

# Commercializing Isobutanol for Drop-In Fuels

**Chris Ryan, President & COO**

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# Multiple Feedstocks; Proprietary Technology; Numerous End Markets

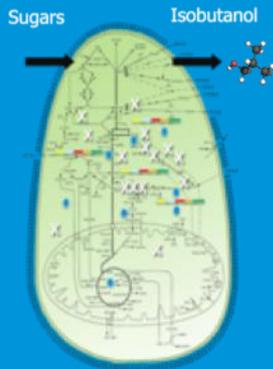


## Feedstock

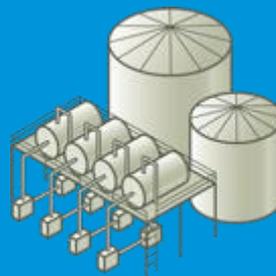


## Gevo Proprietary Technology

### Bio-Cracker



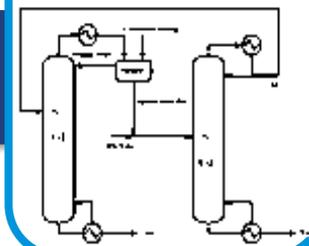
### GIFT® Separator



### Direct "drop-in"



### Green Processing



## Target Markets

# Seven Strategic Markets; Strong Customers



## Specialty Chemicals

## Gasoline Blendstock

## C4 Market

## Bio-PX/PET

## Bio-Jet

## Hydrocarbon Fuels

## Co-Product Revenues

**SASOL**  
reaching new frontiers



**LANXESS**  
Energizing Chemistry



"Lower Cost,  
Drop-In"

"Cleaner  
Performance"

"Structurally Short  
Supply"

"Green Supply  
Chain"

"High  
Performance"

"Fully Renewable"

"Food First"

~\$7bln TAM

~\$100bln TAM

~\$8bln TAM

~\$100bln TAM

~\$200bln TAM

>\$1trl TAM

~\$6bln TAM

Sasol Off-take and distribution agreement in place

Accounts for majority of Luverne and Redfield capacity

Sasol has begun customer sampling Gevo's isobutanol

Mansfield agreement, with their 900+ supply points, will initially focus on Marine

VP Racing Fuels to evaluate a wide array of fuel applications

LOI with Total to evaluate isobutanol as a second-gen biofuel blendstock

Lanxess 10-year exclusive global supply agreement in place

Negotiating terms for Canada supply agreement

Coca-Cola partnership to create renewable paraxylene for plant-based packaging

Toray off-take agreement to create renewable Paraxylene for fibers and films

U.S. Air Force's initial volume delivered with testing underway

USAF interested in energy security / alternative jet fuel supply

United Airlines LOI in place

Airlines want to avoid carbon tax

Can produce fully renewable fuels

Not blends, but actual displacement of petroleum based hydrocarbon fuels

Purina, the premier brand owner, partnership to maximize value of co-products

Exploring how to enhance the value of Isobutanol Distillers Grains

## Unconventional Feedstocks

Canada  
devote  
comparison to the 14,170,000 ha that could be recovered using in situ methods.  
"By 2040, oil sands will account for 25 percent of total liquids supply in NA, SA"  
Milling and Extraction



Source: Suncor Energy Inc.

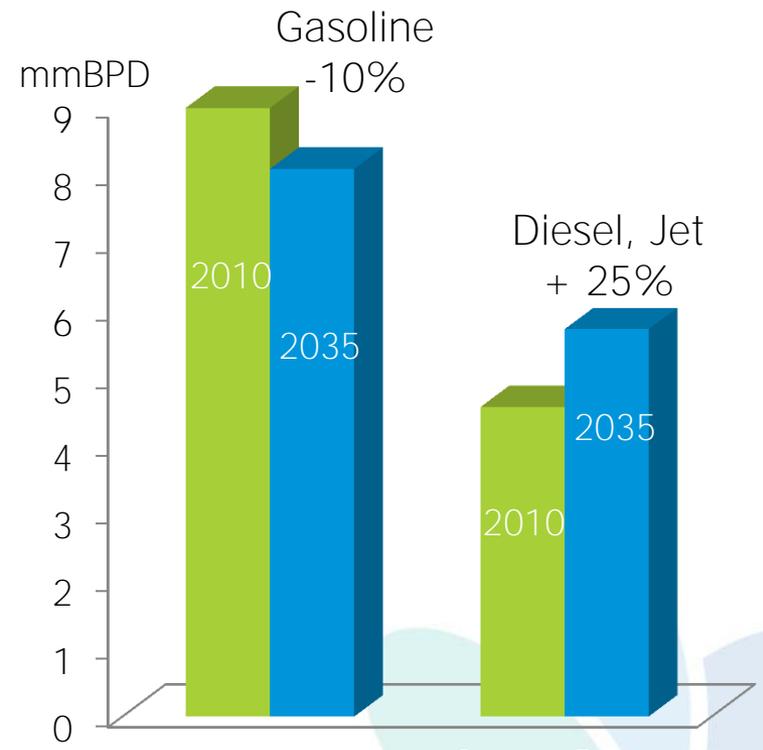
Figure 2.3  
In Situ - SAGD

## People & Plant Health Concerns



Source: Suncor Energy Inc. (Firebag project)

## Shifting Product Demand



Source: Exxon



## Precision Agriculture

- Increased Yields
- Decreased Impacts



## Biotechnology

- Improved crops
- Improved biocatalysts



## Product Diversification

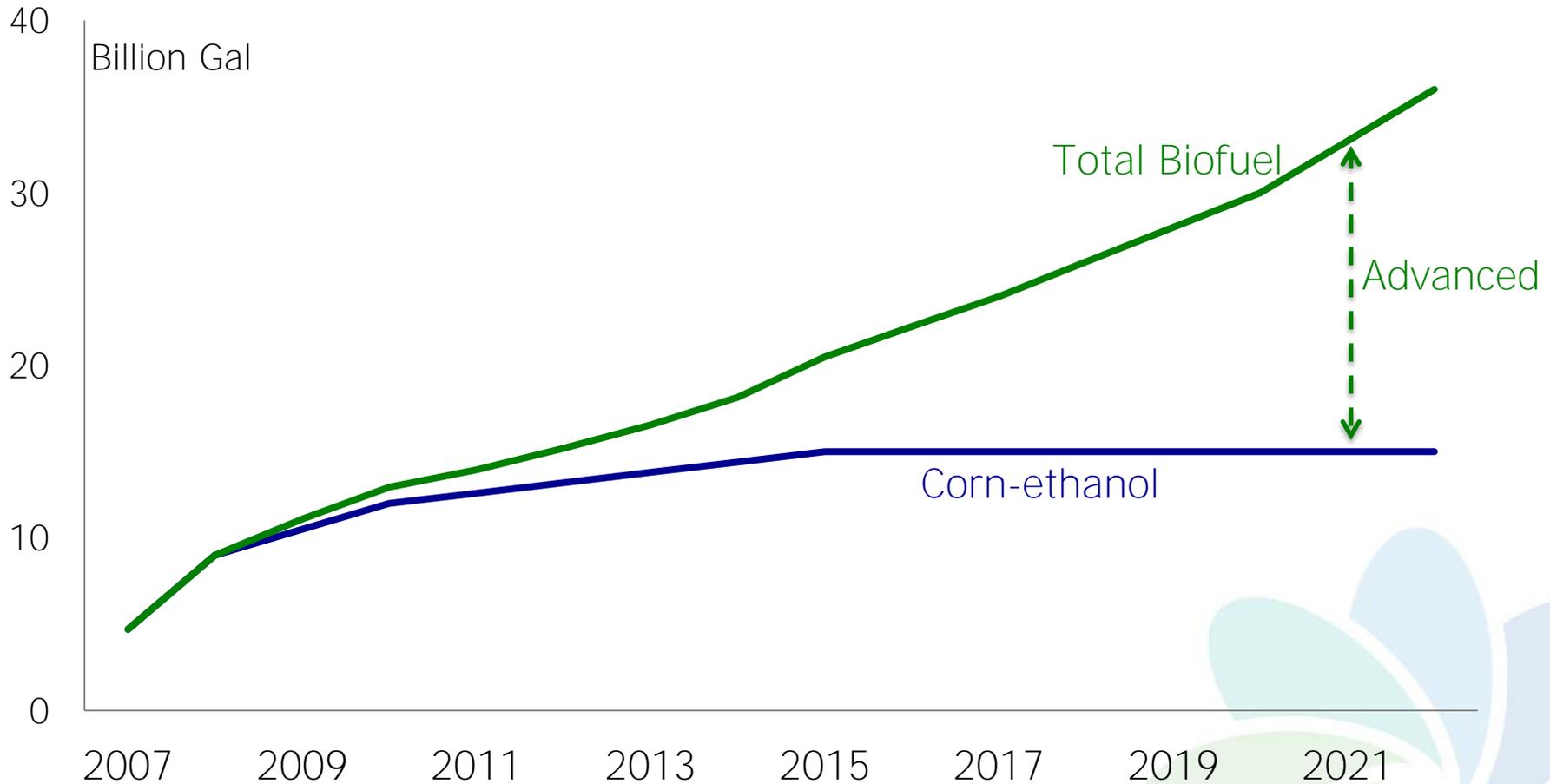


## Feedstock Diversification

# EISA Renewable Volume Obligation



2012 Requirement is 13 BG. 2022 Intent is 36 BG.



Gevo's Retrofit approach enables use of existing downstream assets via investments in the ethanol plant



## Ethanol

- 14 B gal/yr
- \$30 B Asset

## Refining

- 280 B gal/yr
- \$400 B Assets

## Distribution

- 170,000 mi pipeline
- 3,700 terminals
- ~\$80 B asset

## Retail

- >500,000 fuel dispensers
- >\$10 B assets

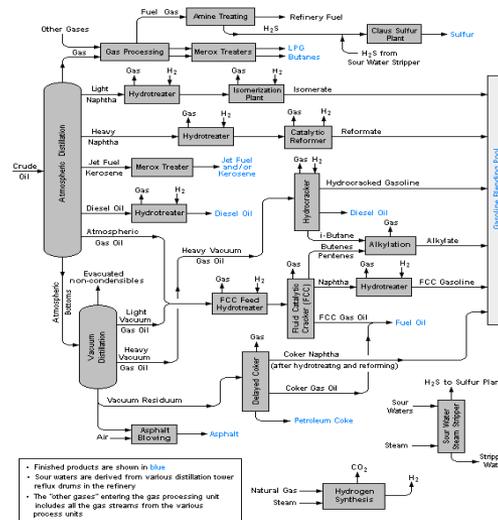
## End User

- >500 MM engines
- Cars
- Boats
- Off-road
- Small engines

## Crude Oil



## Refining



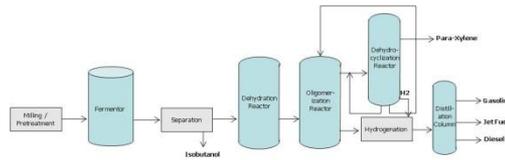
## Deconstruction of barrel

Gallons per Barrel of Oil	
Gasoline	19.4
Diesel Fuel & Heating Oil	10.5
Jet Fuel	4.1
Heavy Fuel Oil	1.7
Propane	1.5
Asphalt & Road Oil	1.3
Petrochemical Feedstocks	1.1
Other Products	5.0

## Biomass



## Fermentation & Conversion



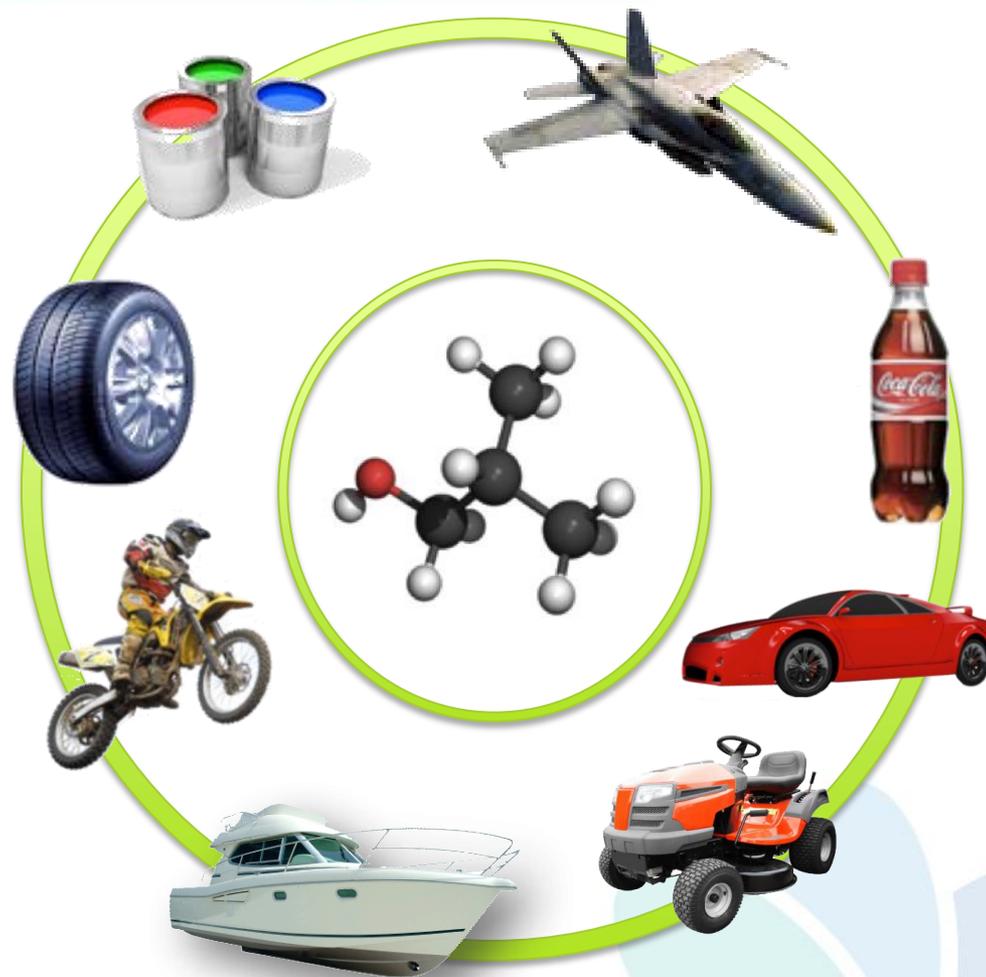
## Tailored Production



Example Production	
Distillate Fuel	38 gal
Petrochemical Feedstocks	4 gal
Animal Feed	~400 lb
Energy from Biomass	

# Isobutanol: A Platform Molecule

- ❁ A primary building block chemical that can be converted into approximately 40% of all petrochemicals and 100% of all hydrocarbon fuels
- ❁ We make it from renewable feedstocks – not petroleum
- ❁ We believe we can make it for less than petroleum-based isobutanol



## **RISK FACTOR**

## **RISK MITIGATION**

Economic Performance

Combine the best biology with known chemical operations for the highest yield path to desired end product

Capital Intensity

Retrofit Existing Assets

Robust Process

Use Industrially Proven Yeast

Scale Up

Use Known Commercial Processes

Limited Markets

Multiple Markets with Agreements

Limited Feedstock Options

Enable any Fermentable Feedstock

# How We Retrofit Ethanol Plants

BEFORE

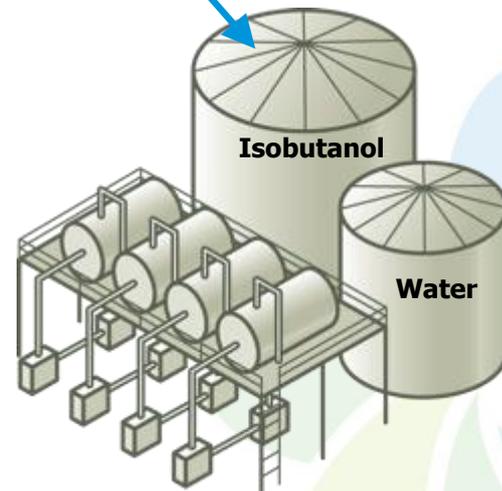


First Commercial isobutanol plant started up May 2012

AFTER



-  Our patented Gevo Integrated Fermentation Technology<sup>®</sup> (GIFT<sup>®</sup>) continually separates isobutanol during fermentation
-  Enables use of the existing ethanol plant



Alcohol



Targeted Hydrocarbon



Jet Fuel Blendstock



Octane, Gasoline



Diesel Blendstock



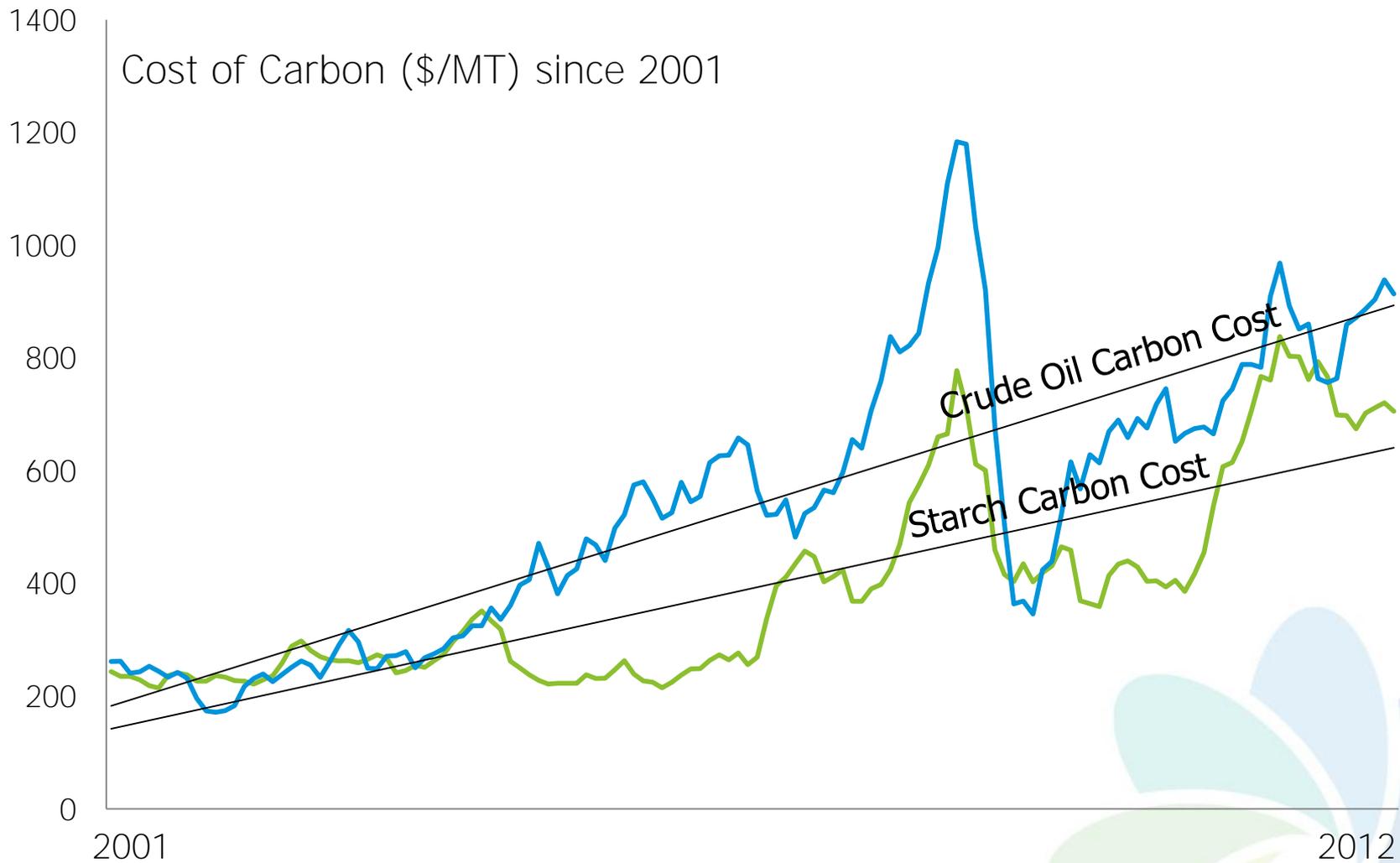
Para-xylene (for PET)

- ❁ ATJ Demonstration Facility near Houston
- ❁ Delivered >10K gallons ATJ to AFRL
- ❁ Alcohol-to-Fuel US Patent 8,193,402
  - Covers C2-C6 alcohols to hydrocarbon fuel

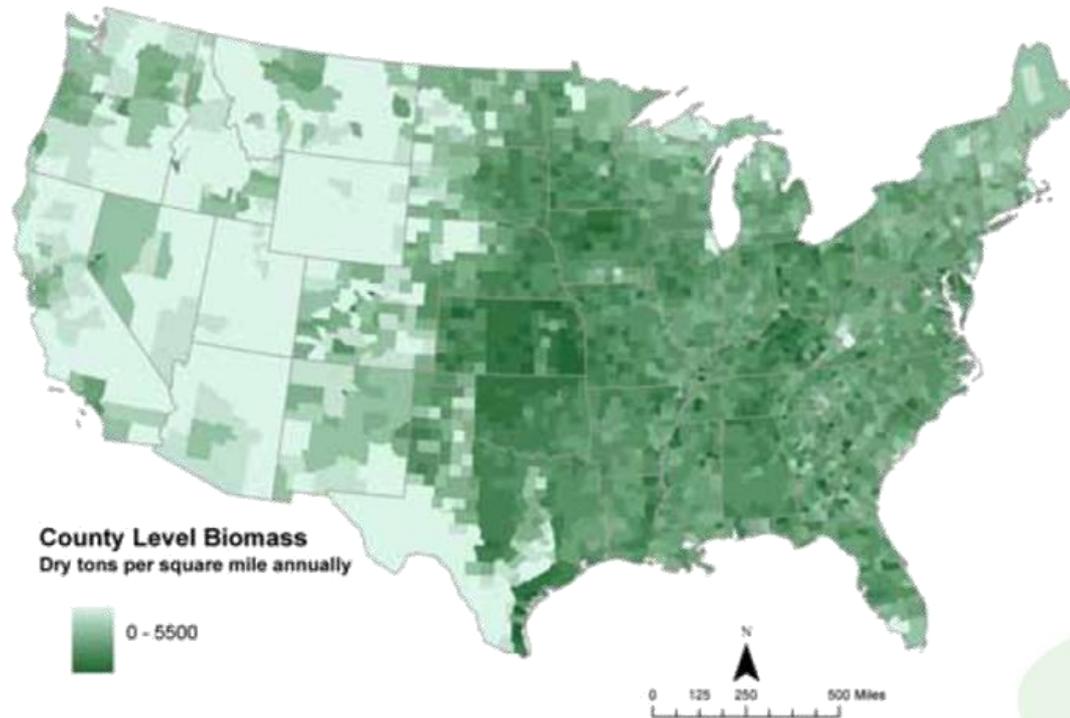
- 🌸 June 28, 40<sup>th</sup> Flight Test Squadron made history flying **Gevo's 50% ATJ and 50% JP-8** fuel blend
- 🌸 **"It flew like a usual A-10 without any issues."**
  - Maj. Olivia Elliott, A-10 pilot
- 🌸 **"You won't be able to determine the difference and you won't care, because all perform as JP-8."**
  - Jeff Braun, Chief for the Air Force Alternative Fuel Certification Division



# Oil Costs Expected to Rise Faster than Carbohydrates



Potential biomass resources	2012	2030
Dry tons per year	0.5 B	1 B
Barrel Oil Equiv Liquid Fuel per day	~1.3 Million	~3.5 Million

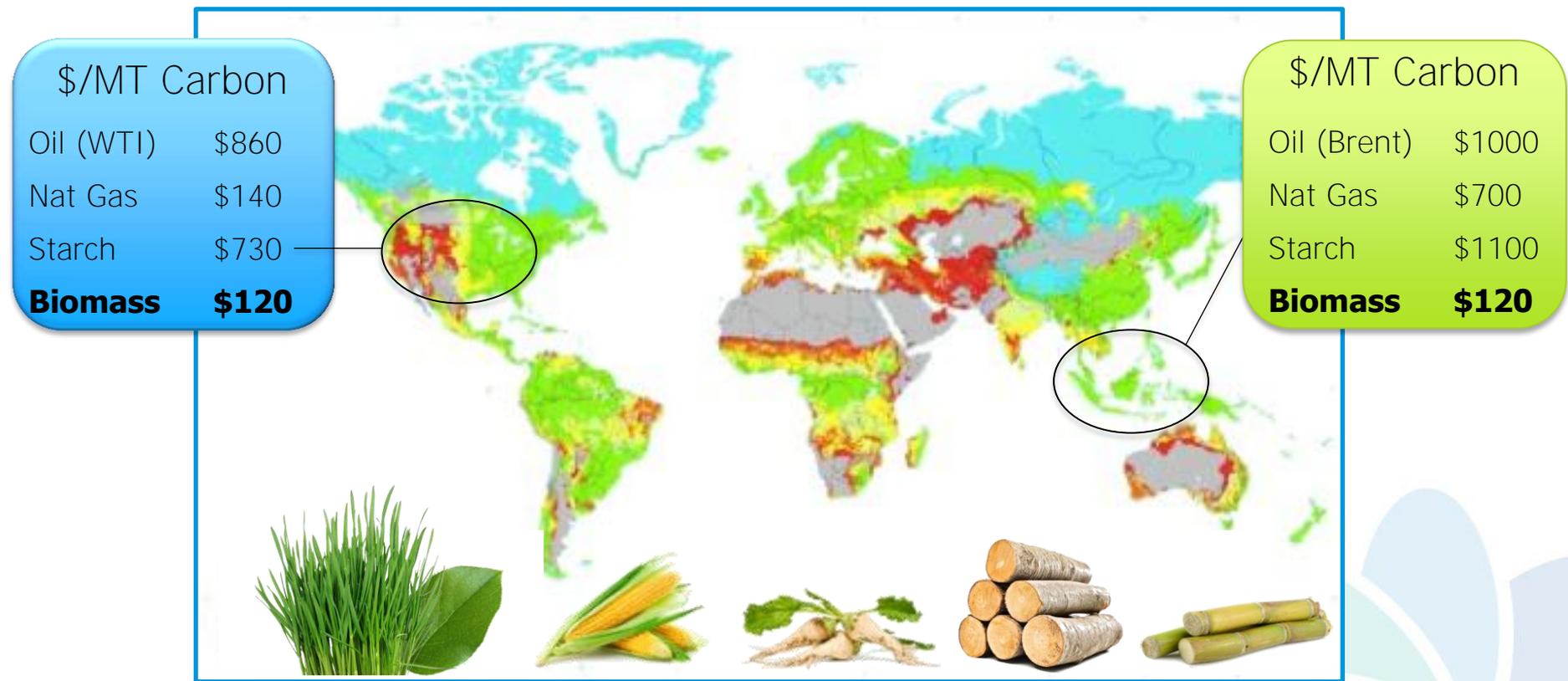


Source: U.S. DOE, U.S. Billion-Ton Study Update, August 2011

Figure 6.4: Potential county-level resources at \$60 per dry ton or less in 2030, under baseline assumptions

US oil reserve figure; CIA, The World Factbook, [www.cia.gov](http://www.cia.gov)

# Biobased Carbon Cost is Competitive Globally



## **Gevo and Beta Renewables (Chemtex/TPG) Sign Agreement to Develop Integrated Process for Cellulosic Isobutanol**

*Potential for bio-based isobutanol and derivatives, including jet fuel, from cellulosic biomass*



