

# DuPont: Initiatives on next generation biofuels

Dr. Wilson Andalécio Araujo  
Biofuels Technology Manager LA  
DuPont Applied BioSciences – Biofuels

## ***1st Brazil-U.S. Biofuels Short Course***

**University of São Paulo – São Paulo - Brazil**

**Conversion Technologies Panel Discussion**

**August 4th, 2009**



TECHNOLOGY THAT *Fuels*™



*The miracles of science™*

# Vision

To be the world's **most dynamic** science company, creating sustainable **solutions essential** to a better, safer, healthier life for people everywhere.



# Mission

**Sustainable Growth:** Increasing **shareholder** and **societal** value **decreasing** our environmental footprint.



## DuPont Worldwide

- Founded in 1802
- Presence in more than 75 countries
- 60,000 employees

## Focus on Science

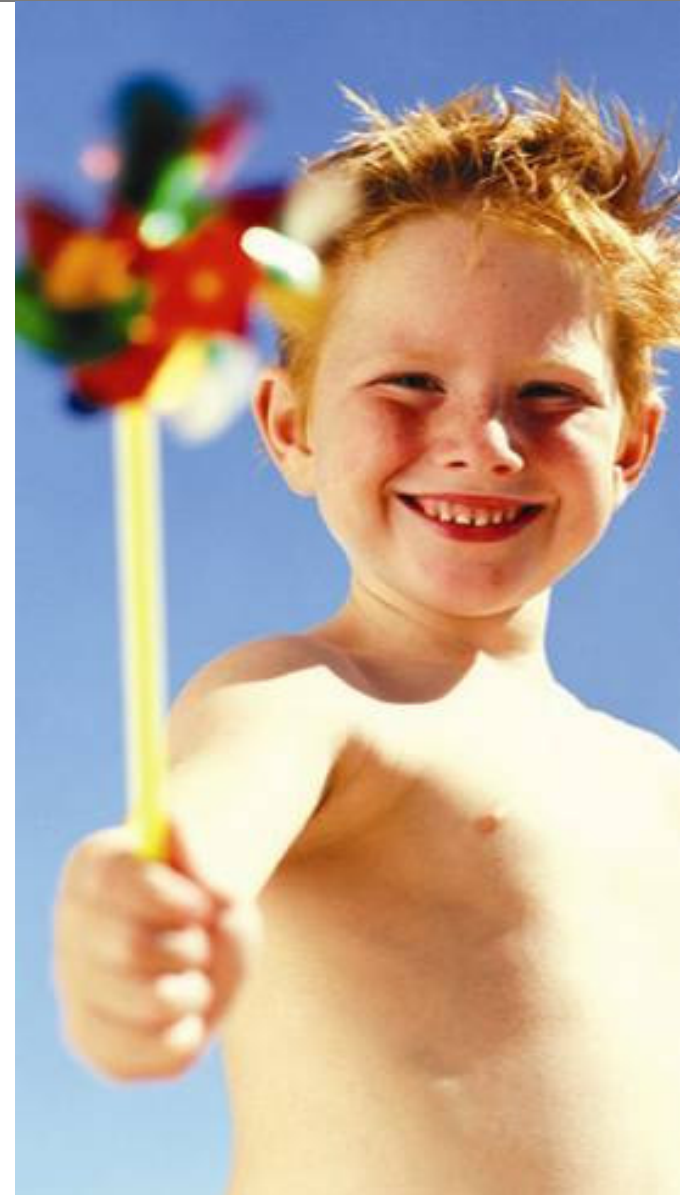
- More than 4,400 Scientists and Engineers
- Over US\$1.3 billion invested in Research & Development
- 34,000 patents since 1804
- 95 research and development laboratories around the world

## DuPont in Latin America

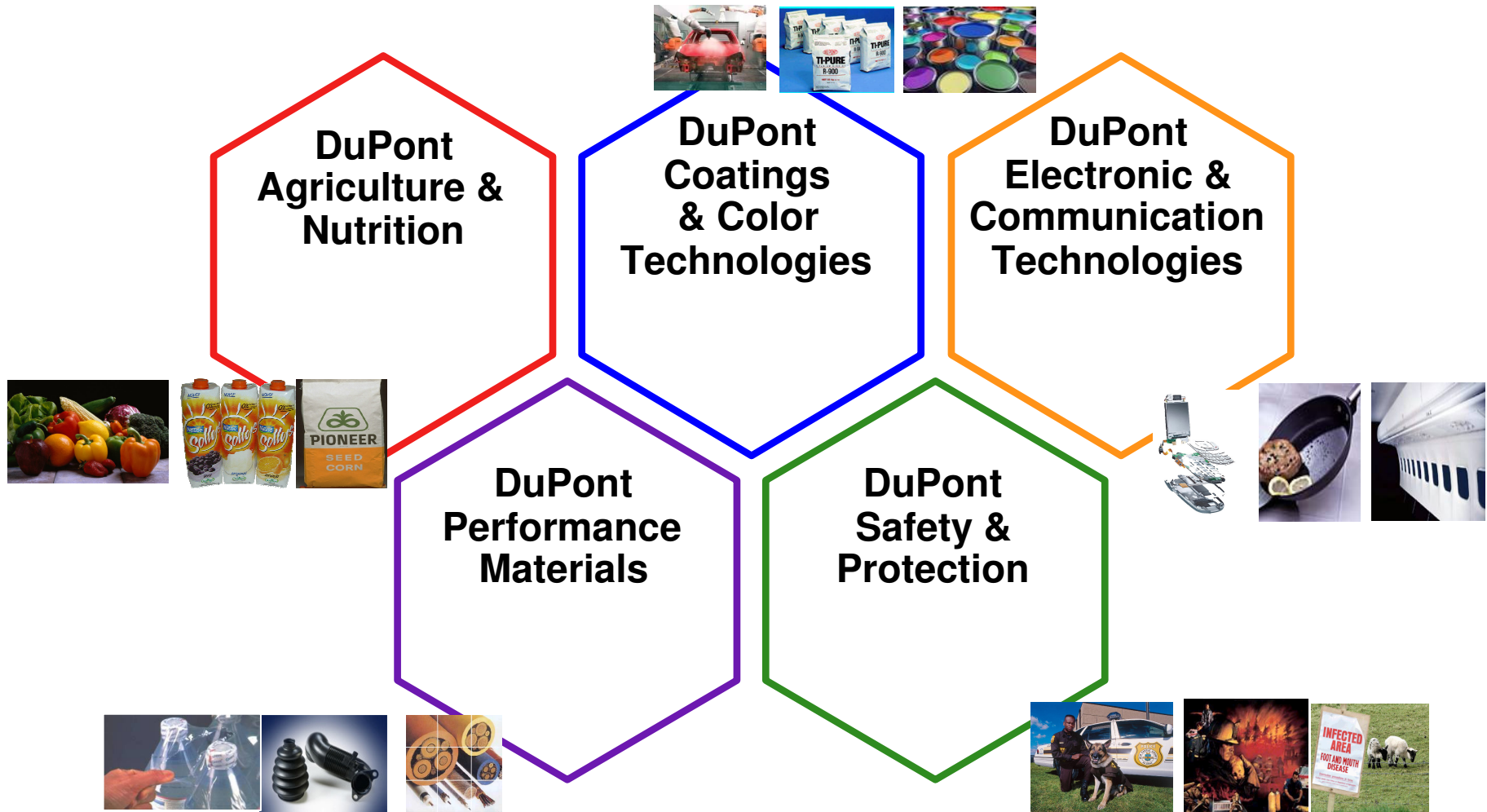
- Present in the region since 1925
- 5.400 employees
- Over 30 industrial plants
- 8 administrative offices

## Core Values

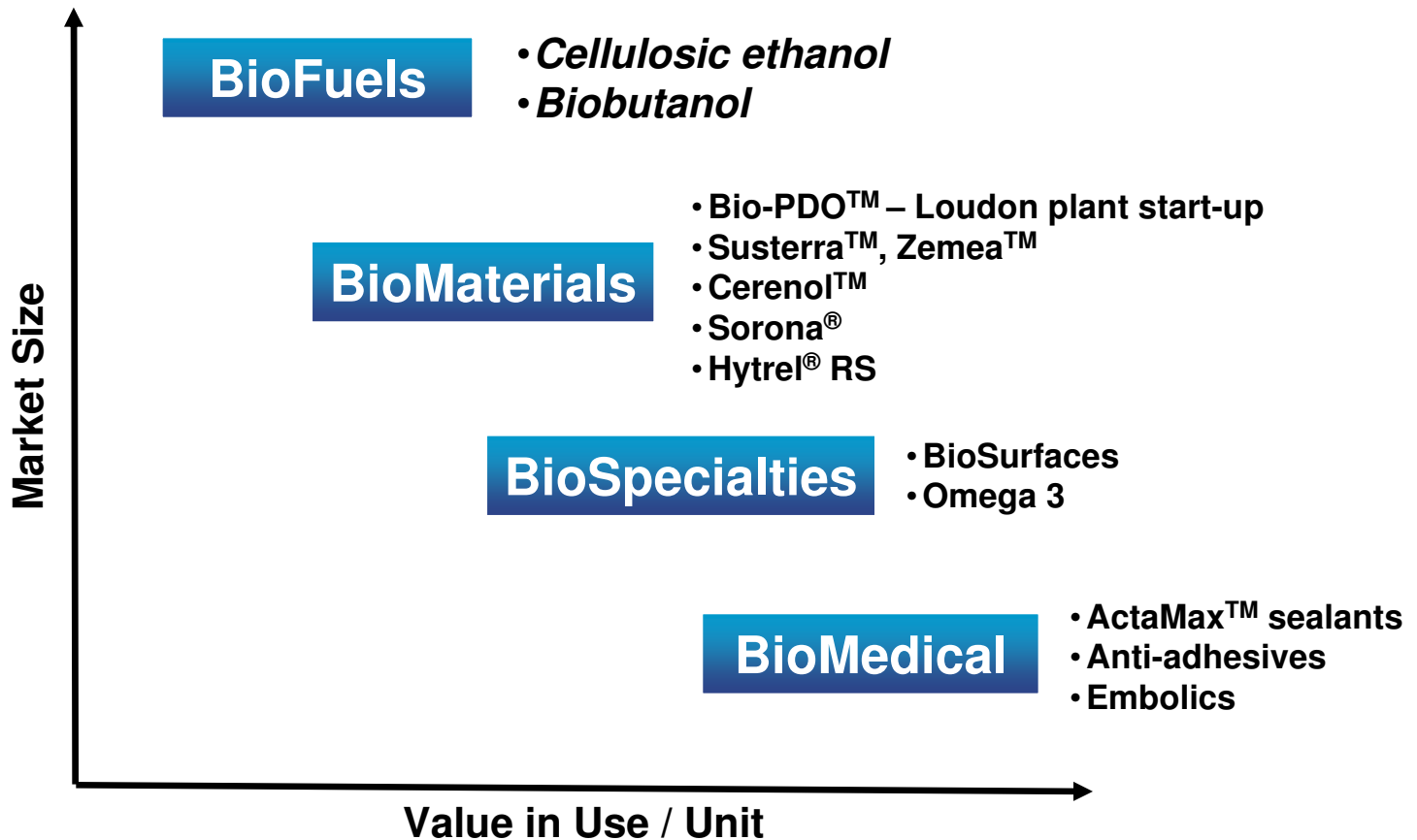
- Safety and Health
- Respect for people
- High Ethical Standards
- Environmental Stewardship



# Platforms



# DuPont Applied BioSciences™



**Unique, disruptive science with significant opportunity to capture above average return on investment**

Zemea™ and Susterra™ are trademarks of DuPont Tate & Lyle Bio Products Company LLC, a joint venture company of DuPont and Tate & Lyle



## Technology Innovation Center – LA R&D efforts



## Paulínia (TIC) – Brazil

“Surveys on strategic alliances - research centers and universities - part of the agenda”

### Laboratory for Physical Chemical analysis



### Laboratory for Ballistic analysis



# One DuPont Approach – Sugar Cane Industry

## DuPont Chemical solutions

- Carbonation Microgel® - Sugar clarification
- Glyclean™ - Equipment Cleaning
- Fermasure™ - microbial contamination control in ethanol fermentation



## Crop Protection

- Herbicides, insecticide, ripener
- Services



## Performance Coatings

- MPS - Management system
- Industrial coating



## DuPont Safety Resources

- Safety Programs
- Consulting solutions



## DuPont Engineering University

- Project Management
- Technical trainings on engineering
- VIP – Value Improvement Practices

## Bio-Based Materials

- Successful startup at Loudon, TN
- New Bio-PDO™ applications
- Sorona® expansions



***The Dawn of Industrial Biotech***

# Emerging Energy Sources

*While the growing need for sustainable power must be met in different ways...*

- Wind Power
- Solar
- Fuel Cells
- Geothermal
- Biofuels



*Biomass is our only renewable source of **carbon-based** fuels and chemicals*

## Biofuels Global Market Perspective Drivers

Increasing demand  
for transport fuel

Increasing concern  
over environment

**Biofuels**

Increasing concern over  
security of supply

A growing market for  
the agriculture sector

# Biofuel imperatives

## Upstream



### Feedstock

Environmentally sustainable,  
low cost carbon sources

Adequate Regional Supply

## Downstream



### Supply Chain

Compatibility with existing  
Infrastructure



### Retail & Consumer

Uncompromised fuel performance

**Current biofuel solutions must be improved to meet future global needs**

# Cellulosic Ethanol (DuPont/Genencor)

Demonstration Plant – Vonore, Tennessee

- Joint investment including \$40.7 million from Tennessee
- Nameplate capacity 250kgal/yr
- On-line 4Q 2009
- Process development unit, pelletizer on site
- Applications lab/ support capability
- Focus on optimal US feedstocks: corn cob and switchgrass



**DDCE**  
DuPont Danisco Cellulosic Ethanol LLC

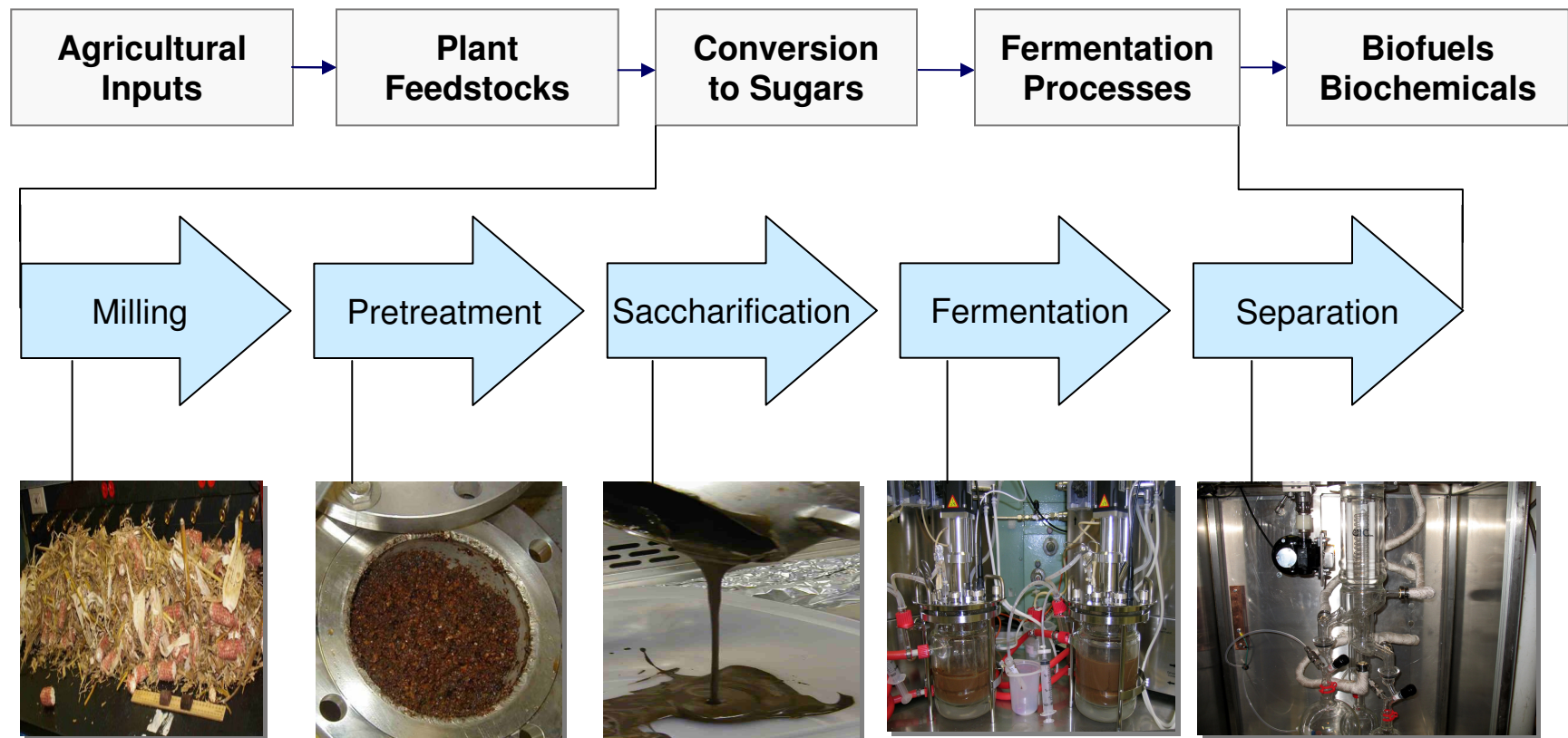
**Genera**  
energy

**BIOREFINERY PILOT PLANT**  
JANUARY 08, 2009

**GRESHAM**  
SMITH AND  
PARTNERS



## Required Operations for Cellulosic Ethanol Process



Integrated Science is paramount to success of venture

# The world's first robust, integrated solution for biomass-to-ethanol



Pretreatment

**DuPont**



Enzymatic hydrolysis



Mixed sugar ethanologen

**DuPont**

- Including:
- ▶ >\$100 million invested since 2000
  - ▶ DOE & NREL support & collaboration
  - ▶ Significant enabling patent estate
  - ▶ Demonstrated capabilities in scale up & design

# Biobutanol the Advanced Biofuel

## BP & DuPont announced June 2006



**RENEWABLE  
FEEDSTOCKS**



**DU PONT**

*The miracles of science™*



**WORLDWIDE  
FUEL MARKETS**



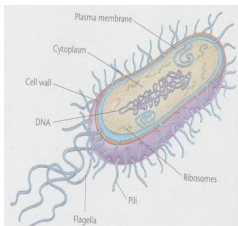
**biobutanol**

- Powerful partnership
- Shared commitment
- Global reach
- Complementary capabilities



# biobutanol

- **Economical parity with ethanol (\$/BTU)**



- **Improve butanol rate, titer, & yield**

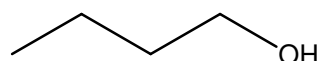
**....but with better value-in-use**

***DuPont / BP JV:***

**Butamax™  
Advanced  
Biofuels LLC**

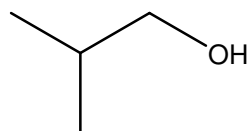


## Which butanol are we going to make?



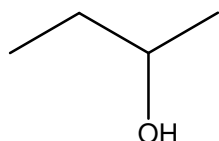
### **1-butanol**

“existing” technology (ABE fermentation)  
with known biological pathway



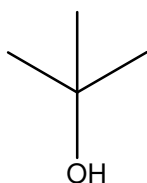
### **isobutanol**

feasible via combination of known biological pathways



### **2-butanol**

feasible via combination of known biological pathways

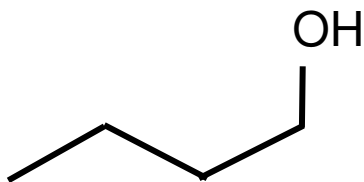


### **tertiary butanol**

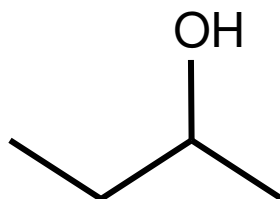
not easily made by any known biological route

## Isomers of Biobutanol

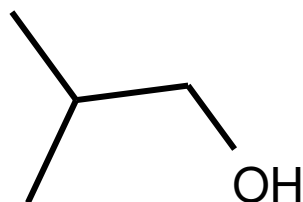
1-butanol



2-butanol



isobutanol

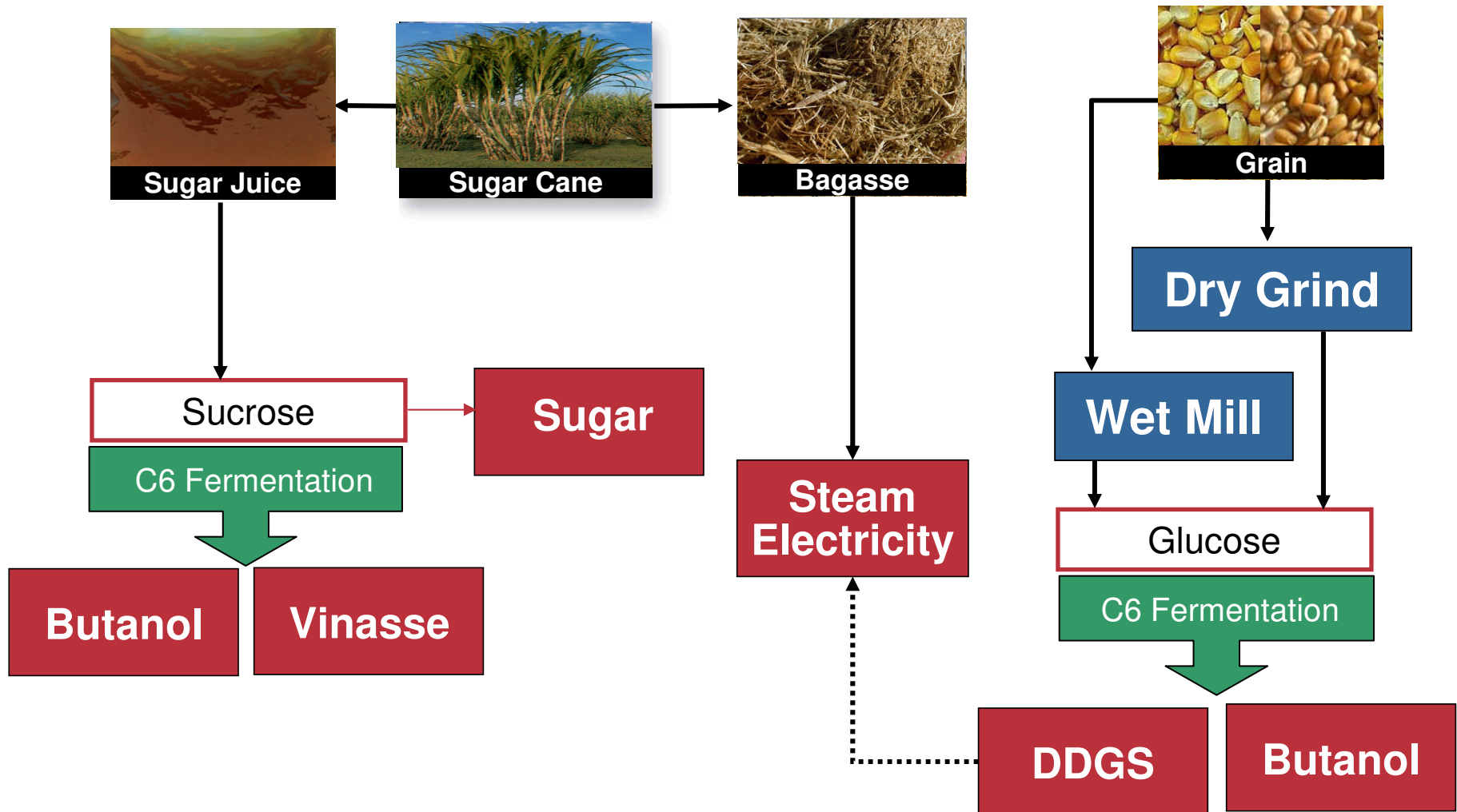


### All isomers have

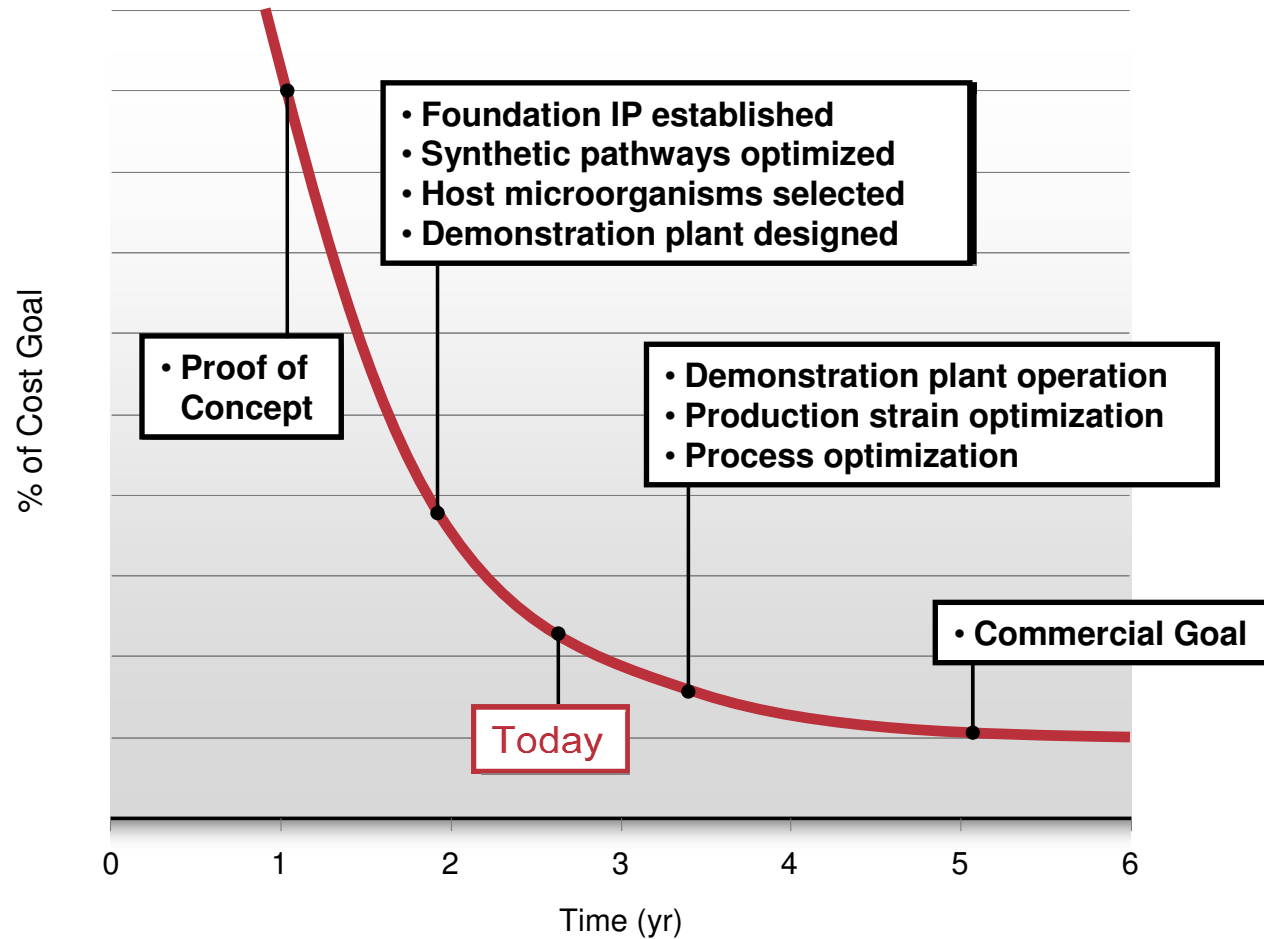
- High energy density
- Easy to handle and blend
- Compatible with existing vehicles

### 2-butanol & Isobutanol have higher octane

# Early Biobutanol Production



# Biobutanol Process Performance



## Metrics & Goals

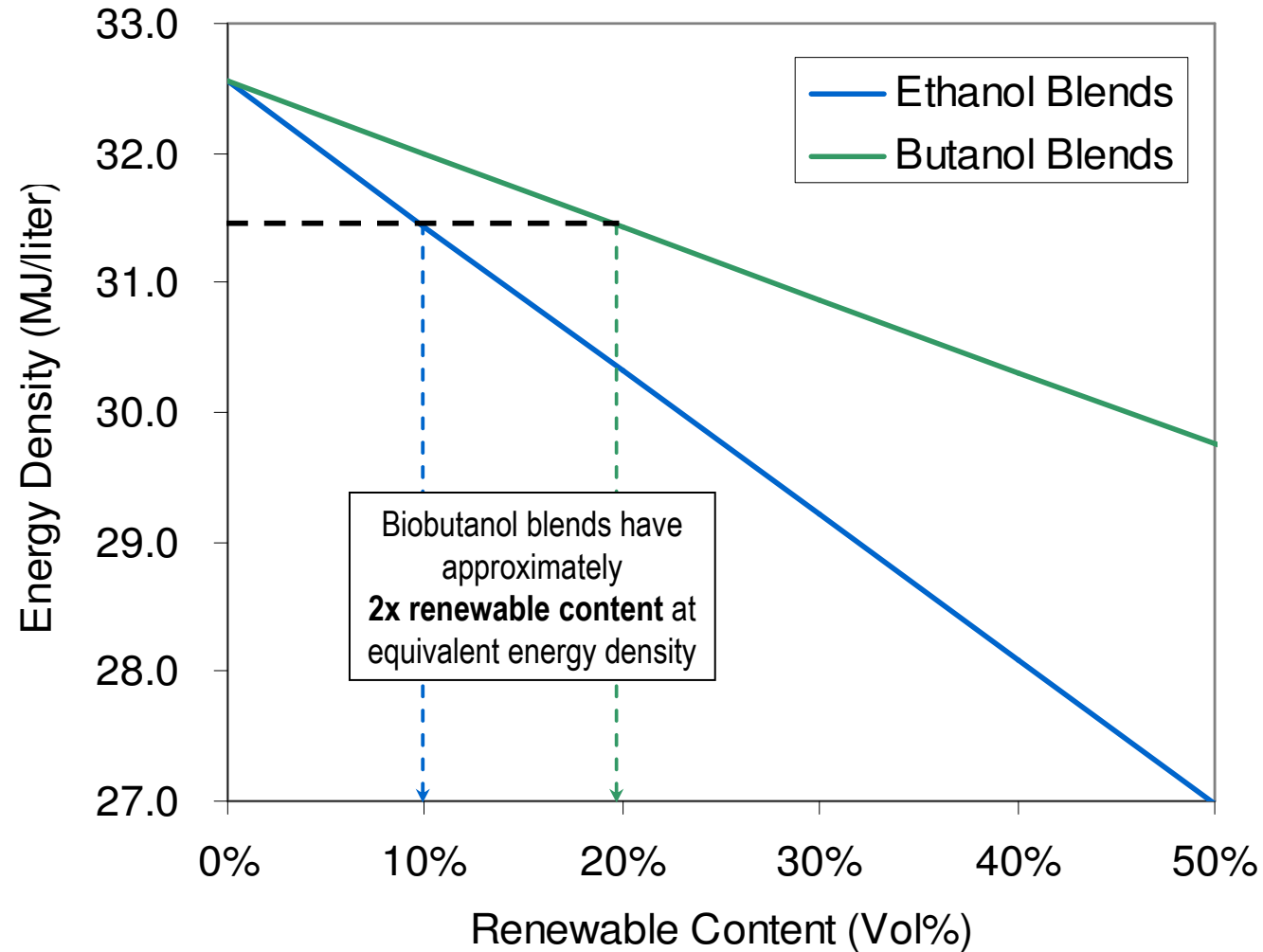
- 2007 – superior to ABE process
- 2010 – economics equivalent to ethanol

## Patents

- Over 70 patent applications
  - Biology
  - Fermentation process
  - Chemical conversion
  - End use applications

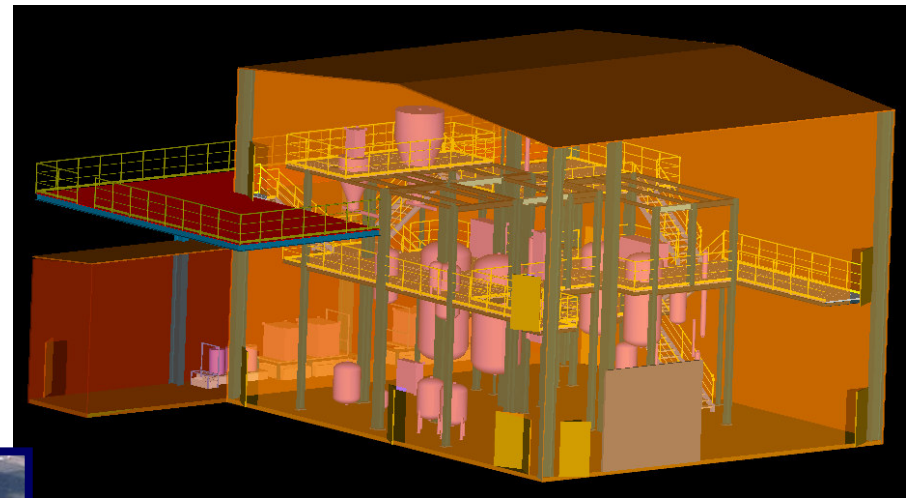


## Biobutanol Enables Higher Blend Levels



# Biobutanol Demonstration Plant

- **Biobutanol demonstration plant sited on existing BP site at Kingston upon Hull in UK**
- **Completion in 2009**



- **Accelerate availability of commercial technology for scale-up to 50-100MM GPY**
- **Same site as 110 MM GPY ethanol plant**

# OEM Engagement

## OEMs Engaged since 2006:

- Ford (Europe and US)
- Toyota (Japan, Europe and US)
- Volkswagen (Europe)
- BMW (Europe)
- Mazda (Japan)
- Honda (Europe and US)
- Daimler (Europe)
- GM (US)

## Comments / feedback:

- All very supportive and recognised Butanol as superior product
- CO2 footprint - same as Ethanol on energy basis
- Feedstock use – compatible with current and planned feedstocks
- Corrosiveness (dry and wet corrosion) - tested
- Driveability / Emission durability - tested
- Octane contribution - significant

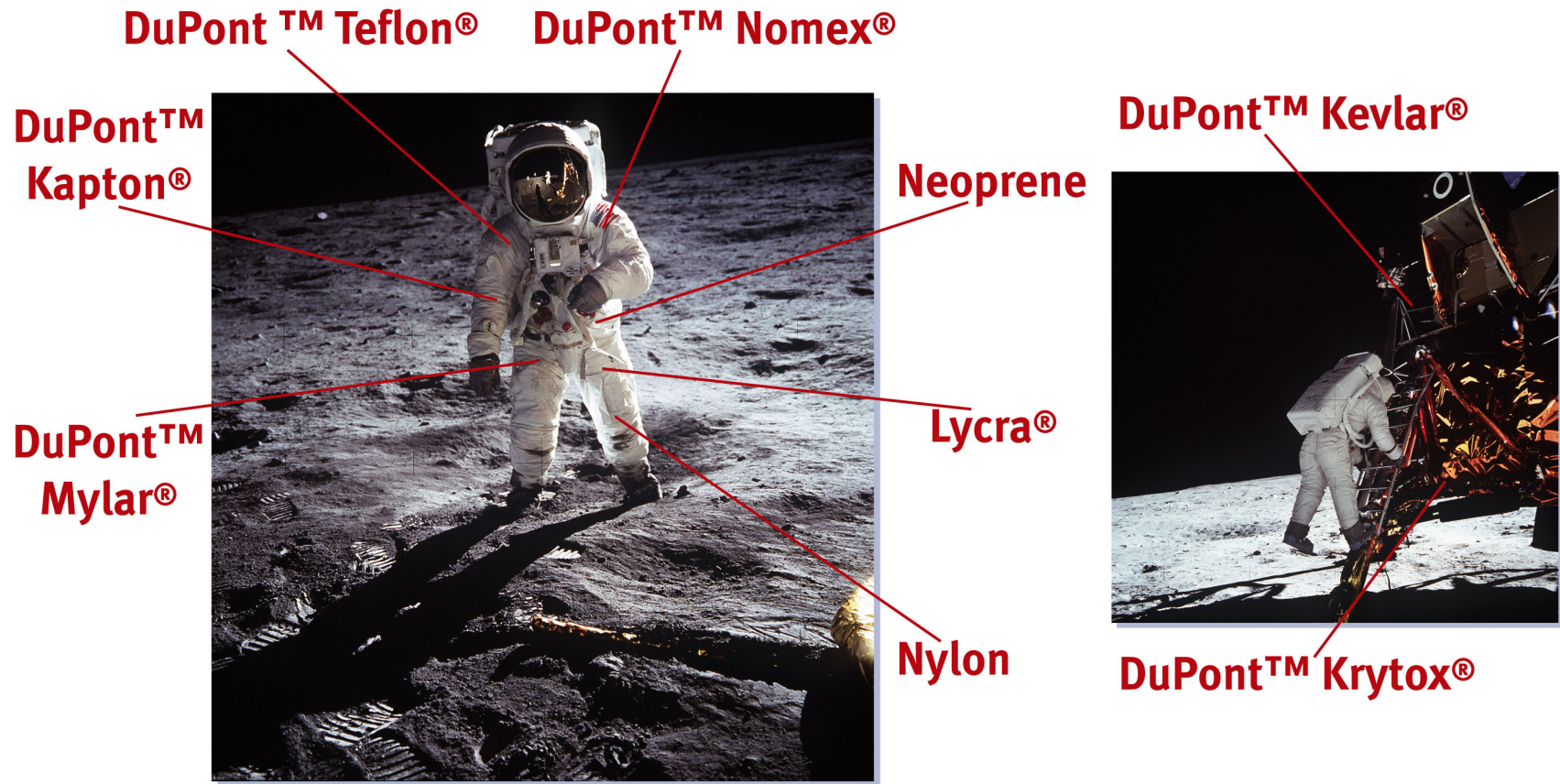


Audi

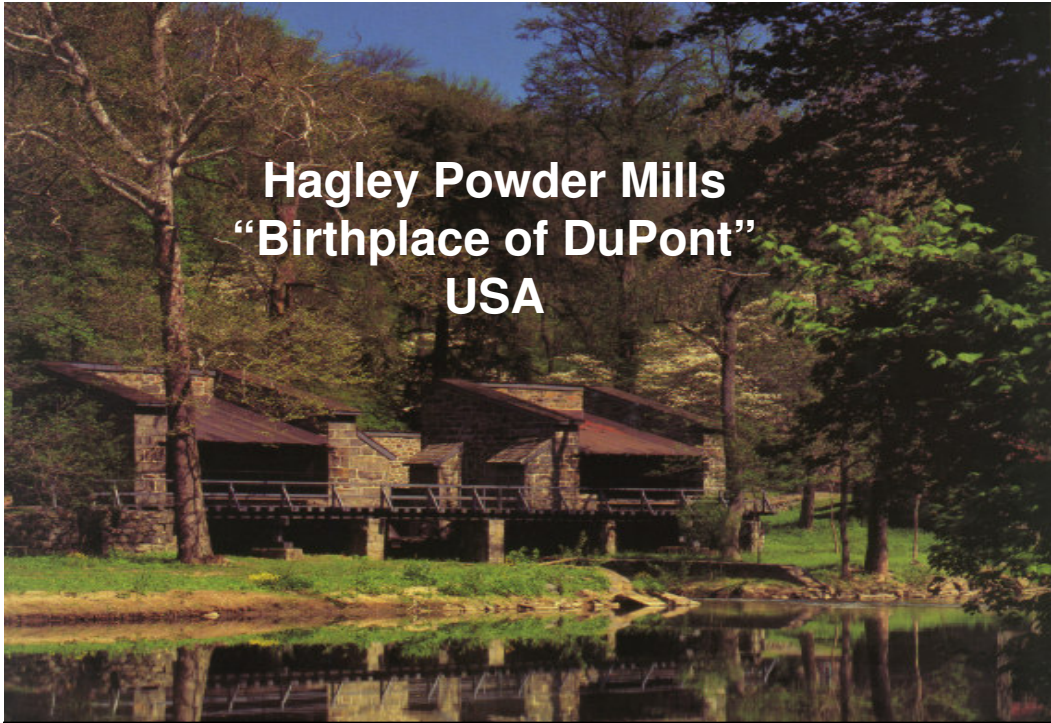


## Learn more.....

- [www.ddce.com](http://www.ddce.com) (Cellulosic Ethanol – DuPont / Genencor)
- [www.butamax.com](http://www.butamax.com) (Biobutanol – Dupont / BP)
- *The Biofuel Bubble*, John Carey – [www.businessweek.com](http://www.businessweek.com) – April, 16, 2009
- [www.engenhariadupont.com.br](http://www.engenhariadupont.com.br) (portuguese)
- [www.dupont.com](http://www.dupont.com)



# THANK YOU!!!



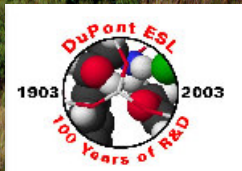
Hagley Powder Mills  
“Birthplace of DuPont”  
USA



DuPont  
Experimental  
Station  
USA



DuPont Tate Lyle  
Bio-PDO™ Plant  
USA



*The miracles of science™*