Conversion of Hydrolyzed Douglas fir Biomass into Isobutanol and Biojet

Grant Balzer (gbalzer@gevo.com)
Gevo, Inc. and NARA
April 29, 2014

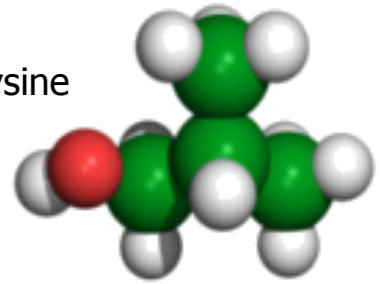
Forward-Looking Statements

Certain statements within this presentation may constitute "forward-looking statements" within the meaning of the Private Securities Litigation Reform Act of 1995. Such statements relate to a variety of matters, including but not limited to: the timing and costs associated with and the availability of capital for Gevo's scheduled retrofits of existing ethanol production facilities, its future isobutanol production capacity, the timing associated with bringing such capacity online, the availability of additional production volumes to seed additional market opportunities, the expected applications of isobutanol, including its use to produce renewable paraxylene, PET, isobutanol-based fuel blends for use in small engines, and ATJ bio-jet, addressable markets, and market demand, Gevo's ability to produce commercial quantities of isobutanol from cellulosic feedstocks, the suitability of Gevo's iDGs™ for the animal feed market, the expected cost-competitiveness and relative performance attributes of isobutanol and the products derived from it, the strength of Gevo's intellectual property position and other statements that are not purely statements of historical fact. These forward-looking statements are made on the basis of the current beliefs, expectations and assumptions of Gevo's management and are subject to significant risks and uncertainty. All such forward-looking statements speak only as of the date they are made, and Gevo assumes no obligation to update or revise these statements, whether as a result of new information, future events or otherwise. Although Gevo believes that the expectations reflected in these forward-looking statements are reasonable, these statements involve many risks and uncertainties that may cause actual results to differ materially from what may be expressed or implied in these forward-looking statements. For a discussion of the risks and uncertainties that could cause actual results to differ from those expressed in these forward-looking statements, as well as risks relating to the business of the company in general, see the risk disclosures in Gevo's Annual Report on Form 10-K, as amended, for the year ended December 31, 2013 and in subsequent reports on Forms 10-Q and 8-K and other filings made with the Securities and Exchange Commission by Gevo.

This presentation is based on information that is generally available to the public and does not contain any material, non-public information. This presentation has been prepared solely for informational purposes and is neither an offer to purchase nor a solicitation of an offer to sell securities.

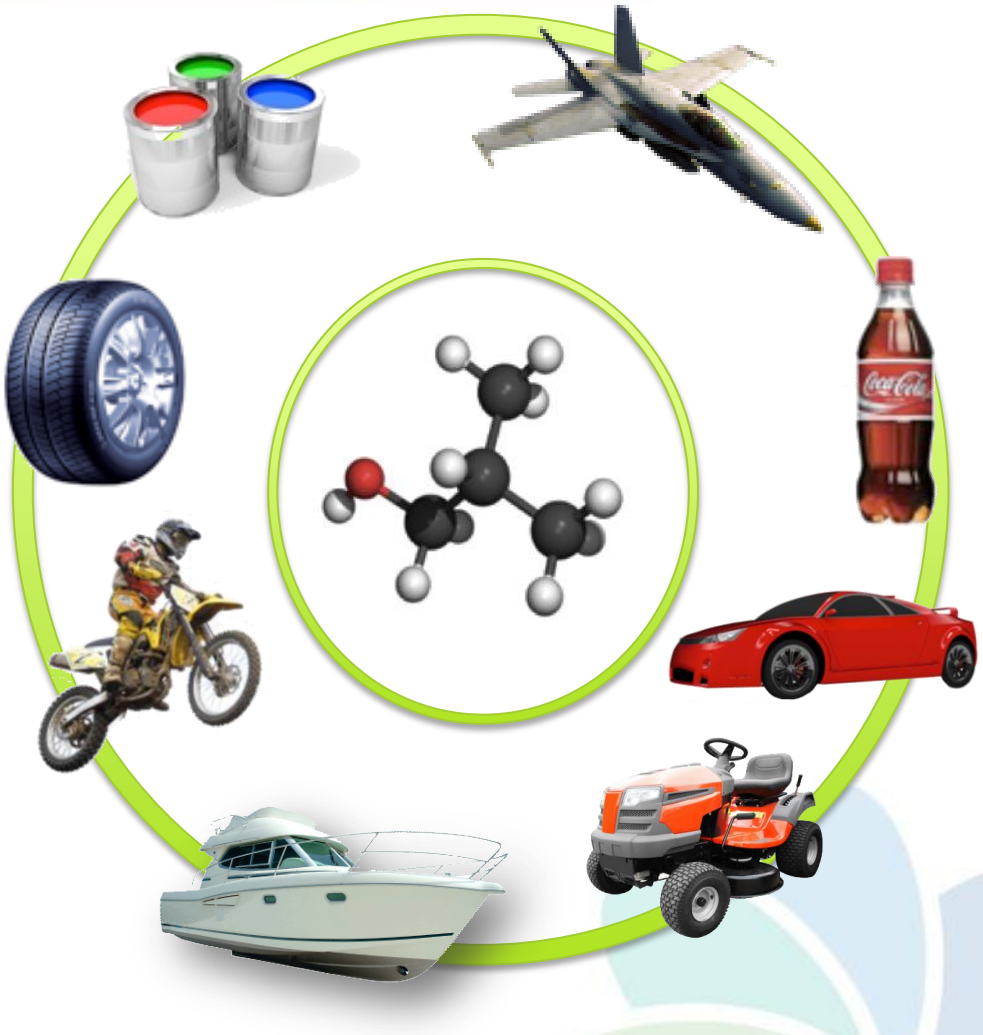
Gevo, Inc.

- Located outside Denver, Colorado with Minnesota production facility
- Founded in 2005 and now composed of ~100 people
- Experienced & successful management team
  - Management team has commercialized lactic acid, polylactide polymers & lysine
  - Management team has developed and commercialized engineered yeast
- Public company listed on Nasdaq as 'GEVO'



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



Source:: Nexant

How do we produce isobutanol?

Feedstock





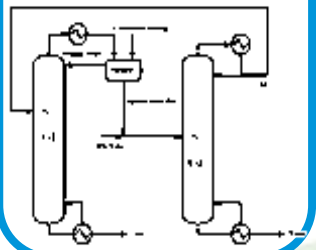
Gevo Proprietary Technology

Bio-Cracker

GIFT® Separator

Direct "drop-in"

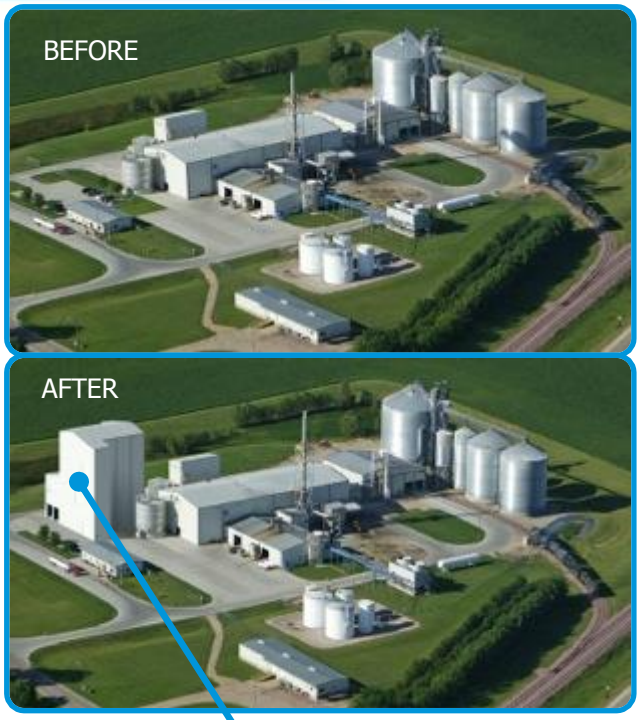
Green Processing



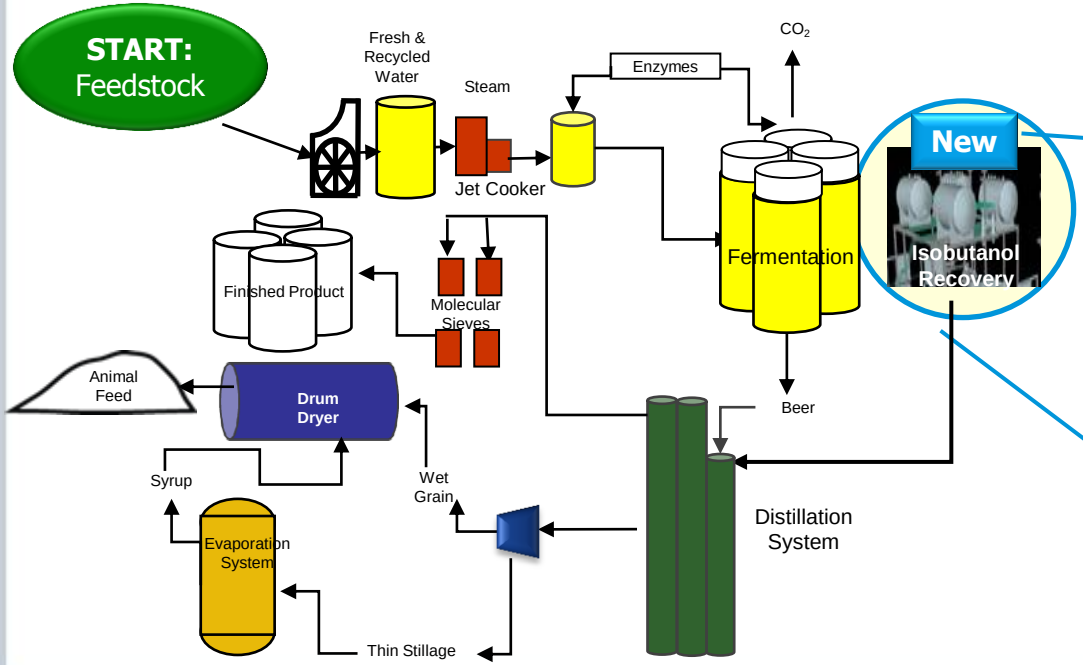
Target Markets

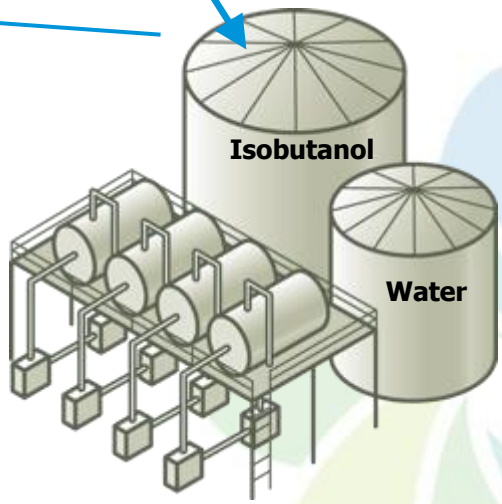
How We Produce Isobutanol (GIFT®)

- Our patented Gevo Integrated Fermentation Technology® (GIFT®) continually separates isobutanol during fermentation
- Gevo owns the patent covering ethanol plants retrofitted to produce isobutanol



Standard Fermentation Process





Seven Strategic End Markets; Strong Customers

Specialty Chemicals	Gasoline Blendstock	C4 Market	Bio-PX/PET	Bio-Jet	Hydrocarbon Fuels	Co-Product Revenues
"Lower Cost, Drop-In"	*"Cleaner Performance"*	*"Structurally Short Supply"*	*"Green Supply Chain"*	*"High Performance"*	*"Fully Renewable"*	*"Food First"*
~$7bln TAM	**~$100bln TAM**	**~$6bln TAM**	**~$100bln TAM**	**~$200bln TAM**	**>$1trl TAM**	**~$7bln TAM**
Sasol off-take and distribution agreement in place	Mansfield agreement, with their 900+ supply points, will initially focus on Marine	**LANXESS 10-year exclusive global supply agreement in place**	Coca-Cola partnership to create fully renewable PET for plant-based packaging	U.S. Air Force's (USAF) initial volume delivered with testing underway	Mansfield agreement, with supplier network in place, will support regional distribution rollout strategy	**Purina, the premier brand owner, partnership to maximize value of co-products**
Accounts for majority of initial capacity	VP Racing Fuels to evaluate a wide array of fuel applications	Negotiating terms for Canadian supply agreement	**Toray off-take agreement to create renewable Paraxylene for fibers and films**	USAF interested in energy security / alternative jet fuel supply		Exploring how to enhance the value of isobutanol Distillers Grains (iDGs™ or animal feed)
Customer sampling of Gevo's isobutanol has begun	LOI with Total to evaluate isobutanol as a second-gen biofuel blendstock			**USAF test flight end of June**		
				United Airlines LOI in place		

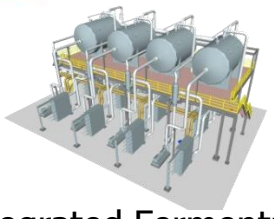
Source: Company materials, IEA, EIA and Nexant

Gevo and NARA

Pretreated Woody Biomass Sugars

Feedstock Screening and Adaptation

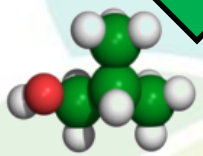
Fermentation Development



Integrated Fermentation & Recovery of Isobutanol

Verify Woody Biomass Feedstocks & Pretreatment in Biojet Process

- Screen fermentable biomass sugars to determine optimal feedstock and pretreatment technology for isobutanol production
- Adapt yeast to fermentable biomass sugars
- Produce isobutanol from biomass sugars



Isobutanol

Biojet

ASTM Testing & End Users: Commercial and Military

NARA Feedstock Composition

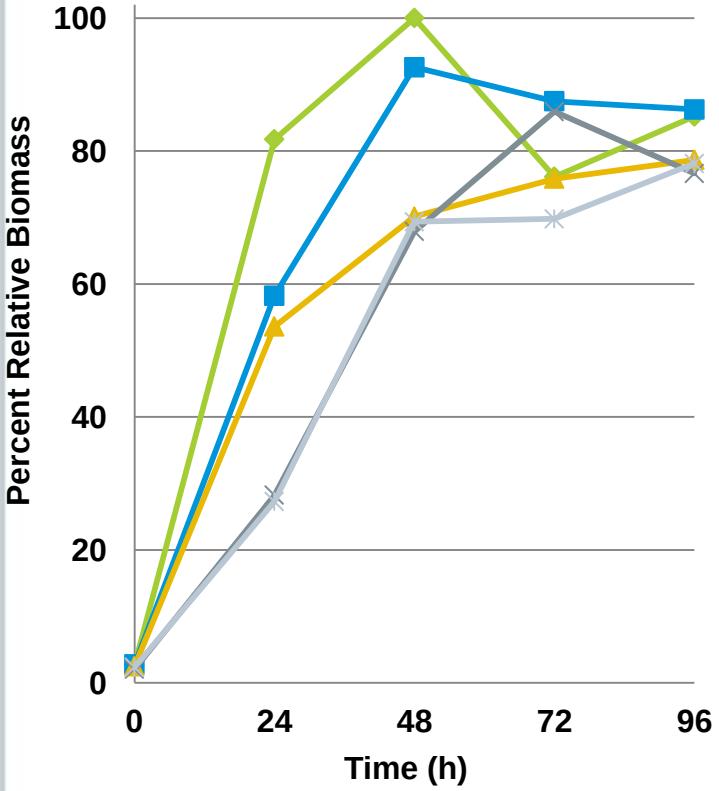
- NARA has established several standardized Douglas fir residual feedstocks
- Multiple pretreatment partners provide diverse hydrolyzate streams for fermentation testing at Gevo

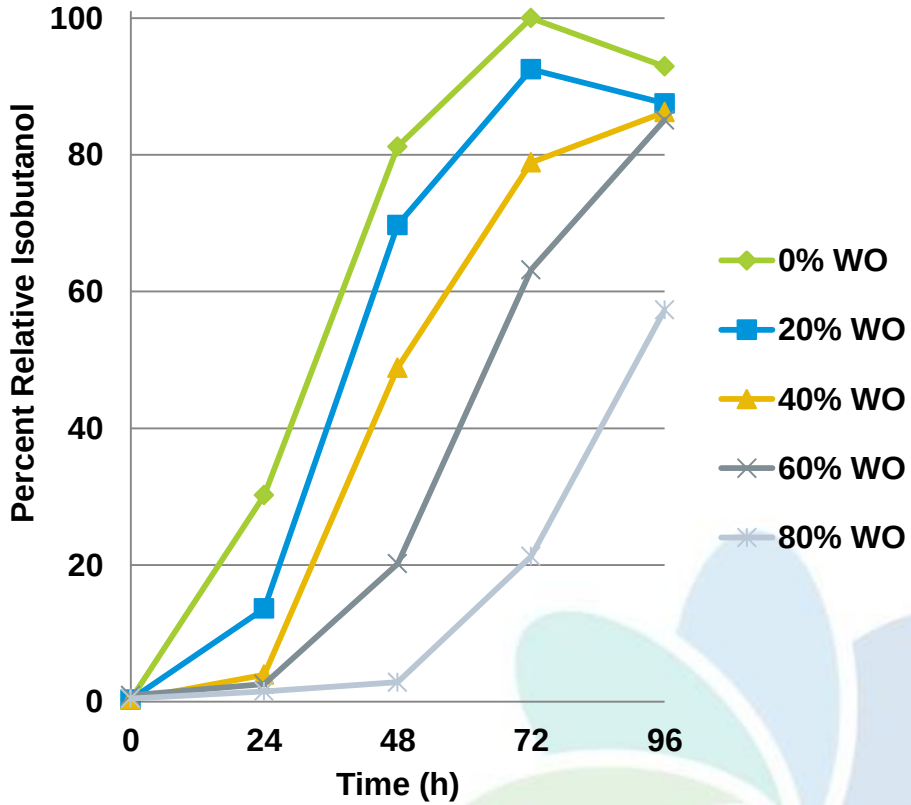
Table 1. Sugar and inhibitor concentrations in FS-01 and FS-03 feedstocks from different pretreatments. Compositional analysis was determined using high performance liquid chromatography (HPLC) at Gevo. (n.d. = not detected)

	Glucose (g/L)	Xylose (g/L)	Galactose (g/L)	Arabinose (g/L)	Mannose (g/L)	Acetate (g/L)	HMF (g/L)	Furfural (g/L)	Total Hexose (g/L)
FS-01 Wet Oxidation Hydrolyzate	57.20	6.67	5.12	1.58	20.87	7.27	3.90	0.99	83.19
FS-03 Wet Oxidation Hydrolyzate	87.54	4.67	5.14	0.76	10.06	12.46	3.66	0.81	102.74
FS-10 Wet Oxidation Hydrolyzate	54.79	12.01	5.38	4.43	9.59	7.99	3.53	0.26	69.76
FS-01 SPORL Hydrolyzate	93.65	6.89	4.94	1.24	23.01	4.56	0.79	0.10	121.60
FS-03 SPORL Hydrolyzate	81.81	5.79	3.82	0.40	7.02	5.78	1.84	0.63	92.65
FS-10 SPORL Hydrolyzate	62.74	6.84	5.07	n.d.	11.83	0.62	n.d.	n.d.	79.64
FS-03 Catchlight Combined Hydrolyzate	164.12	8.56	5.24	0.94	13.34	3.45	0.15	0.14	182.70
FS-03 Catchlight Clean Hydrolyzate	130.89	1.84	0.49	n.d.	1.34	0.26	0.14	0.01	132.72
FS-10 Mild Bisulfite SSL	7.83	7.32	5.29	2.21	18.06	3.61	n.d.	n.d.	31.18
FS-10 Mild Bisulfite Solids Hydrolyzate	63.88	3.77	2.07	0.68	7.52	1.65	n.d.	n.d.	73.47
FS-10 Combined Mild Bisulfite Hydrolyzate	84.22	10.14	5.26	2.02	20.93	3.44	n.d.	n.d.	110.41
FS-10 Unconcentrated Milled Wood Hydrolyzate	39.84	7.61	1.87	2.04	11.40	0.74	n.a.	n.a.	53.11
FS-10 Concentrated Milled Wood Hydrolyzate	61.84	9.21	0.46	1.36	12.76	0.77	n.d.	n.d.	75.06

Feedstock Benchmarking

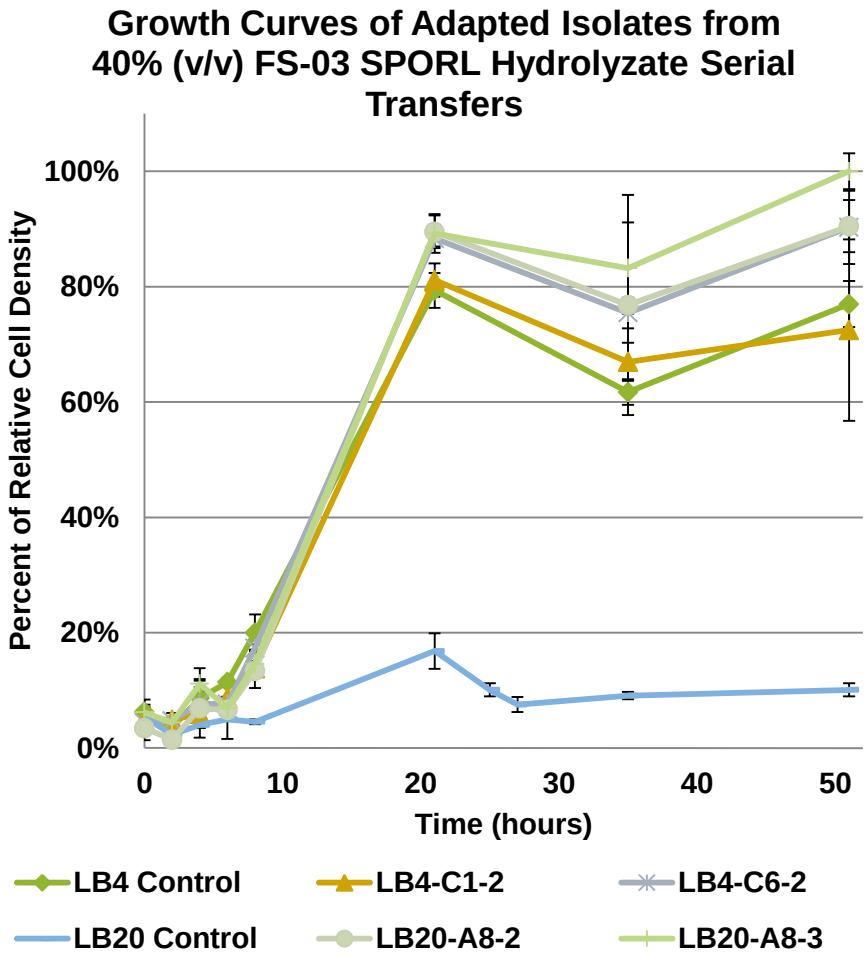
- Gevo evaluates each hydrolyzate/feedstock combination for biocatalyst growth and production of iBuOH
- High-throughput growth, shake flask fermentations, then bioreactors

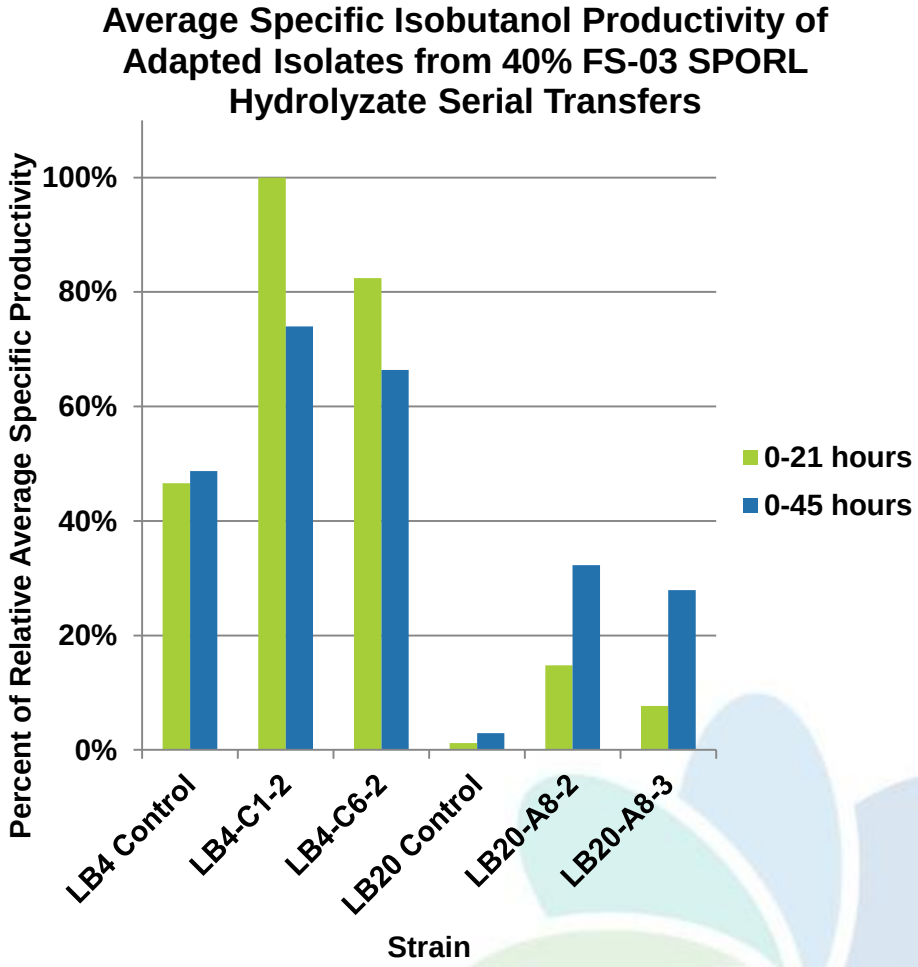




Shake flask fermentations showing the percent relative growth (Left) and relative isobutanol titer (Right) of the wet oxidation adapted parent LB4 in different percentages of FS-03 WO hydrolyzate. The clarified FS-03 wet oxidation pretreated hydrolyzate was supplemented with a nutrient package, salts, and a buffering agent. Different percentages of hydrolyzate media contained equal amounts of corresponding sugars and supplements. At 100% (v/v, not shown), wet oxidation pretreated hydrolyzate was equal to approximately 20-30% equivalent solids. Fermentation was carried out at 33°C for 96 hours in shake flasks. Isobutanol levels were determined by GC analysis.

Adaptation of Biocatalysts to Hydrolyzate

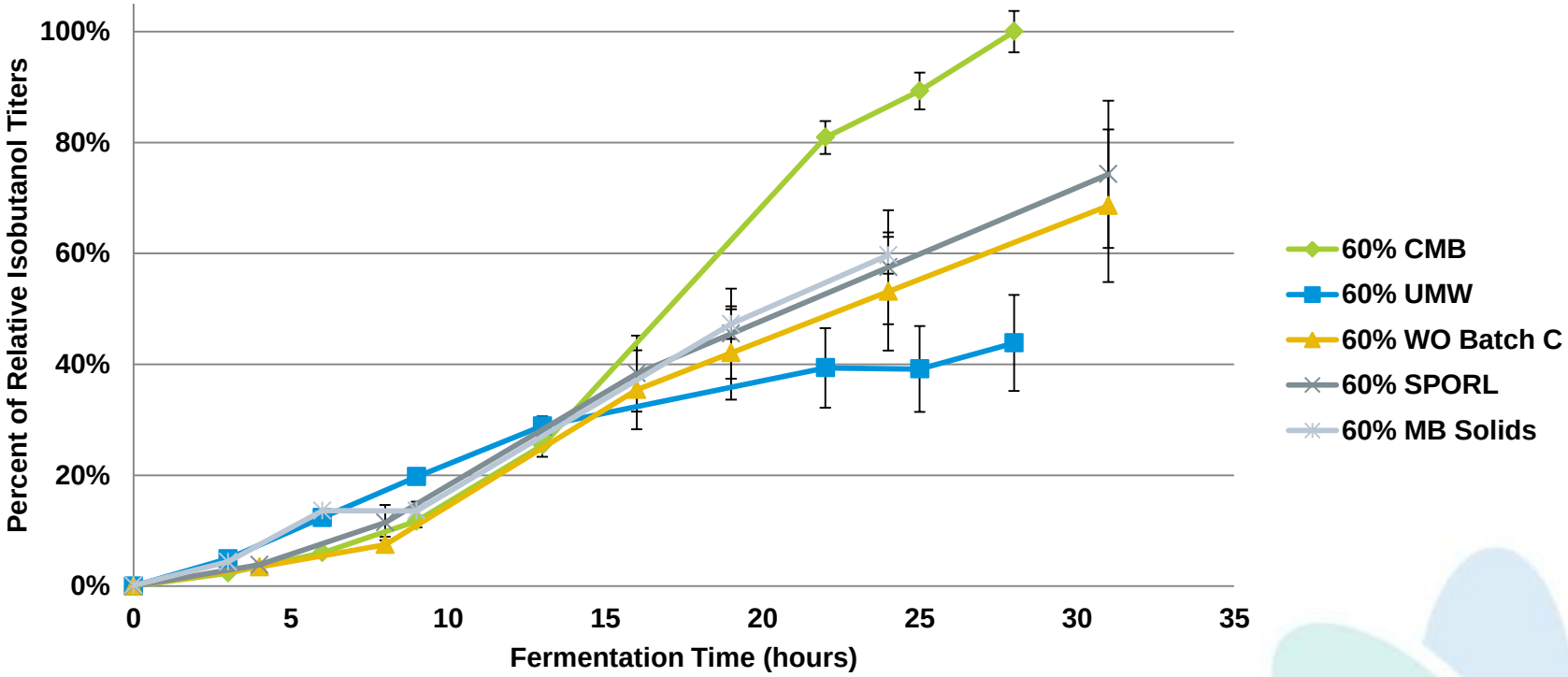




Relative cell densities (Left) and average specific isobutanol productivity (Right) of hydrolyzate adapted LB4 and LB20 derived biocatalysts using 40% (v/v) FS-03 SPORL pretreated hydrolyzate medium in shake flask fermentations. All hydrolyzates were clarified to remove solids and were supplemented with a nutrient package, salts, and a buffering agent. The 40% (v/v) mixtures have sugars and acetate equivalent to 100% of the hydrolyzate. 100% hydrolyzate is equal to approximately 30-36% equivalent solids. Fermentation was carried out at 33°C. Cell density was measured using a spectrophotometer. Error bars represent the standard deviation. Abbreviations: SPORL, sulfite pretreatment to overcome recalcitrance of lignocellulose.

Isobutanol Production at 1L GIFT® Scale

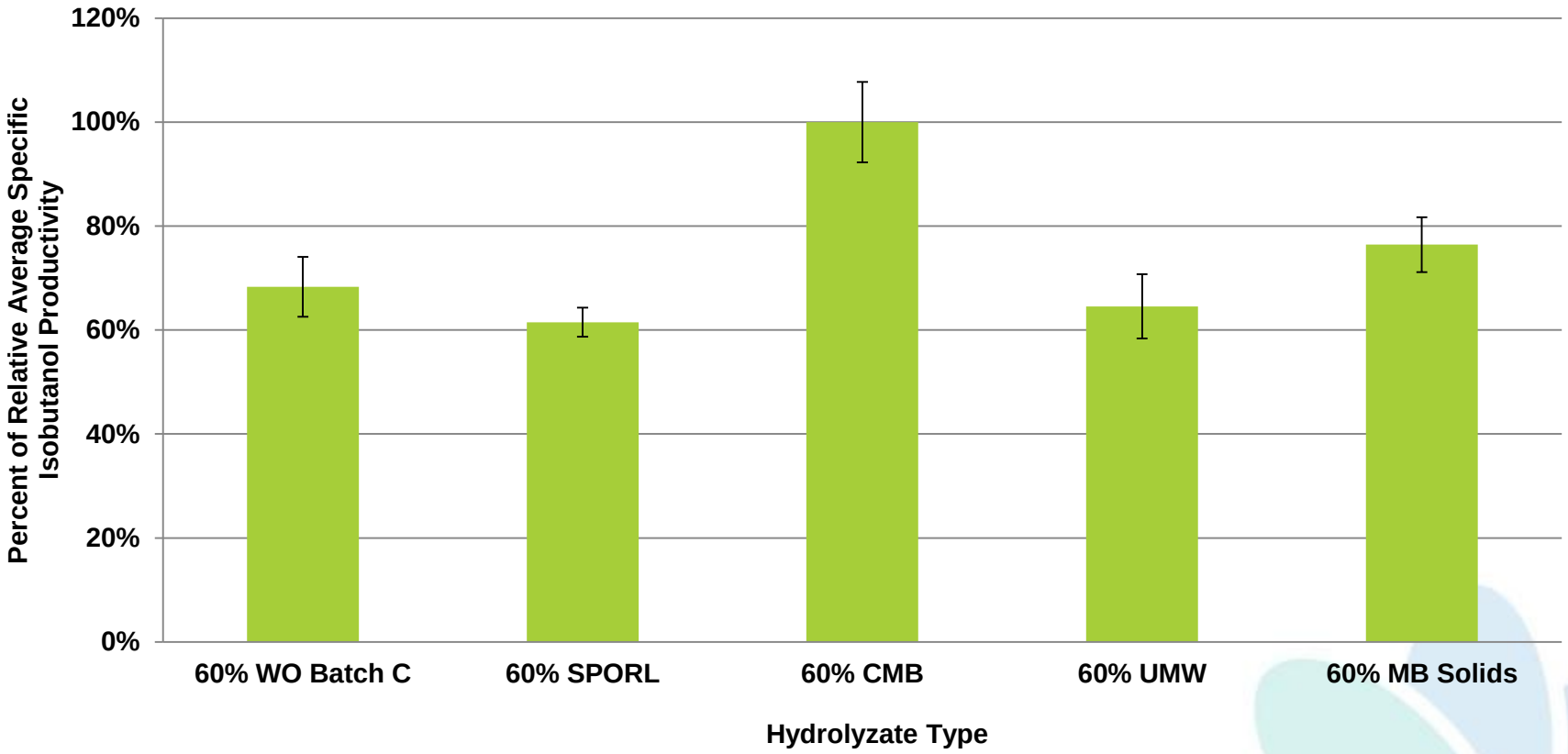
Isobutanol Titers of LB4 in Pretreated Douglas Fir Hydrolyzates



- Abbreviations: CMB (Combined Mild Bisulfite), UMW (Unconcentrated Milled Wood), WO (Wet Oxidation), SPORL (Sulfite Pretreatment to Overcome Recalcitrance of Lignocellulose), MB (Mild Bisulfite)
- Isobutanol producing biocatalyst LB4 was grown in fermentors with 20% (v/v) of each hydrolyzate type, and then harvested and pitched into GIFT® fermentation systems with 60% (v/v) of each hydrolyzate.

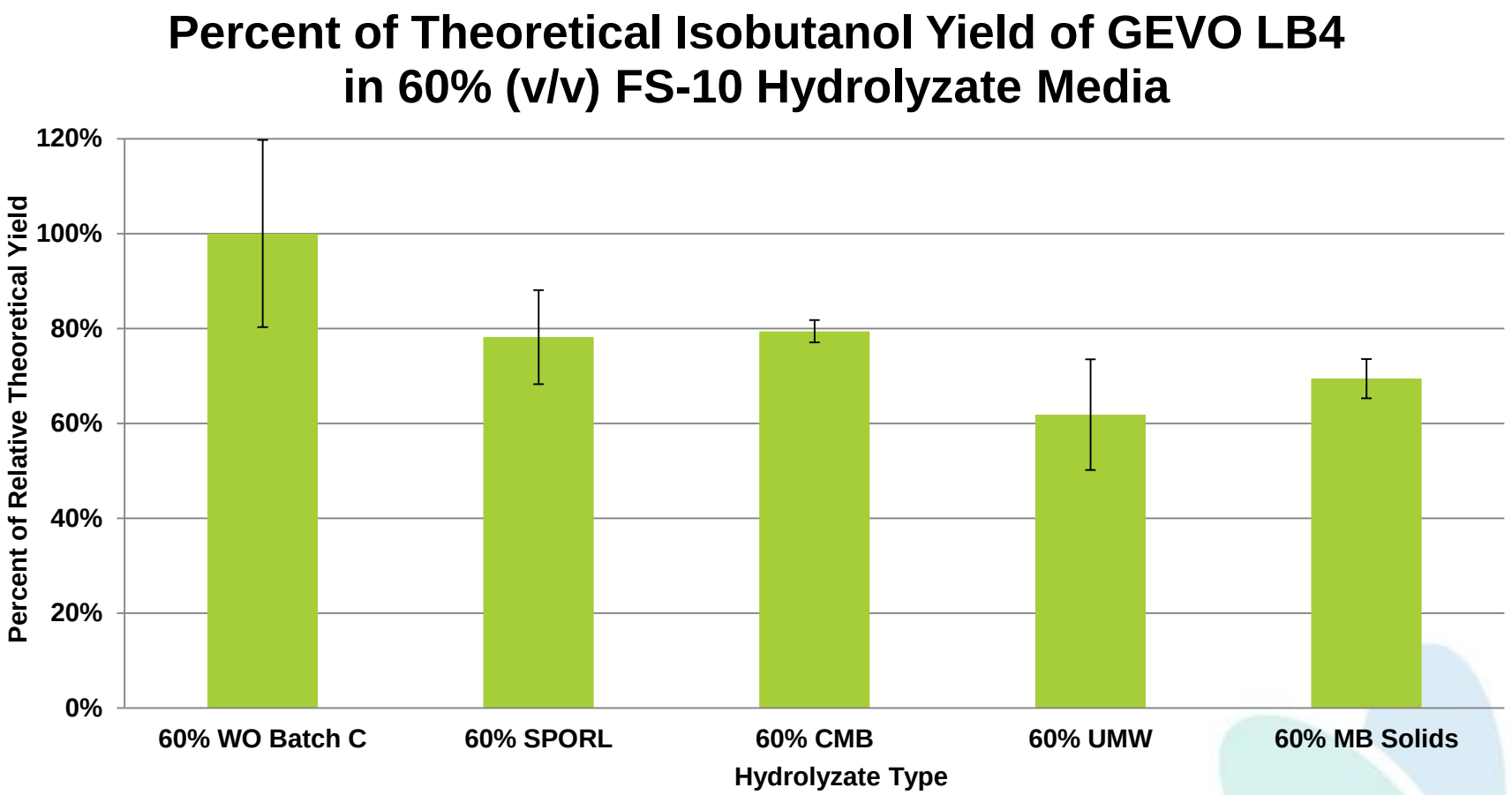
Isobutanol Productivity at 1L GIFT® Scale

Average Specific Isobutanol Productivity in Pretreated Douglas Fir Hydrolyzates



- Average specific isobutanol productivity is the amount of isobutanol produced per cell density over time ($g_{isobutanol}/g_{DCW}$-h)
- Abbreviations: CMB (Combined Mild Bisulfite), UMW (Unconcentrated Milled Wood), WO (Wet Oxidation), SPORL (Sulfite Pretreatment to Overcome Recalcitrance of Lignocellulose), MB (Mild Bisulfite)
- Hydrolyzate adapted isobutanol producing biocatalyst LB4 was grown in fermentors with 20% (v/v) of each hydrolyzate type, and then harvested and pitched into GIFT® fermentation systems with 60% (v/v) of each hydrolyzate.

Percent of Theoretical Isobutanol Yield at 1L GIFT® Scale



- Percent of Theoretical Yield is calculated by dividing the experimental isobutanol yield by the maximum theoretical isobutanol yield
- Abbreviations: CMB (Combined Mild Bisulfite), UMW (Unconcentrated Milled Wood), WO (Wet Oxidation), SPORL (Sulfite Pretreatment to Overcome Recalcitrance of Lignocellulose), MB (Mild Bisulfite)
- Hydrolyzate adapted isobutanol producing biocatalyst LB4 was grown in fermentors with 20% (v/v) of each hydrolyzate type, and then harvested and pitched into GIFT® fermentation systems with 60% (v/v) of each hydrolyzate.

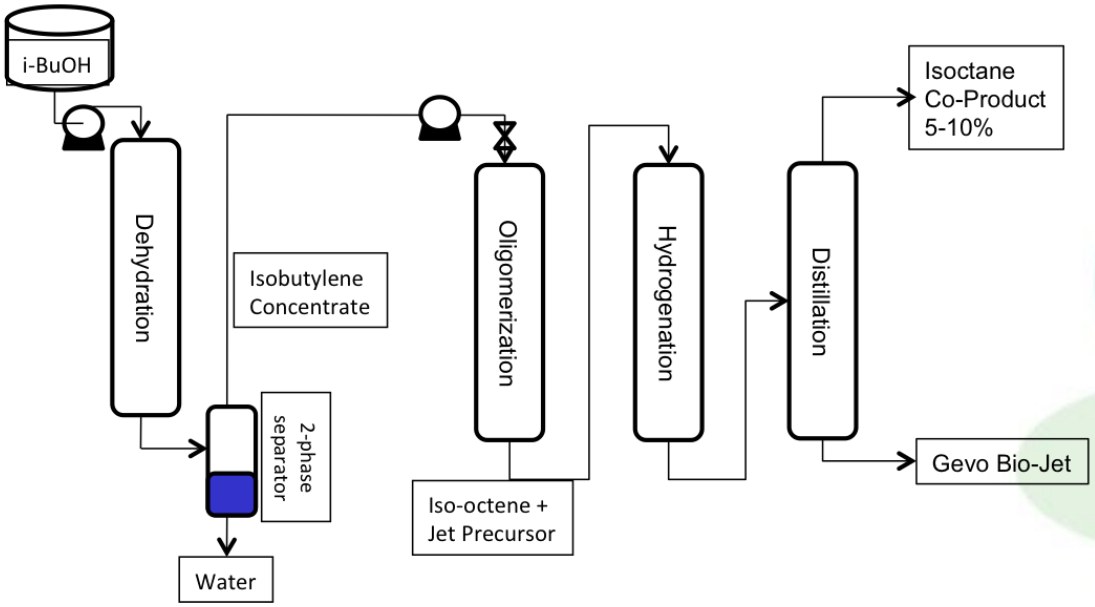
Gevo's Alcohol to Jet Process

Synthetic Alcohol-to-Jet (ATJ)

Alcohols → Olefins → Kerosene Jet Blendstock

- Fermentation

isobutanol → isobutylene concentrate → isooctene + jet precursor → isooctane (MON ~95) + Gevo Jet



Gevo Hydrocarbon Demo Plant – Silsbee, TX

Major Products

Jet Fuel Blendstock

Para-xylene (for PET)

- Hydrocarbon demonstration facility
  - Jet production started up Dec 2011
  - Delivered ~30,000 gallons of isobutanol-derived jet fuel to the Air Force, Army and Navy
  - PX Demo startup Oct 2013
  - Nameplate capacity 8,000 gal/month isobutanol feedstock.
  - Isooctane and other renewable hydrocarbons produced as byproduct of jet process have been sampled and sold to customers.

Gevo ATJ Fuel Makes History in USAF Flight

"It flew like a usual A-10 without any issues."

Maj. Olivia Elliott
A-10 pilot

U.S. AIR FORCE

"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

Gevo ATJ Powers US Army Black Hawk Flight

US Army flew a Sikorsky UH-60 Black Hawk helicopter on a 50/50 blend of Gevo ATJ

"This test is the final milestone test leading to certification of the Black Hawk for use with ATJ fuel blends. ATJ is a renewable, drop in alternative fuel for JP8 that addresses the Army Energy Security Strategy and Plans mandate that the Army certify 100% of its air platforms on alternative/ renewable fuels by 2016."

The Significant Activity Report from the U.S. Army


gevo®