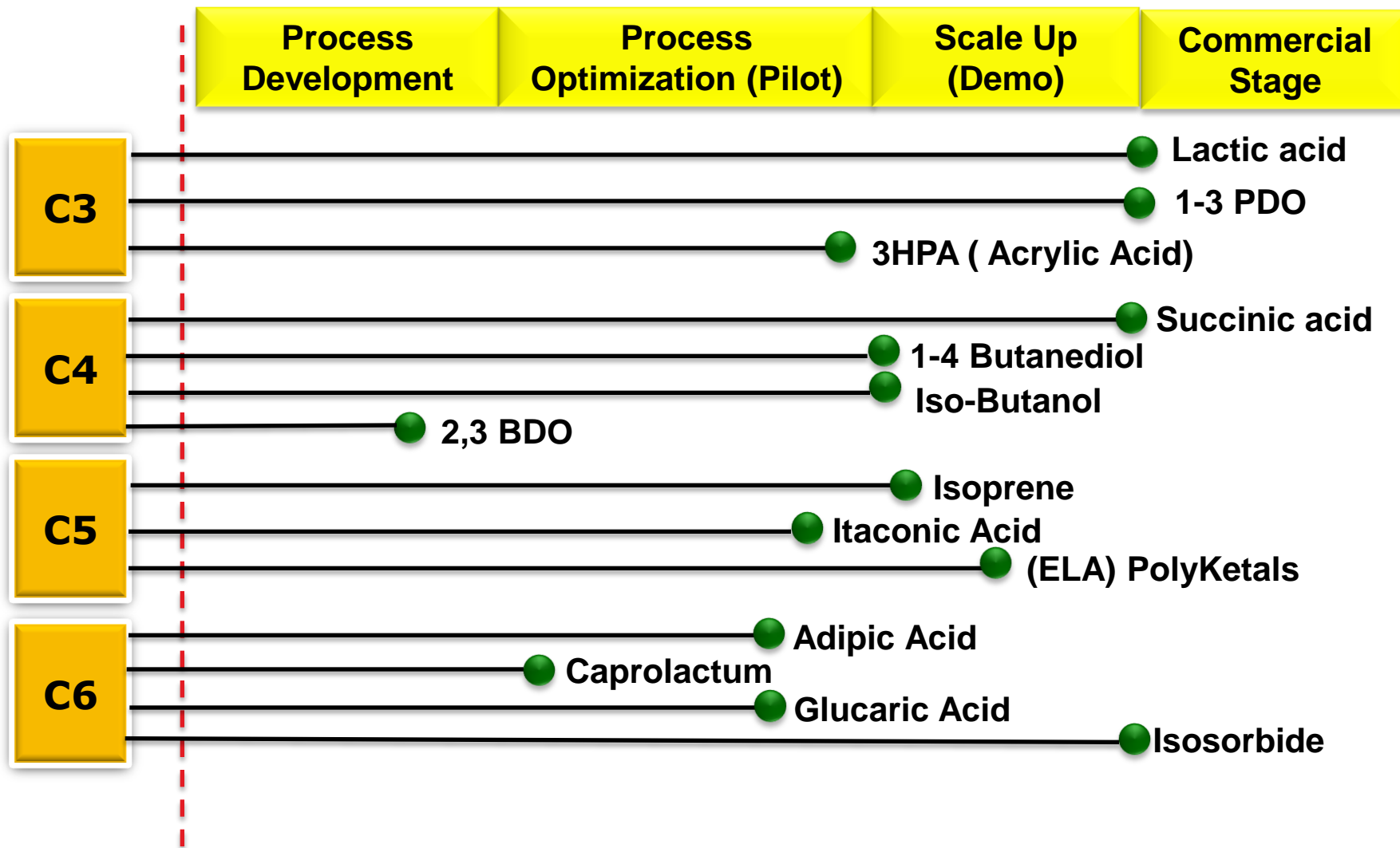
Power / Steam

Multi feed, Multiproduct Smart Biorefineries

Bio-Refinery Models Evolution



Future is Happening Now !



Bio Refineries – Key Considerations

- **Feedstock**
 - Price Volatility
 - Seasonality
 - Availability
- **Process**
 - Rate, Titer, Yield, Selectivity, Recovery
 - Capex, Opex
 - Scalability, Complexity, Flexibility
- **Product**
 - Performance
 - Price Volatility
 - Oil Price
 - Applications: Drop-In versus Replacement
- **“Green”**
 - Energy, CO₂, Land, Water



CATALYSIS

- Proven for Bulk Chem
- Lower uncertainties
- Higher yields
- Scalable Operations
- Existing Assets

Challenges

- Novel Catalysts
- Byproducts formation
- Minimum Economic Size

BIOTECHNOLOGY

- Higher Specificity
- Novel Products
- Lower effluent issues
- Lower Min Economic Size

Challenges

- Novel Microbes
- RM & Product Toxicity
- Scalability Challenges
- New Investments

Integration of Multi Technology Platforms Possible



**Multi feed, Multiproduct
“ Smart Biorefineries ” will Win !**

Regional Story : INDIA

Rich Biodiversity

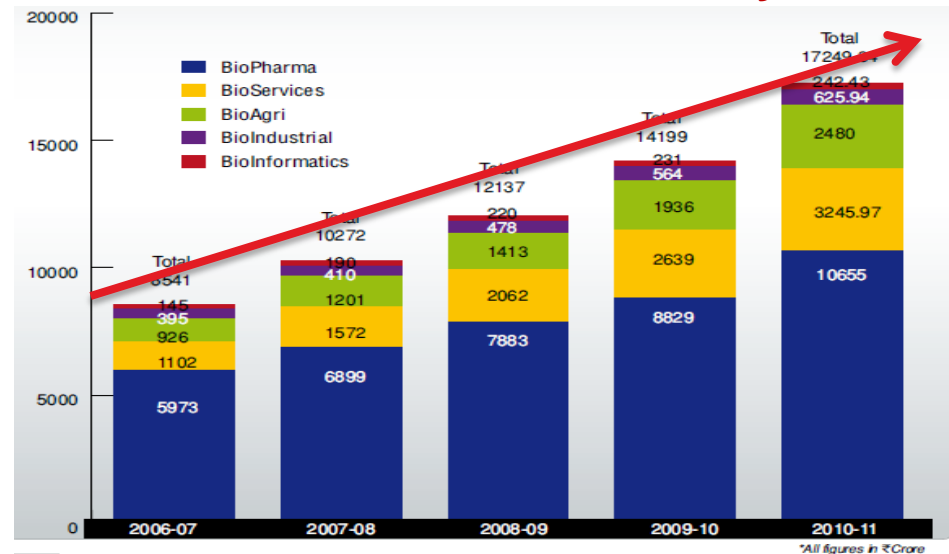
- 45,000 different plant species
- 16 different agro climatic zones
- 10 vegetative zones
- 426 habitats of specific species
- 30 million micro-organisms
- 23,000 fungi, 2,500 algae

Access to Agricultural Biomass

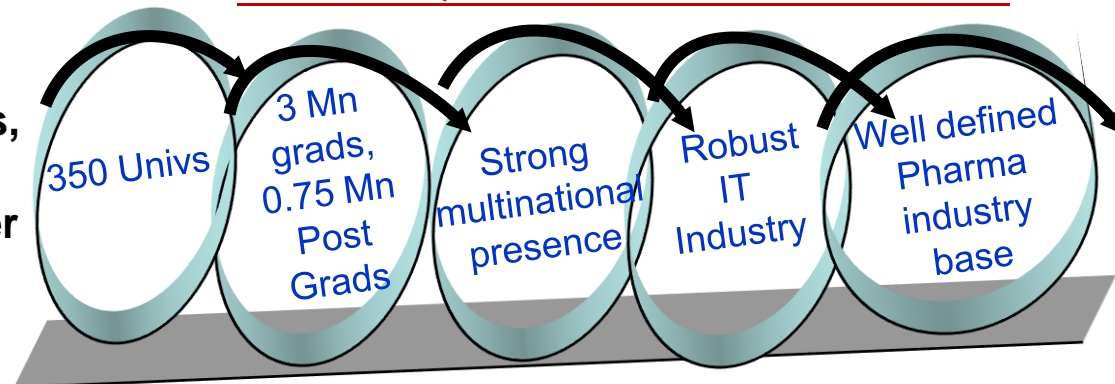
- ✓ Approx 125 Mn ha Agricultural Land
- ✓ 130-200 Mn tpy Surplus Biomass (Rice, Wheat Straws, Cotton Stalks, Oilseed residues, Pulse residues, Sugarcane tops / trash, Pulp/Paper Wood, Forest Wood)

Large Consumer Markets

US \$ 4 Bn Biotech Industry



Pool of Qualified Human resource



Indian BioTech Clusters

- Gennova (Emcure)
- Serum Institute
- Sci-gen
- Advinus
- Tata Chemicals
- Battelle India
- Acoris (HIKAL)
- Venkateshwara Group
- **Praj Industries Ltd.**
- Hijewadi Biotech Park

- National Chemical Laboratory
- National Center for Cell Sciences
- National Institute of Virology
- Institute of Bioinformatics and Biotechnology
- Pune University



INDIA Strategic Advantage

Reverse Innovation



Shifting Trends in MNC R&D Strategy in India



- Capturing Opportunities in Emerging Markets Need Innovations Directed to local needs
- International Collaborations are key to Rapid Commercialization, Globally.
- Indian Companies are launching Global Strategies based on these innovation.

From India For the World



Thank you !

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