

# Cellulosic & Advanced Biofuels

William D. Provine  
Global Technology Manager, DuPont Biofuels

**Low Carbon Fuel Symposium**  
**Berkeley, California**  
**May 18<sup>th</sup>, 2007**



# Biofuel Demand – Market Opportunity

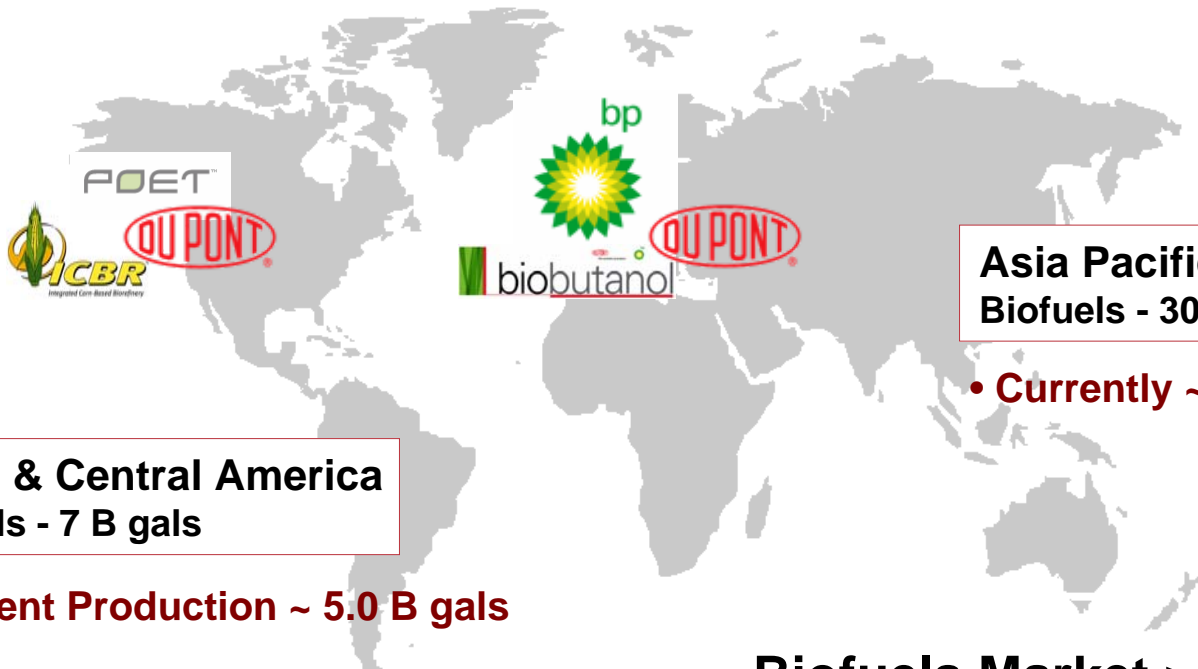
*Biofuels Growth - 2020 Estimates by Region*

**North America**  
Biofuels > 30 B gals

- Current Production > 6.0 B gals

**EU & Eurasia**  
Biofuels - 20 B gals

- Current Production ~ 1.1 B gals



**Asia Pacific**  
Biofuels - 30 B gals

- Currently ~ 1.7 B gals

**South & Central America**  
Biofuels - 7 B gals

- Current Production ~ 5.0 B gals

**Biofuels Market > 87 B gals**

Source: Dept of Energy and DuPont/BP estimates



# The DuPont 2015 Sustainability Goals

A concrete business commitment



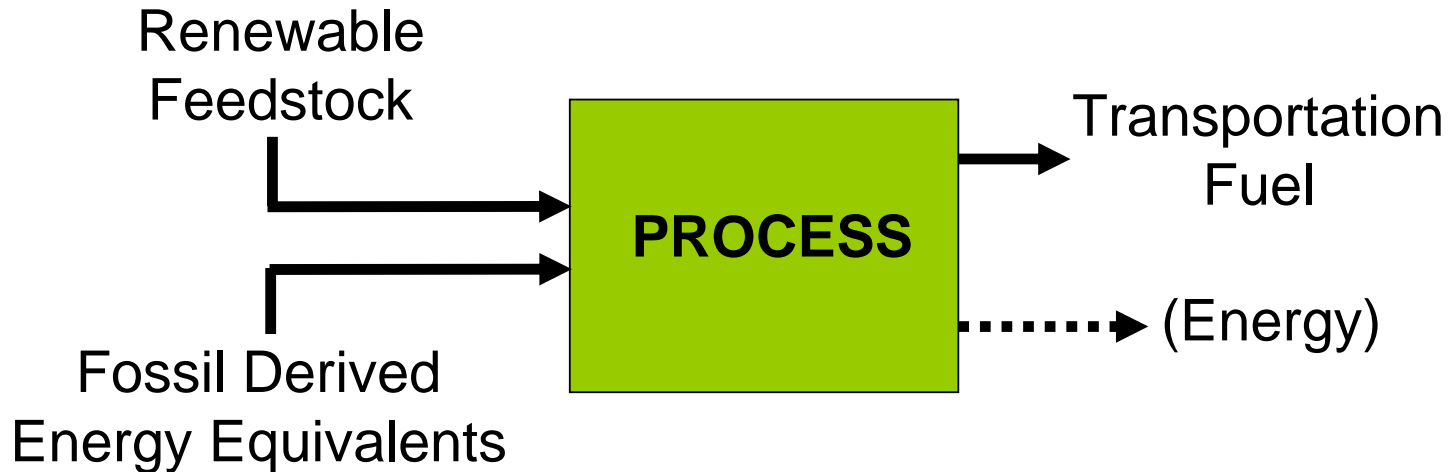
## Bringing sustainable solutions to the marketplace:

- Grow annual revenue by \$2 billion from products that create energy efficiency and/or reduce greenhouse gas emissions.
- Invest in R&D to address environmentally smart market opportunities.
- Double annual revenue from non-depletable resources from 4 to \$8 billion.
- Introduce at least 1,000 new safety products or services.

## While reducing our environmental footprint:

- **Greenhouse Gas Emissions:** 72% reduction to date, a further 15% reduction
- **Water Conservation:** a reduction in consumption by 30% at water lean sites
- **Fleet Fuel Efficiency:** 100% fleet using fuel efficiency technologies/alternatives
- **Air Carcinogen Emissions:** 92% reduction to date, a further 4% reduction by 2015
- **Energy Use:** flat vs. 1990 baseline

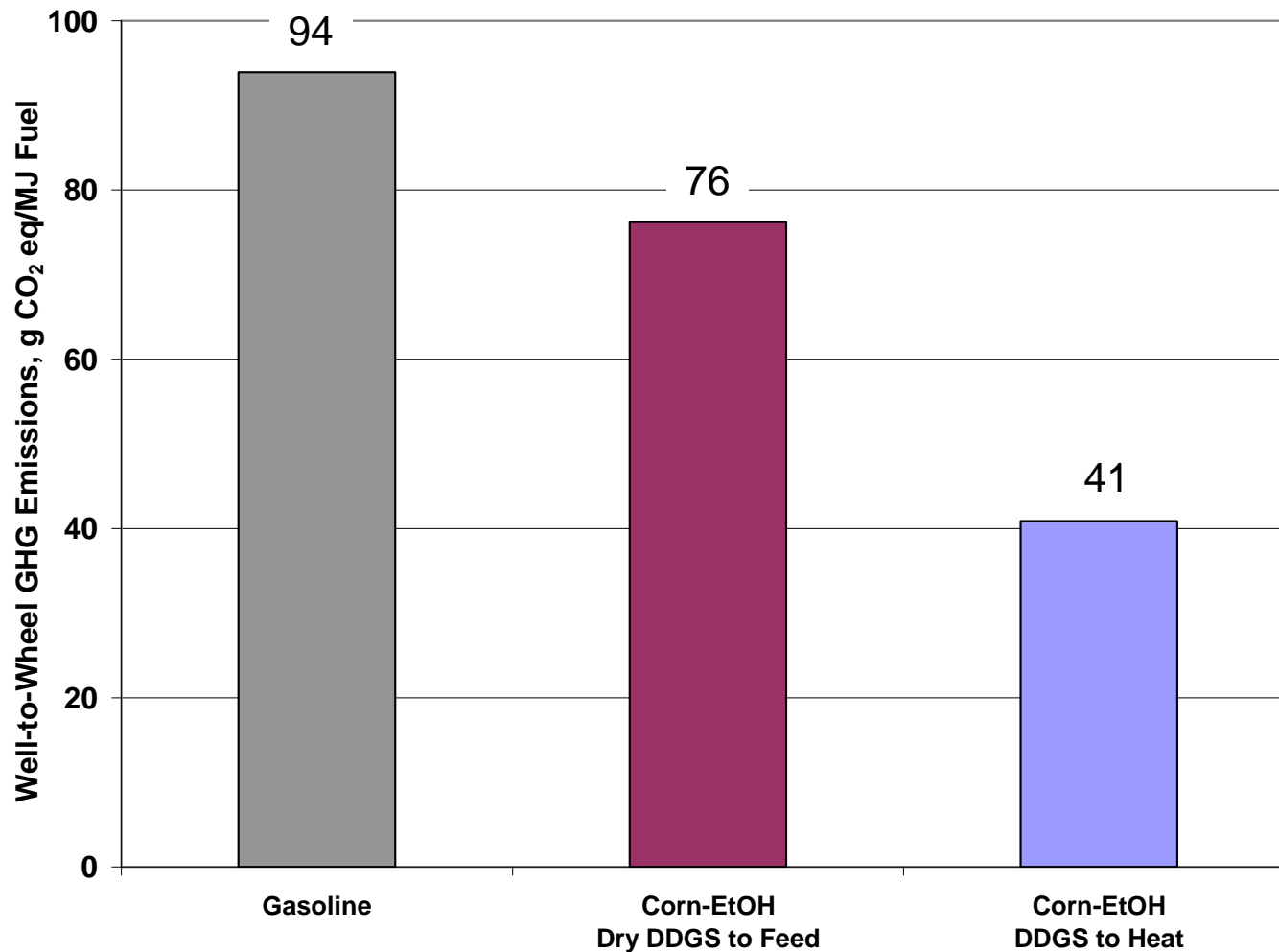
# Framing of Biofuel Process Options



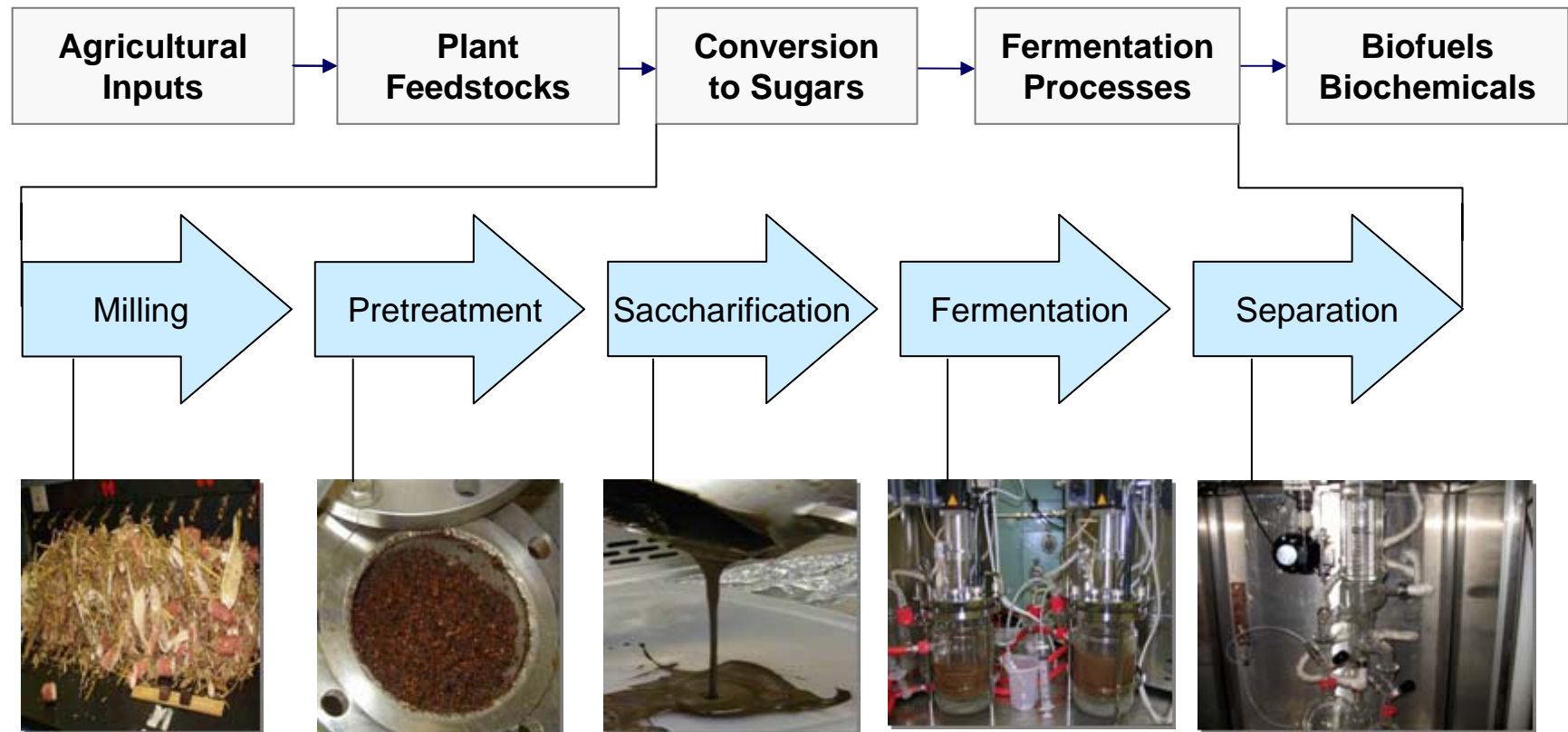
**Routes to renewable fuels must be subject to following constraints:**

- I. Sustainable  $\Rightarrow$  Biofuel GWI (gCO<sub>2</sub>e/MJ)  $\ll$  Gasoline or Diesel GWI (gCO<sub>2</sub>e/MJ)
- II. Maintain lowest costs in terms of investment and operating costs (\$/BTU) while maximizing overall fuel performance properties.

## Grain Ethanol Well-to-Wheels Greenhouse Gas Emissions

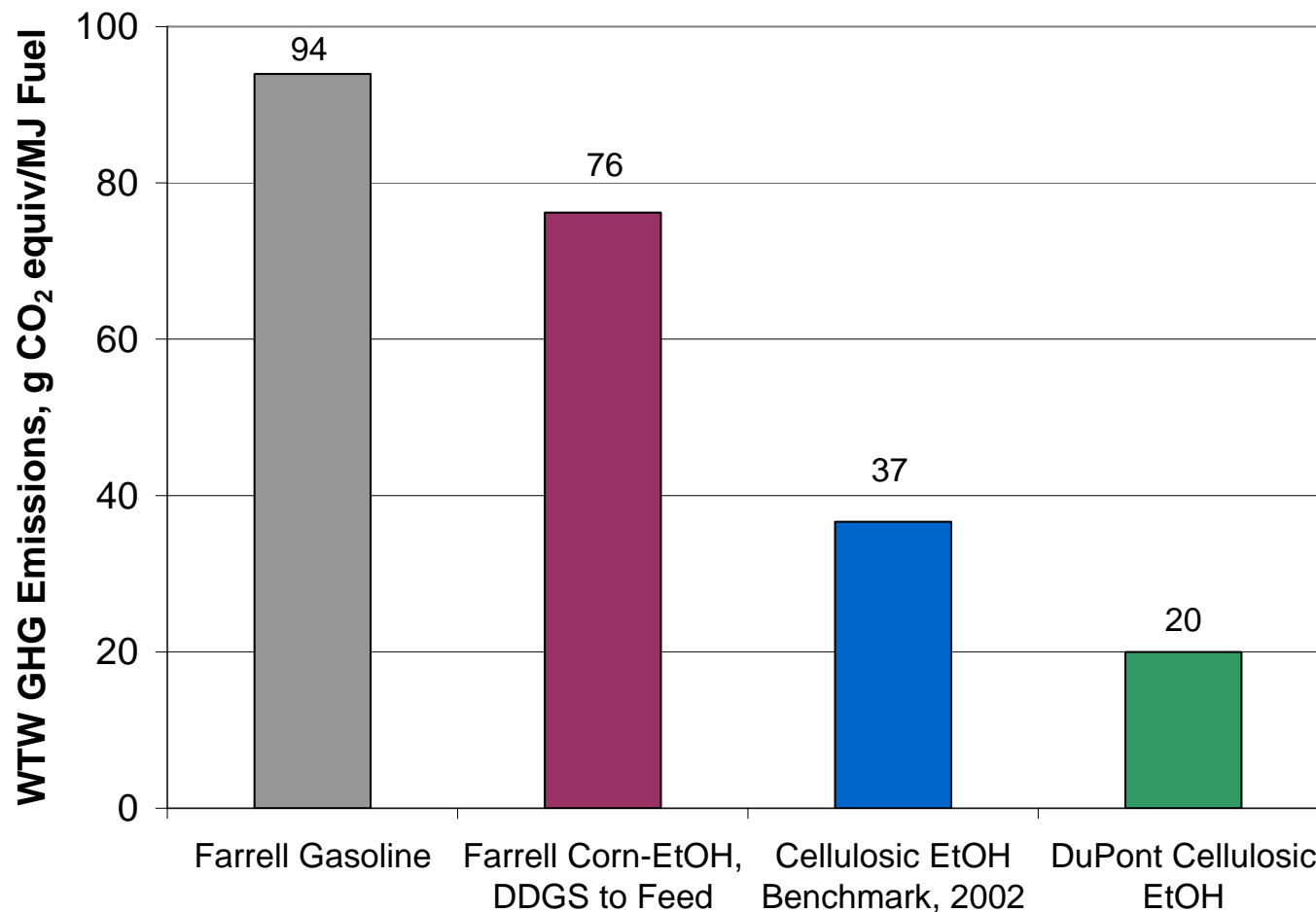


# Required Operations for Biomass to Ethanol Process



**Process options impact carbon intensity (GWI) of overall process**

## Cellulosic Ethanol Well-to-Wheel Greenhouse Gas Emissions



# Advanced Biofuels: Biobutanol



*BIOFUEL PRODUCTION*

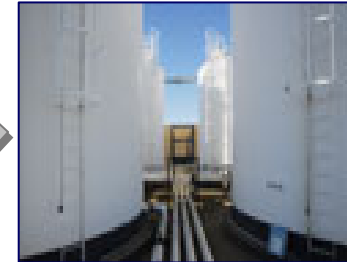
- SAME AGRICULTURAL FEEDSTOCKS
- UTILIZE ETHANOL PRODUCTION ASSETS
- SUPPORTS AGRICULTURAL DEVELOPMENT



*REFINERY*



*PIPELINE*



*TERMINAL*

- LIMITED WATER ABSORPTION
- FUNGIBLE BLENDING COMPONENT
- LOWER VAPOR PRESSURE
- LESS CORROSIVE
- UTILIZE EXISTING INFRASTRUCTURE



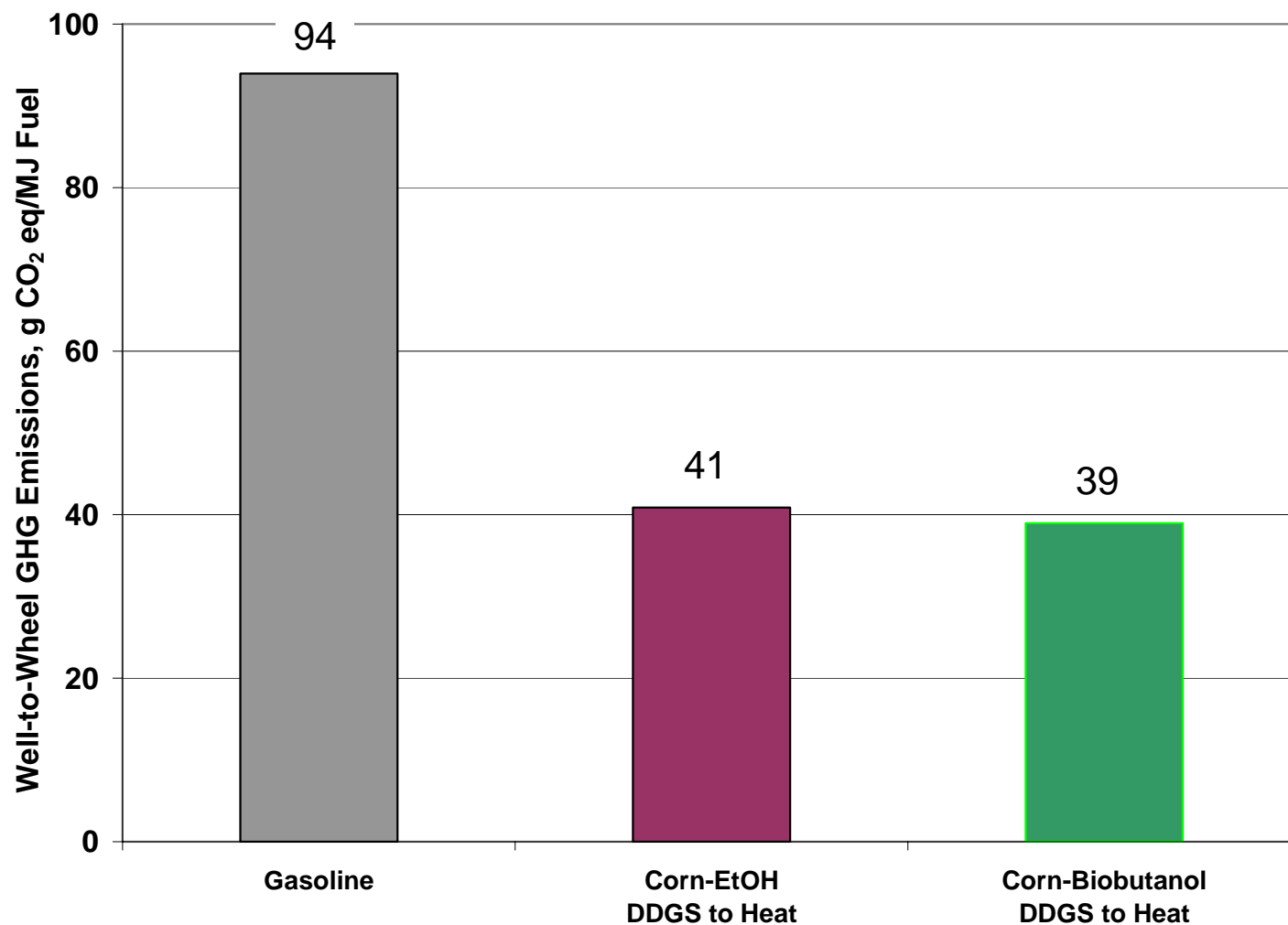
*RETAIL / AUTO INDUSTRY / CONSUMER*

- BETTER FUEL CONSUMPTION
- OXYGEN CONTENT SUPPORTS HIGH BLEND RATIOS
- POTENTIAL FOR HIGHER BLEND LEVELS WITHOUT VEHICLE MODIFICATION
- NO INCREASE IN CO, HC, NO<sub>x</sub> EMISSIONS





# Biobutanol Well-to-Wheel Greenhouse Gas Emissions

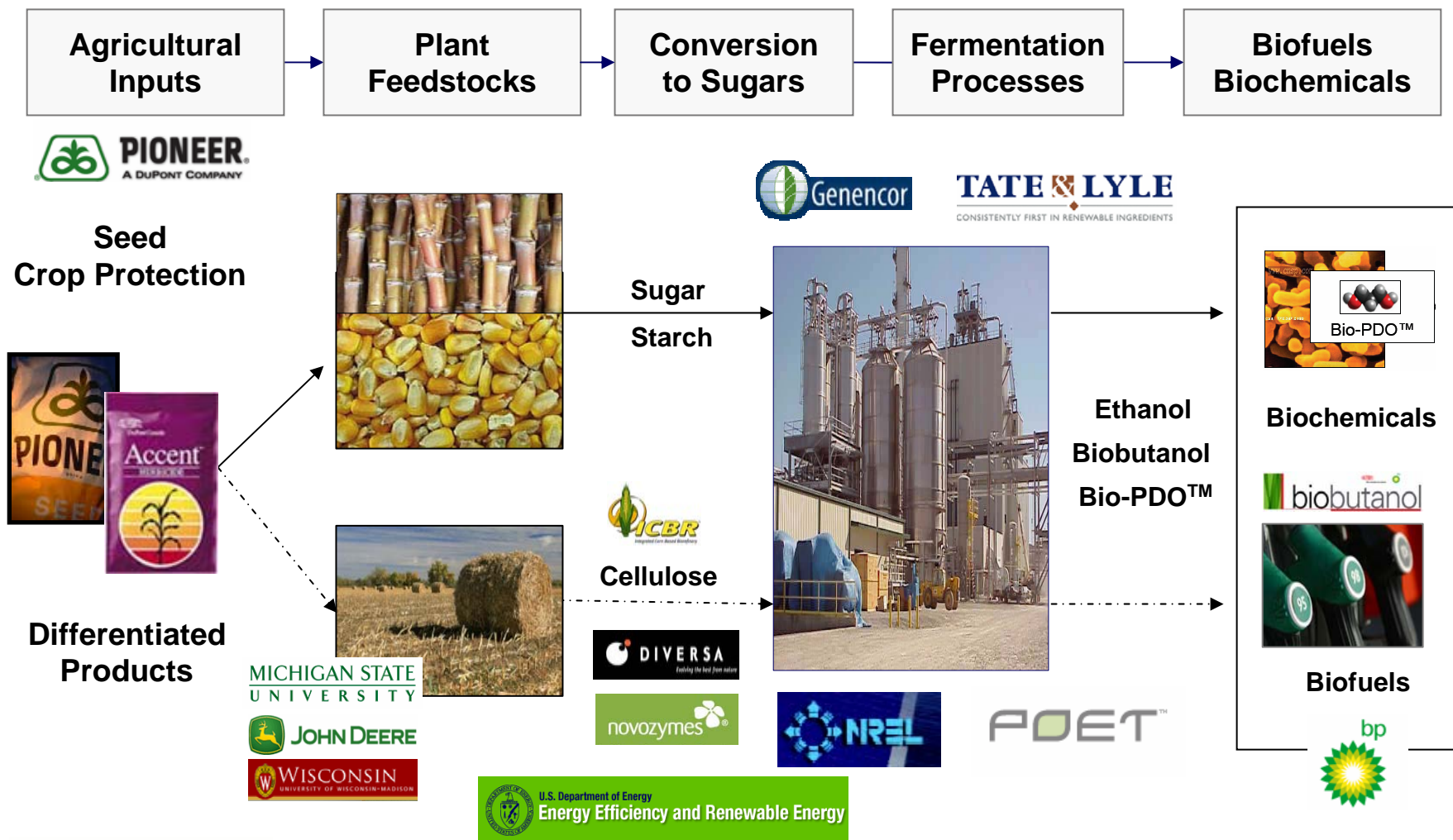


Source: DuPont, 2007 & Farrell, 2006

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# Biorefinery Value Chain

## Carbohydrates to Fuels & Chemicals






A photograph of the Hagley Powder Mills, a historic stone building with multiple chimneys, situated in a lush, wooded area. The building is reflected in a body of water in the foreground.

Hagley Powder Mills  
“Birthplace of DuPont”

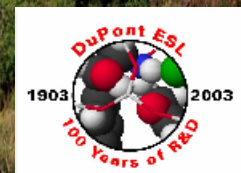
An aerial photograph of the DuPont Experimental Station, showing a dense cluster of brick buildings and industrial structures nestled in a valley. A river is visible on the right side of the image.

DuPont  
Experimental  
Station

Thank  
You

A photograph of the DuPont Tate Lyle Bio-PDO Plant at night. The industrial facility is brightly lit with numerous lights, and large storage tanks are visible in the foreground.

DuPont Tate Lyle  
Bio-PDO™ Plant



*The miracles of science™*