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Sugars, Renewable Chemicals & Fuels

US EIA AEO 2013 Biofuels Workshop

Washington, DC

March 2013



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- **PROMOTUM** is a management consulting firm focused on the chemicals, fuels and materials industries. We help clients analyze markets and technology, develop strategy, and conduct business development.



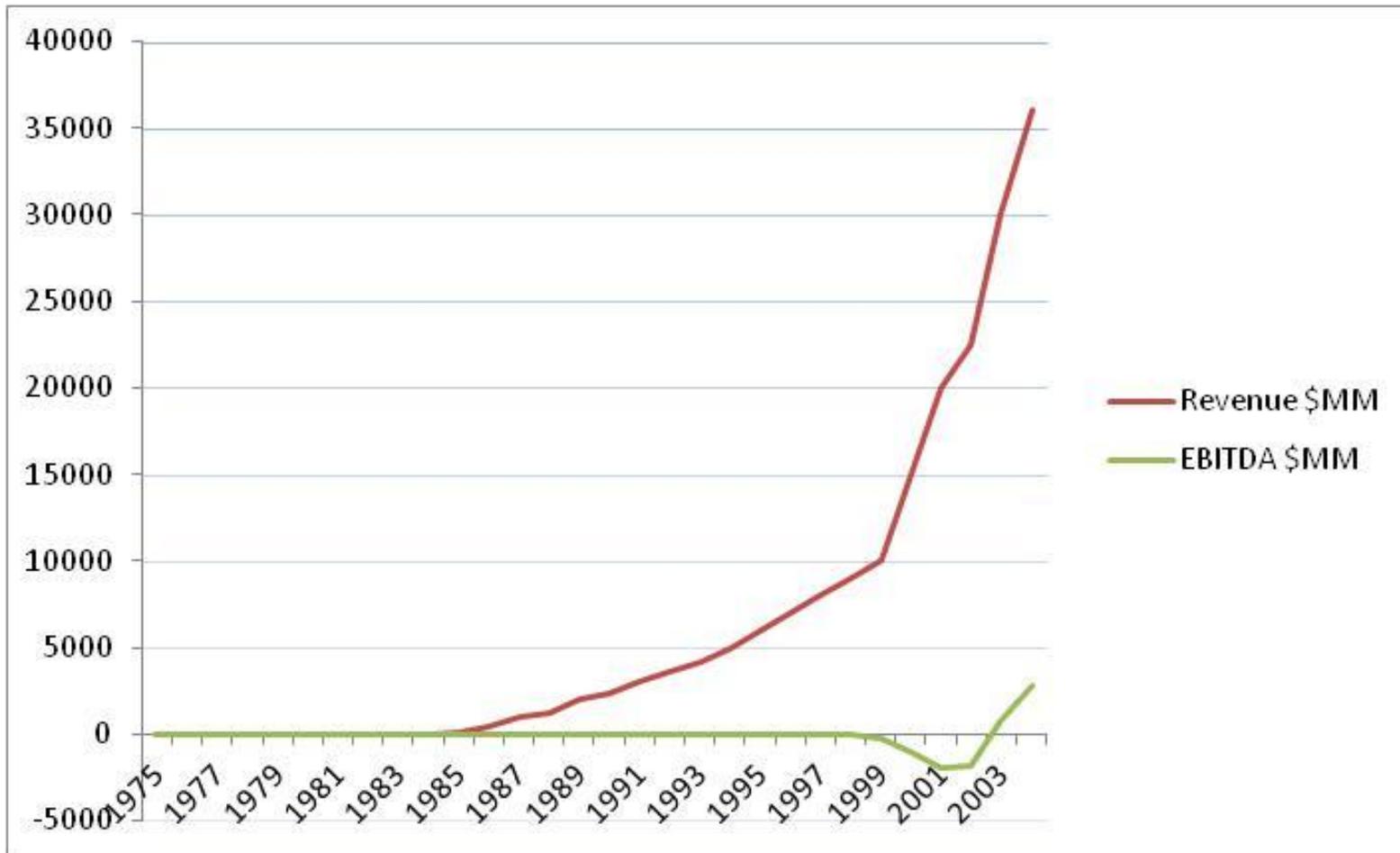
Sugar, Fuel & Chemical Agenda – Where are we?

- 1. Comparison of the first wave of Biotechnology with today's wave of Industrial Biotechnology**
2. Where are we status of: C-Sugars, Renewable Chemicals & Advanced Biofuels
3. Derivates as chemical building blocks – butanol an example



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Aggregate Biotechnology Industry Performance – The First 30 Years





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“There is little doubt that, since the invention of genetic engineering technology in the early 1970s, we have been living amid one of the greatest scientific revolutions in human history. Many expected that this scientific revolution would lead to a vast trove of new drugs, and these would create massive economic profits.”

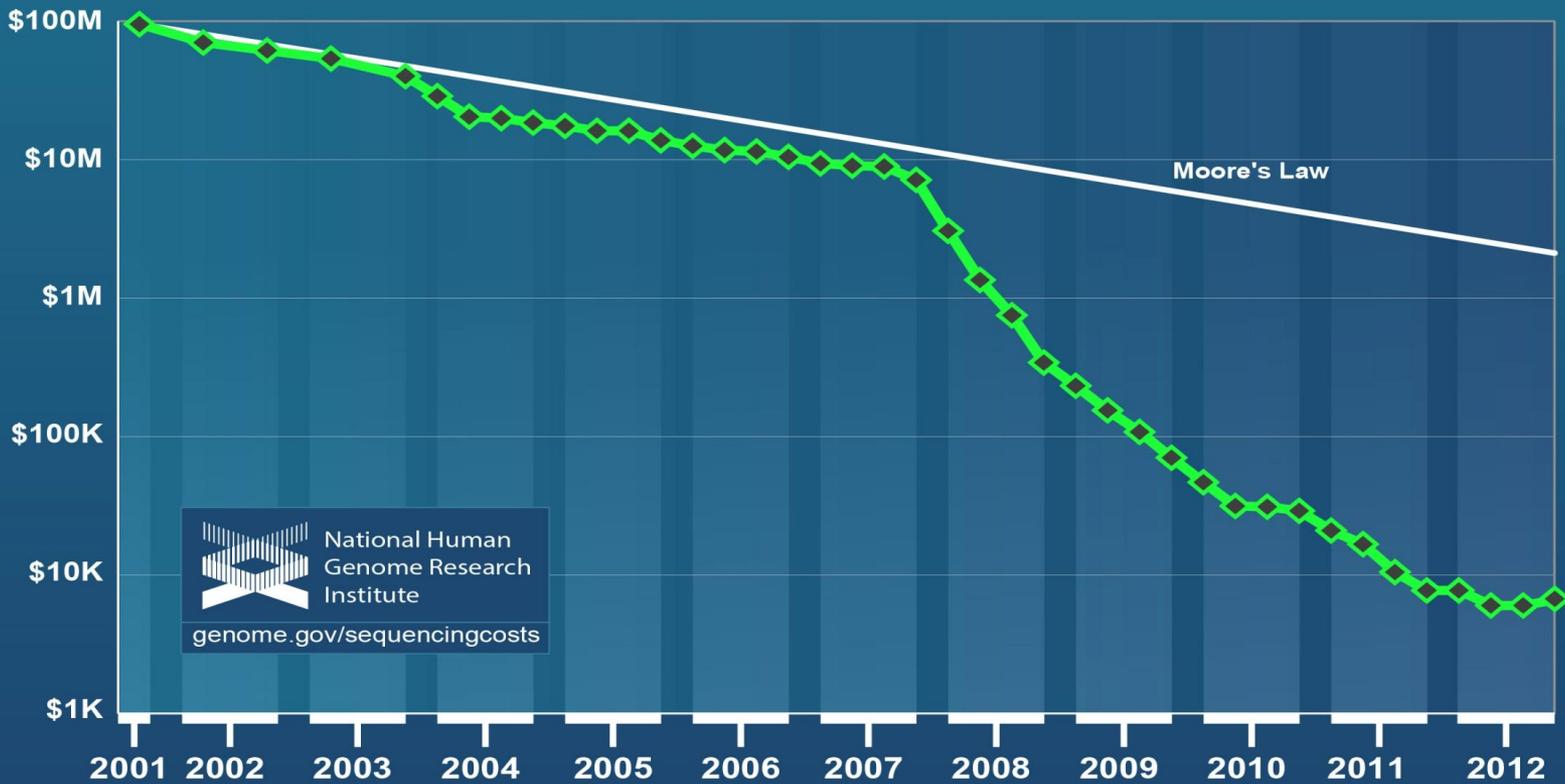
“While there have been a few very successful biotechnology firms, the economic performance of the sector overall has been disappointing by any objective standard. While revenues have grown, profits have hovered consistently at or below zero. The vast scientific success has yet to translate into financial success or improved drug R&D productivity.”

- Gary Pisano, Harvard Business School



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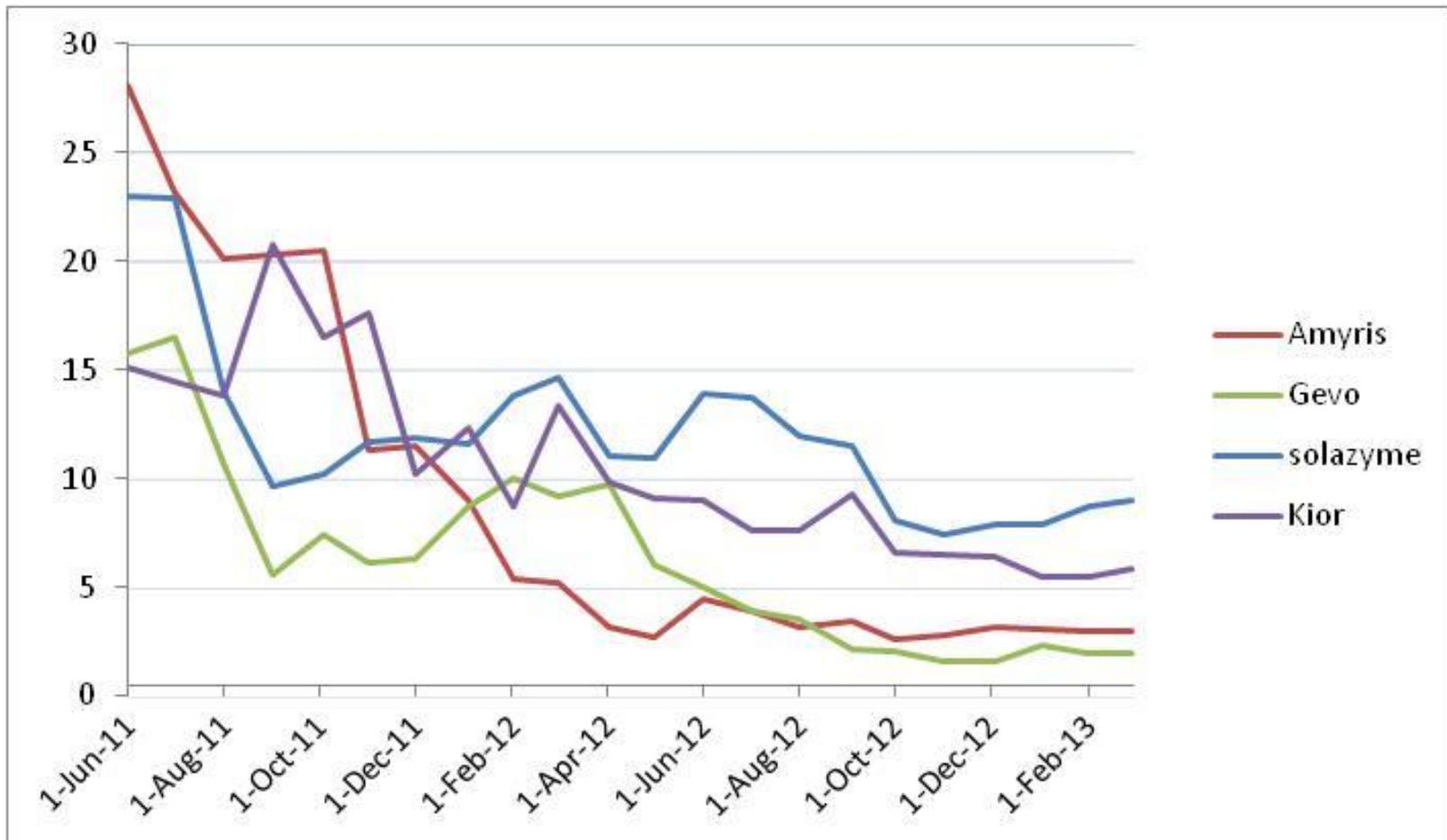
Cost per Genome





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Advanced Biofuels & Chemicals - Sector Performance Monthly Ave Price (\$/Share)



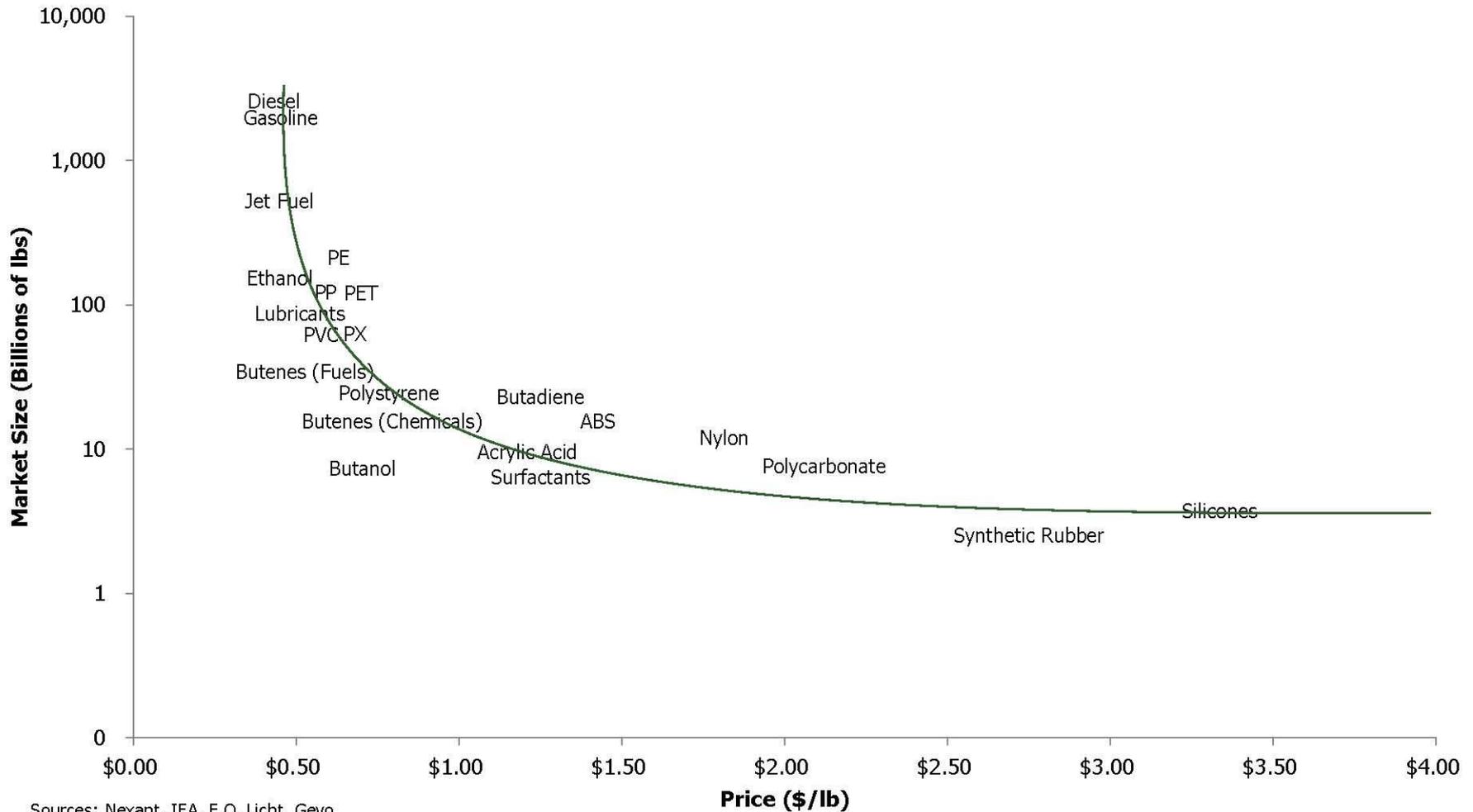


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Chemical, Fuels & Polymer Market Size v. ASP





“We have a brief window to prove ourselves, otherwise they’re going to run out of patience and we’re going to run out of money.”

- Cellulosic Sugars Executive



Cellulosic Sugars Companies

American Process, Beta Renewables, Blue Sugars, Bunge, Catchlight Energy, Midori Renewables, Proterro, Renmatix, Sweetwater, Virdia, Enerkem, Envergent, Fiberight, Fulcrum, Haldor Topsoe, INEOS Bio, Iogen, POET

- Cane, Energy crops, Waste
- Quality and standards
- C5/C6 issues
- Logistics
- Supply chain security



Biobased Chemicals – Who’s Pursuing What?

Molecule	Applications	Companies Pursuing
Butanol	solvents, paints, fuel, butyl rubber, PET	Gevo, Butamax, Cathay, Green, Cobalt
Adipic Acid	nylon, polyurethane	Verdezyne, Rennovia, BioAmber, Genomatica
Succinic Acid	solvents, BDO, PBS, PBT	BioAmber, Myriant, DSM/Roquette, BASF/Purac
Butanediol	PBS, PBT	Genomatica, LanzaTech, BioAmber
Butadiene	butyl rubber, ABS	Genomatica, Amyris, Others
Isoprene	butyl rubber, ABS	GlycosBio, AE Biofuels/Zymetis, Amyris
Propanediol	fibers, polyurethanes, PTT, cosmetics	DuPont/T&L, GlycosBio
Acrylic Acid	coatings, adhesives, plastics	OPX Bio, Itaconix, Novomer
Furans	polyesters, polyurethane, fuel	Avantium
Terephthalic acid	PET, plasticizers	Amyris, Avantium, Gevo



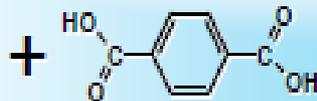
Gold Standard – DuPont/Tate & Lyle PDO Process



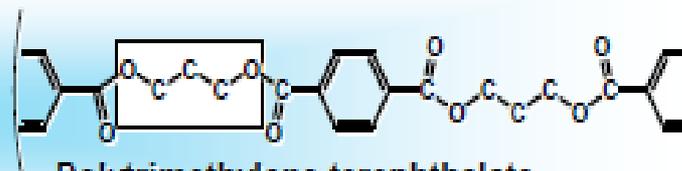
PTT (Sorona[®])



1,3-Propanediol
(PDO)



Terephthalic Acid

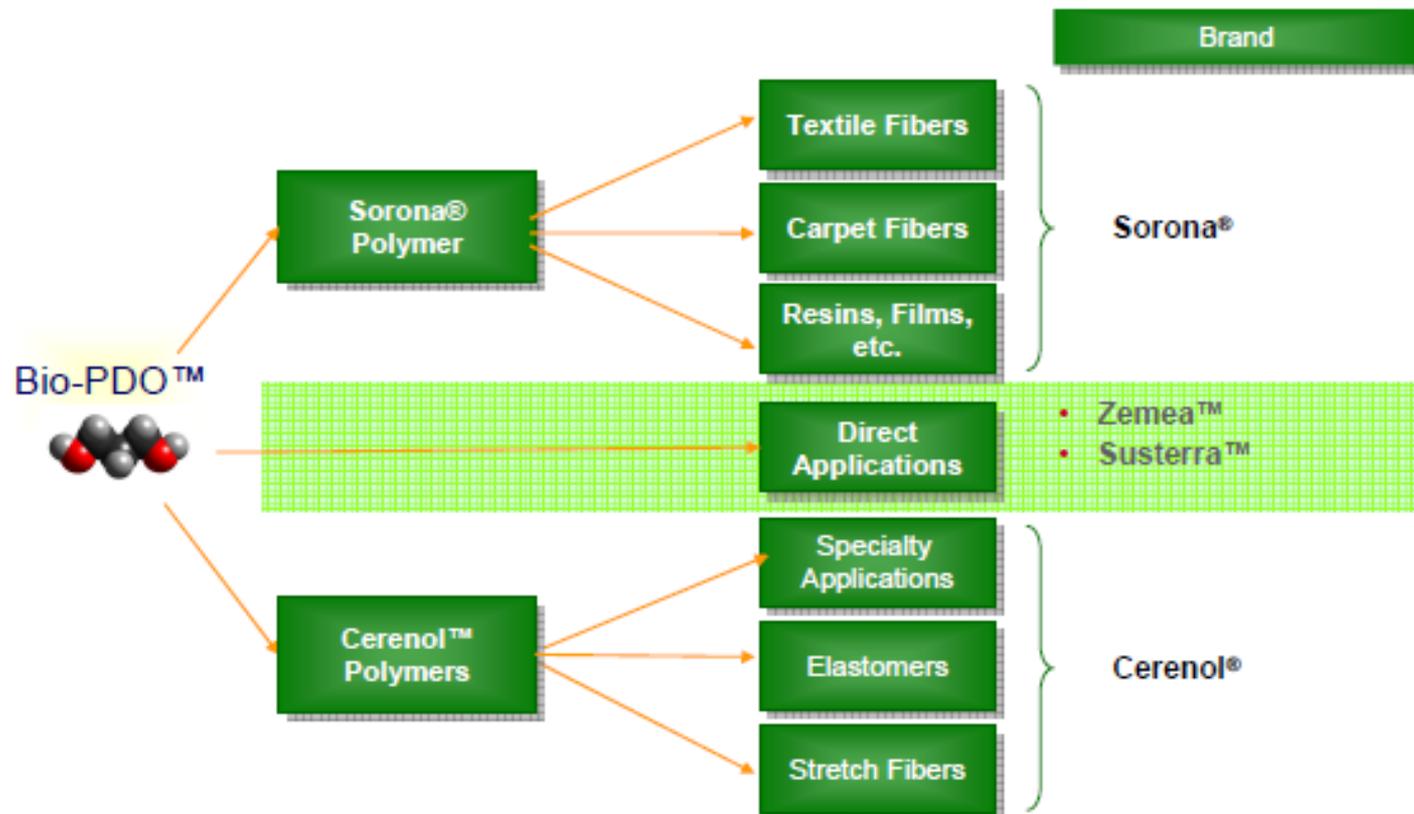


Polytrimethylene terephthalate



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The DuPont Bio-PDO™ Value Chain





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The (*long*) DuPont Sorona® Journey !

1946 - first DuPont internal report

1960's, 70's, and 80's – worked off and on towards various chemical PDO options

2Q95 – first isolated bio-PDO; Genencor collaboration begun; Shell entered PTT

1Q96 – first batch in Carother's autoclave – chemical PDO

3Q96 – first batch made in a plant autoclave

4Q96 – first PTT carpet fiber spun in Seaford, DE

2Q97 – first commercial (batch) production, broad bio patent allowed

4Q98 – Chemical PDO plant opened in Wesseling, Germany

2Q99 – Chemical PDO source qualified, Tate & Lyle selected for Bio

1Q00 – launched Sorona® with chemical PDO using converted CP at Kinston, NC

2002 – achieved commercial Bio-PDO™ catalyst performance in pilot plant

2003 – Mohawk Smartstrand™ Carpet Launch

2005 – broke ground for Bio-PDO™ plant

2006 – 100 MM ppy Bio-PDO™ plant started up – first shipment

2009 – FTC granted “Triexta” generic; Shell exited PTT

2010 – DT&L announced 35% Bio-PDO™ expansion

Bio
12
years

Chem
5
years

- Shell's threat to DuPont's nylon franchise motivated DuPont.
- If we had waited for Bio-PDO™, we could not have competed.
- **The commercialization of Bio-PDO™ accelerated Shell's exit.**



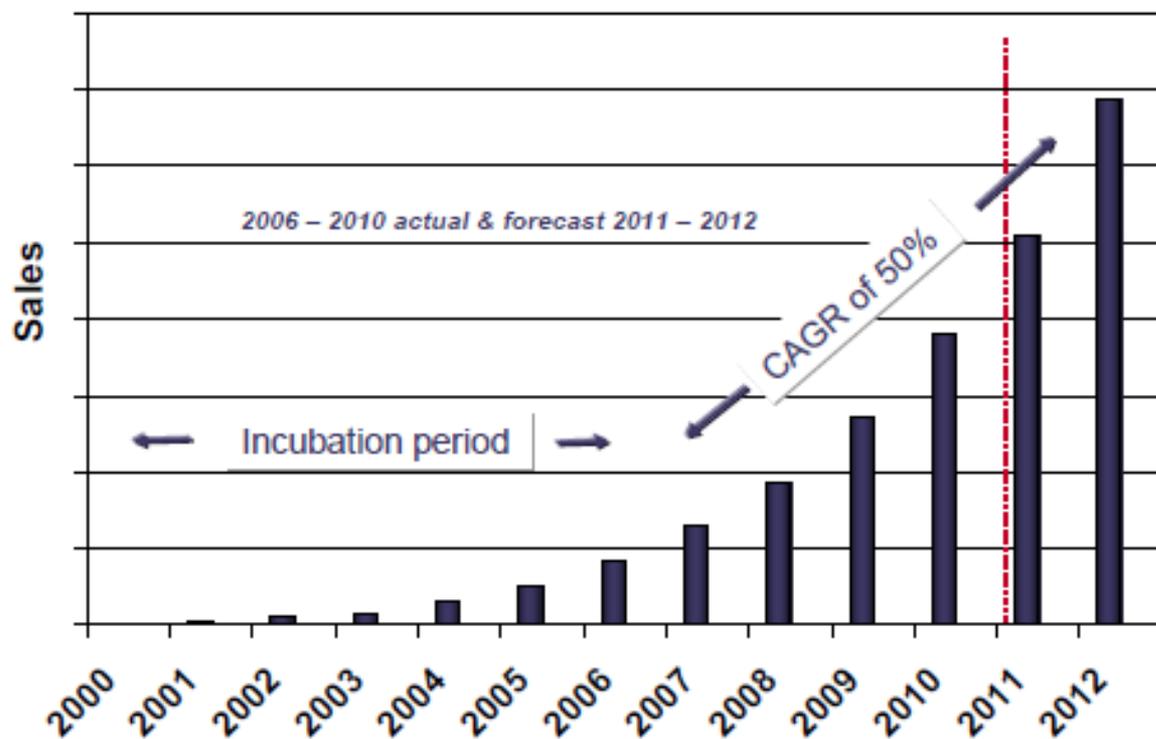


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Reward:

Sorona[®] Revenue

(ex PDO JV)





Advance Biofuel Companies & Status

Abengoa	Diamond Green	Fulcrum	POET
Aemetis	DuPont Cellulosic	Gevo	RenTech
Algenol pilot	Dynamic Fuels	Haldor Topsoe	Sundrop Fuels
American Process & Cobalt	EdeniQ & Logos	INEOS Bio	Terrabon
Beta Renewables	Logos Tech	logen	US Envirofuels
BlueFire	NextStep	Joule Unlimited	Virent
Blue Sugars Corp	Enerkem	KiOR	ZeaChem
BP- Vercipia	Envergent	LanzaTech	
Cool Planet	Honeywell/UOP & Ensign	LS9	
Coskata	Fibright	Mascoma	

Demo and Commercial; by Fuel Type:

	Company Count	2012	2013	2014	2015
Ethanol	24	14.225	126.325	267.325	337.225
Diesel	5	75.075	215.075	248.445	248.445
Gasoline	5	2.405	2.405	52.405	52.405
Butanol	1	19	56	56	56
Aviation	1	0.07	0.07	0.07	23.07
Multiple	1	11	11	11	11
Crude oil	2	0	0	1.1	1.1
TOTAL	39	121.775	410.875	636.345	729.245



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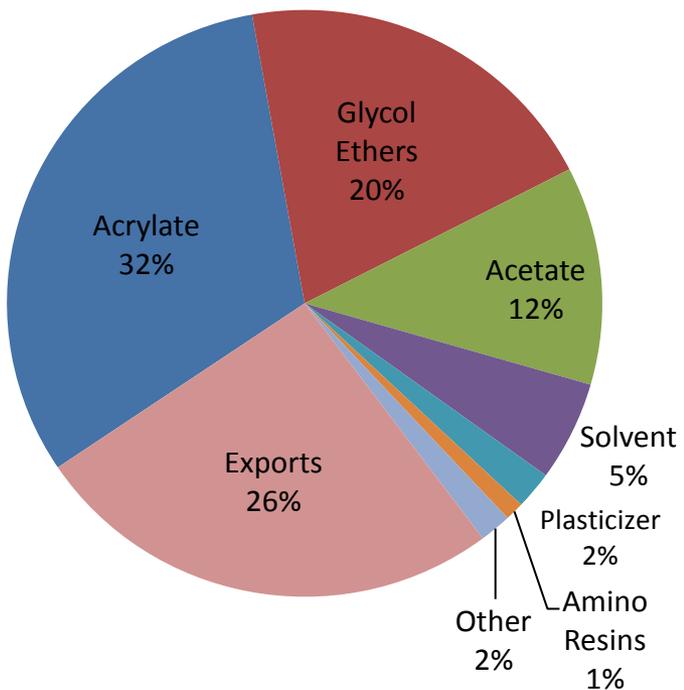


Why should anyone care about butanol?

Physical Property	i-butanol	n-butanol	Ethanol
Density at 20°C (g/cm ³)	0.802	0.810	0.794
Boiling Point at 1 atm (°C)	108	118	78
Water Solubility at 20°C (g/100ml)	8.0	7.7	Miscible
Net Heat of Combustion (BTU/gal)	95,000	93,000	80,000
R+M/2	103.5	87	112
Blend RVP (psi at 100°F) ¹	5.0	4.3	18-22

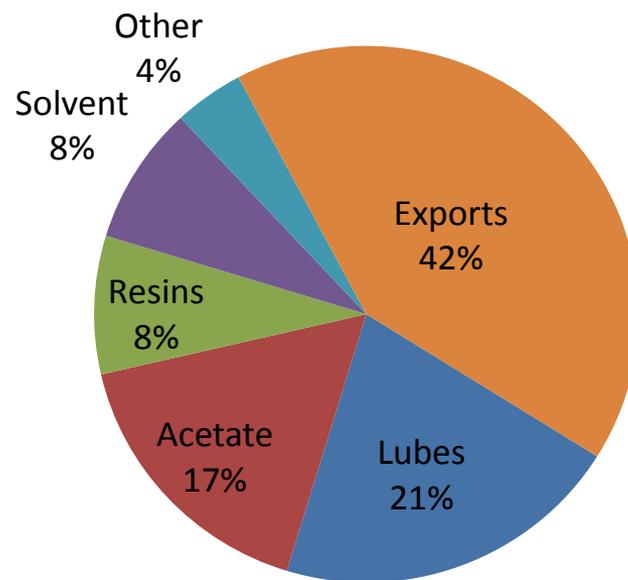


US N-Butanol Demand



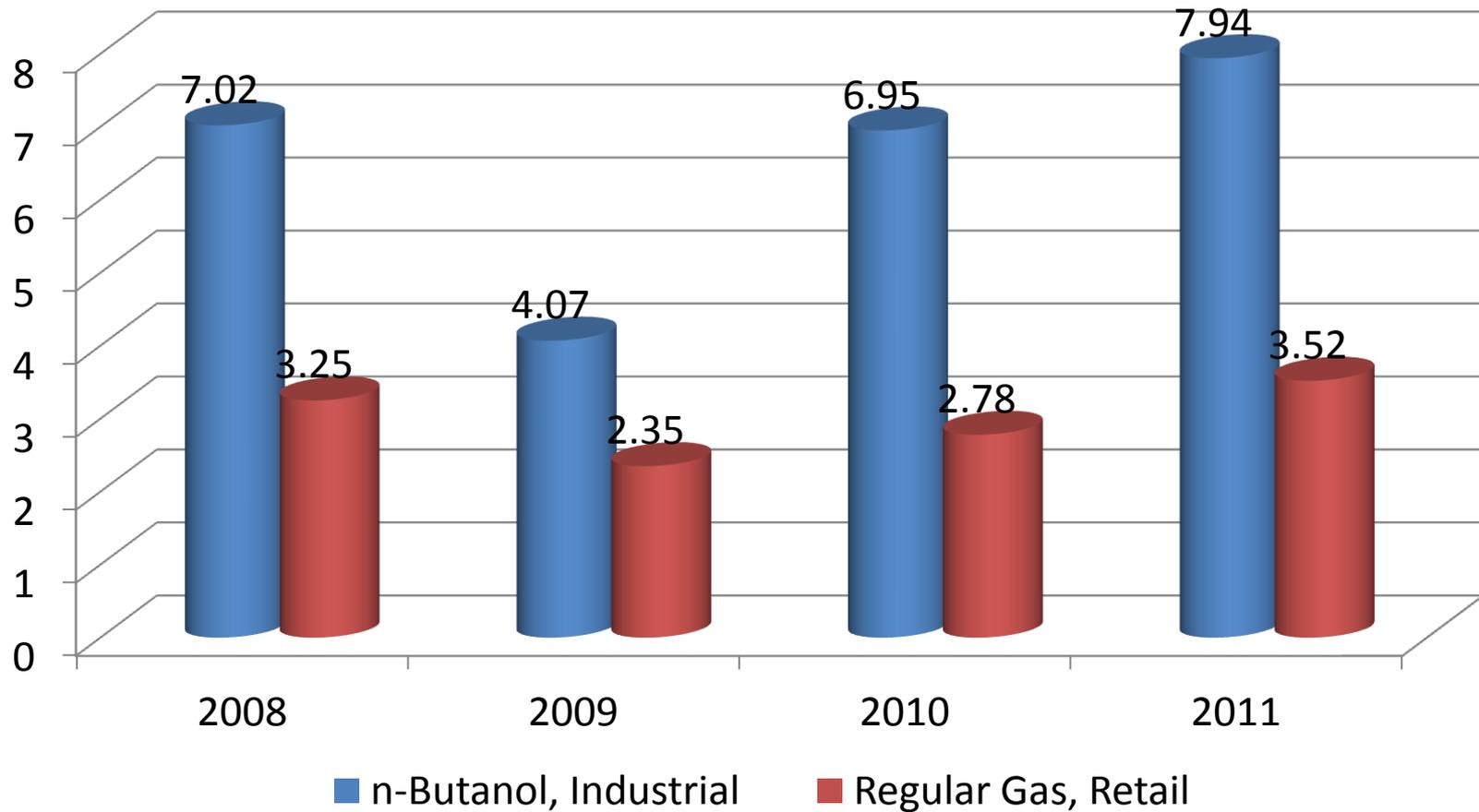
2012

US Iso-Butanol Demand



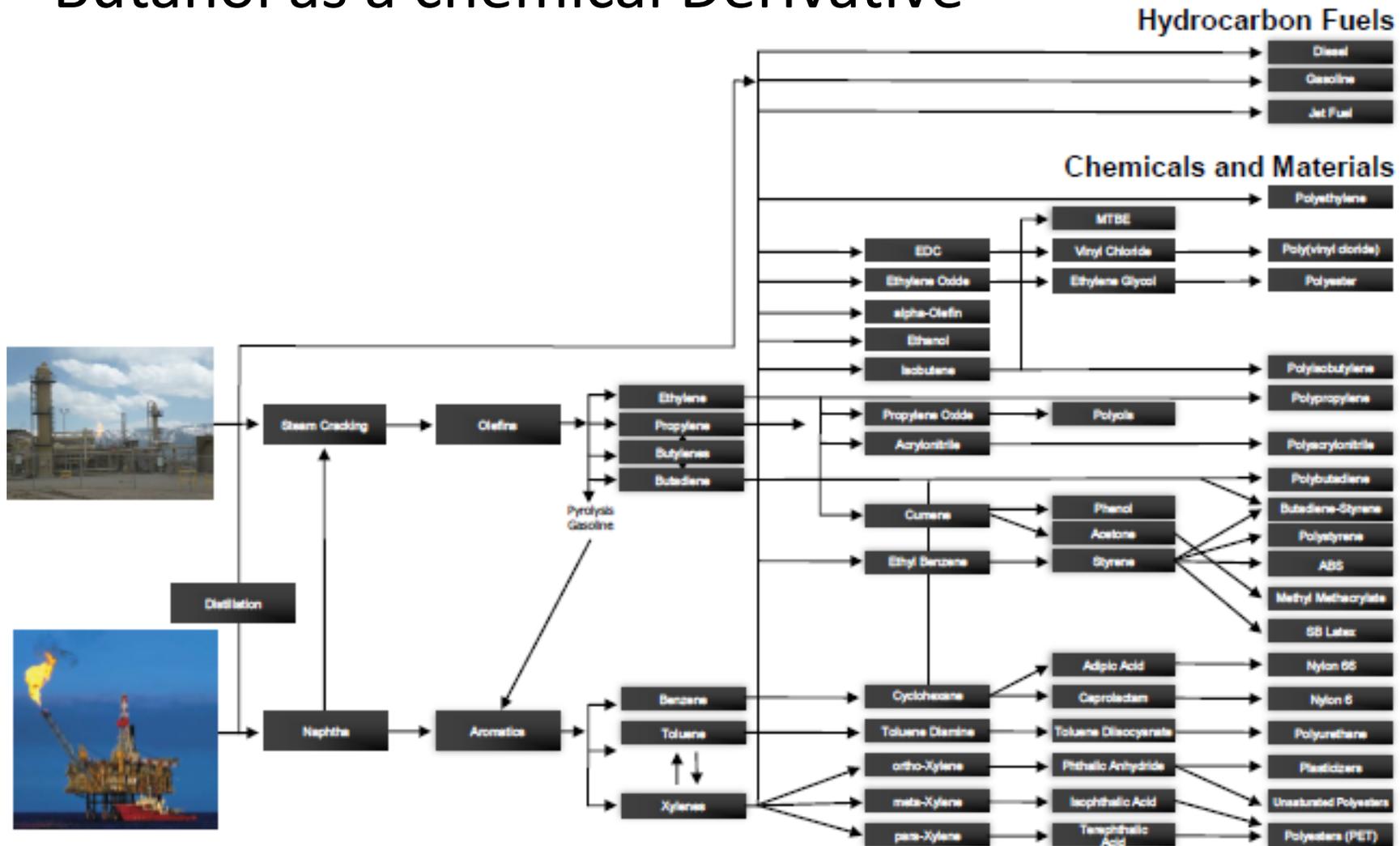


Butanol - Average US Market Price (\$/Gal)





Butanol as a chemical Derivative

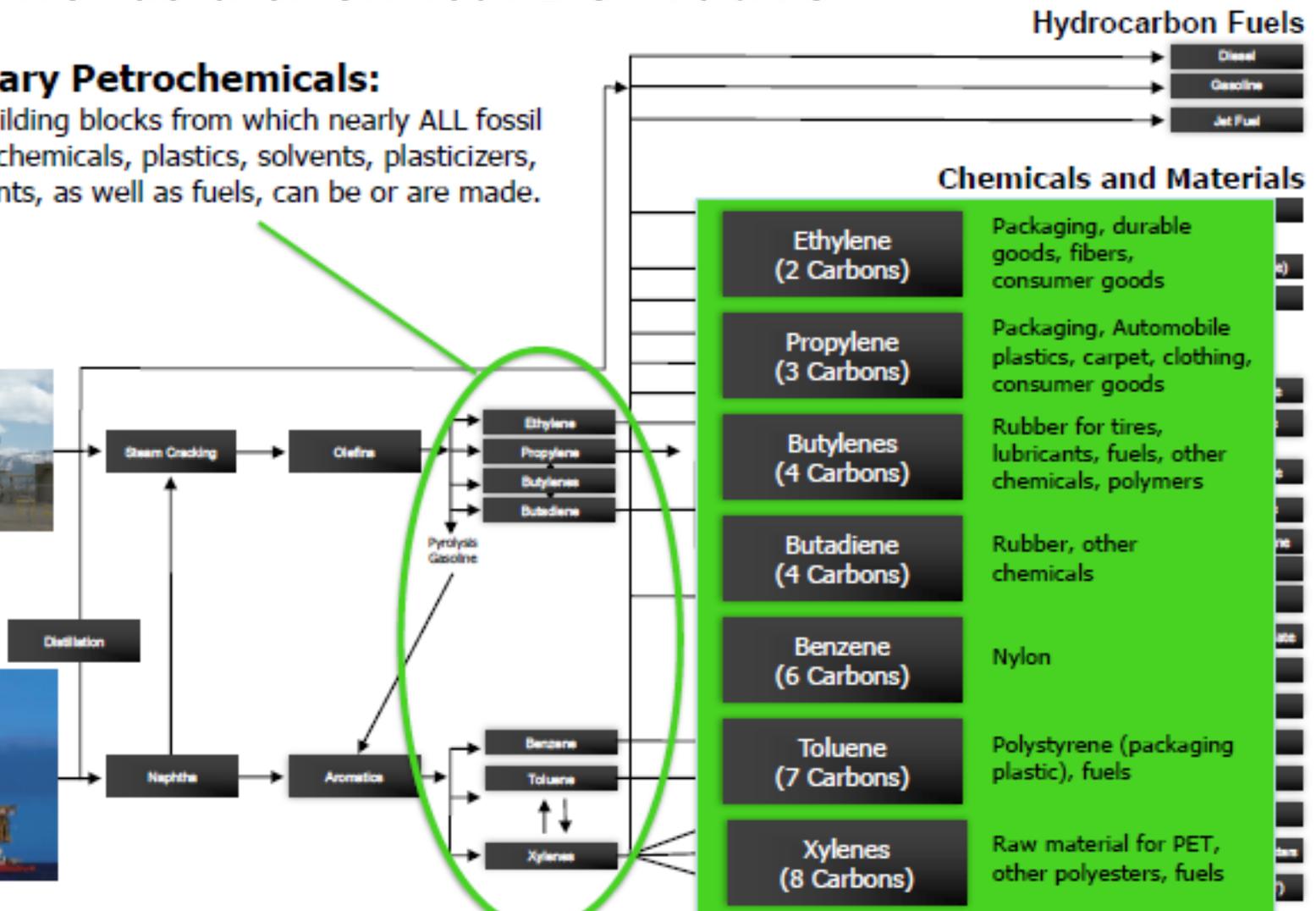




Butanol as a chemical Derivative

Primary Petrochemicals:

The building blocks from which nearly ALL fossil based chemicals, plastics, solvents, plasticizers, lubricants, as well as fuels, can be or are made.





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COMING SOON

BIOBUTANOL: THE GAME CHANGER

A Joint Study From:

**Chemical Strategies
JVP International, Inc.
Promotum**

**From the developer of "Biobutanol: The Next Big Biofuel" (Nexant 2008)
Scheduled for publication third quarter 2013**

Reduced pricing for early subscribers.



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Thank You

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