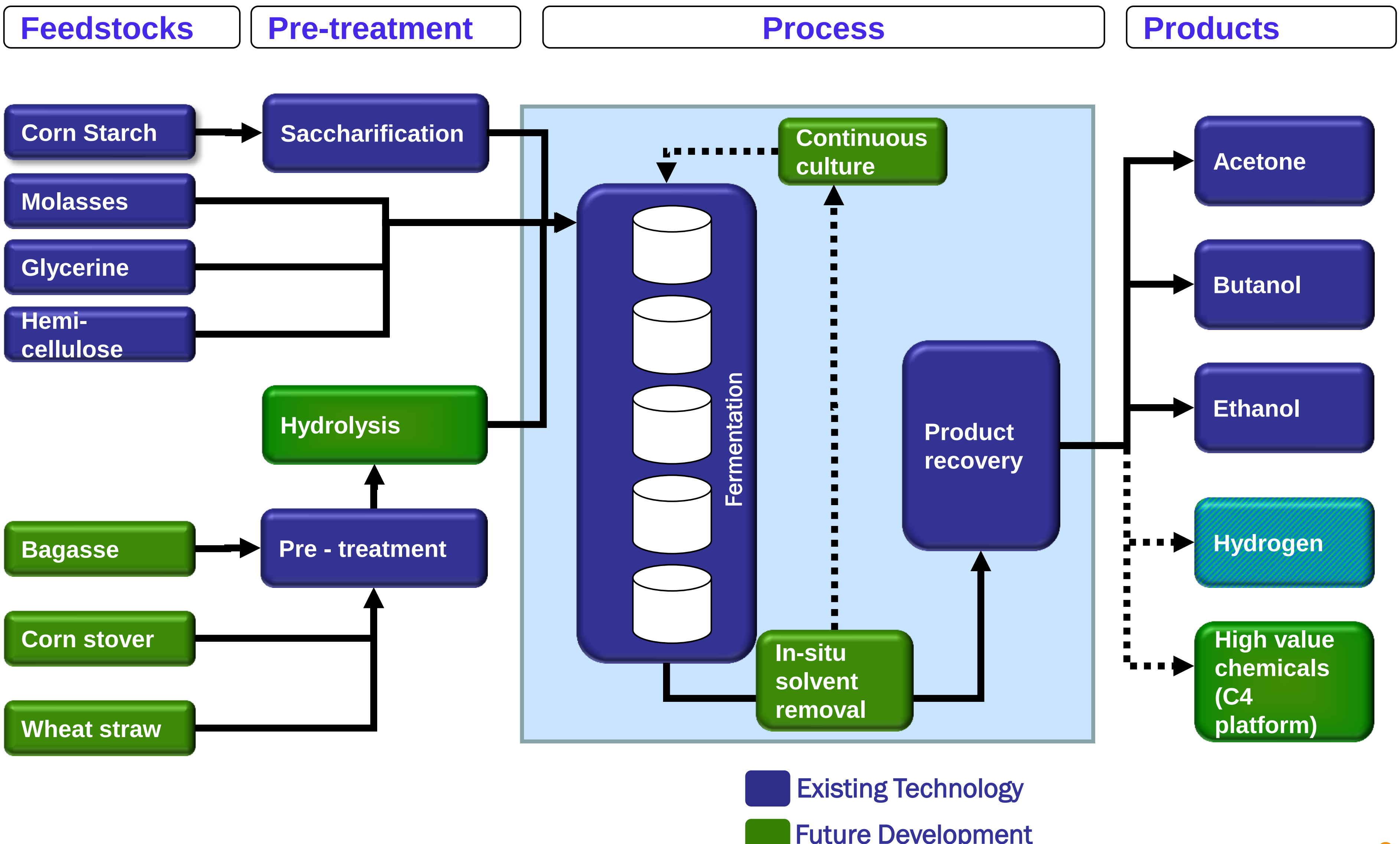
Commercialising Biobutanol

GBL Experience

- A UK (Oxford) based industrial biotech
- Founded 2003, VC backed
- Global leader in production of bio-butanol by fermentation
- Focus on the chemical market as accelerator to the biofuel market
- Team with proven commercial & technical expertise
- Technology Company focused on commercial deployment

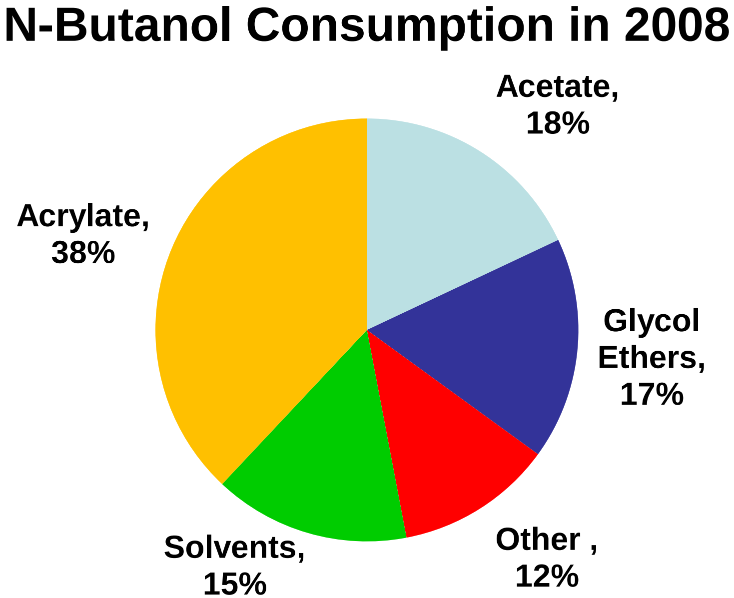
GBL's Process Expertise



Chemical Market

Chemicals Today
($4.3bn p.a. market, inc. at 4% p.a.)

- Achieve a premium price ($1800-2000/t)
- Used for paints, coatings, resins, polymers & solvents
- Bio-butanol can be used as a direct substitute (competes on price)
- Offers significant reductions in GHG emissions
- Growing demand for renewable chemicals



Biofuel Market

Biofuels Tomorrow
($50bn p.a. worldwide market inc. at 7.5% p.a.)

- Derived from multiple feedstocks
- High energy content
- Non-corrosive (can be shipped via pipeline)
- 1:1 replacement potential for gasoline
- Can be blended into diesel (up to 40%)
- Can replace gasoline in E85 fuel
- Reduces GHG emissions by 95%
- Reduces carbon monoxide emissions to .001% & oxides of nitrogen by 37%
- Regulations requiring biofuel blends guarantees the market (EU/US)

Cellulosic butanol will be a premium product at lowest cost

Fermentation Route

South Africa

- ABE process (1940’s to 1980’s)
- Struggled to compete with low cost oil
- GBL has unique process & production insights

China

- $200mn investment in 300,000 tonnes of capacity built in 2006
- In 2008, plants uneconomic due to a sharp drop in oil price
- Plants rely on corn starch & the fermentation technology is inefficient
- Require advanced technology solutions

ABE Production in China

Longlive,
Yucheng, Shandong x
Current: 3ktpa
cellulosic Ethanol
(Future: 10ktpa ABE)

Lianhua Chemical
Lianyungang ,Jiangsu
Current: 40ktpa

Songyuan Laihe Chemicals
Songyuan, Jilin
Current: 150 Ktpa
(Future: 200 Ktpa)

Jilin Cathay
Biotechnology,
Jilin, Jilin
Current: 100Ktpa
Future: 200 Ktpa)

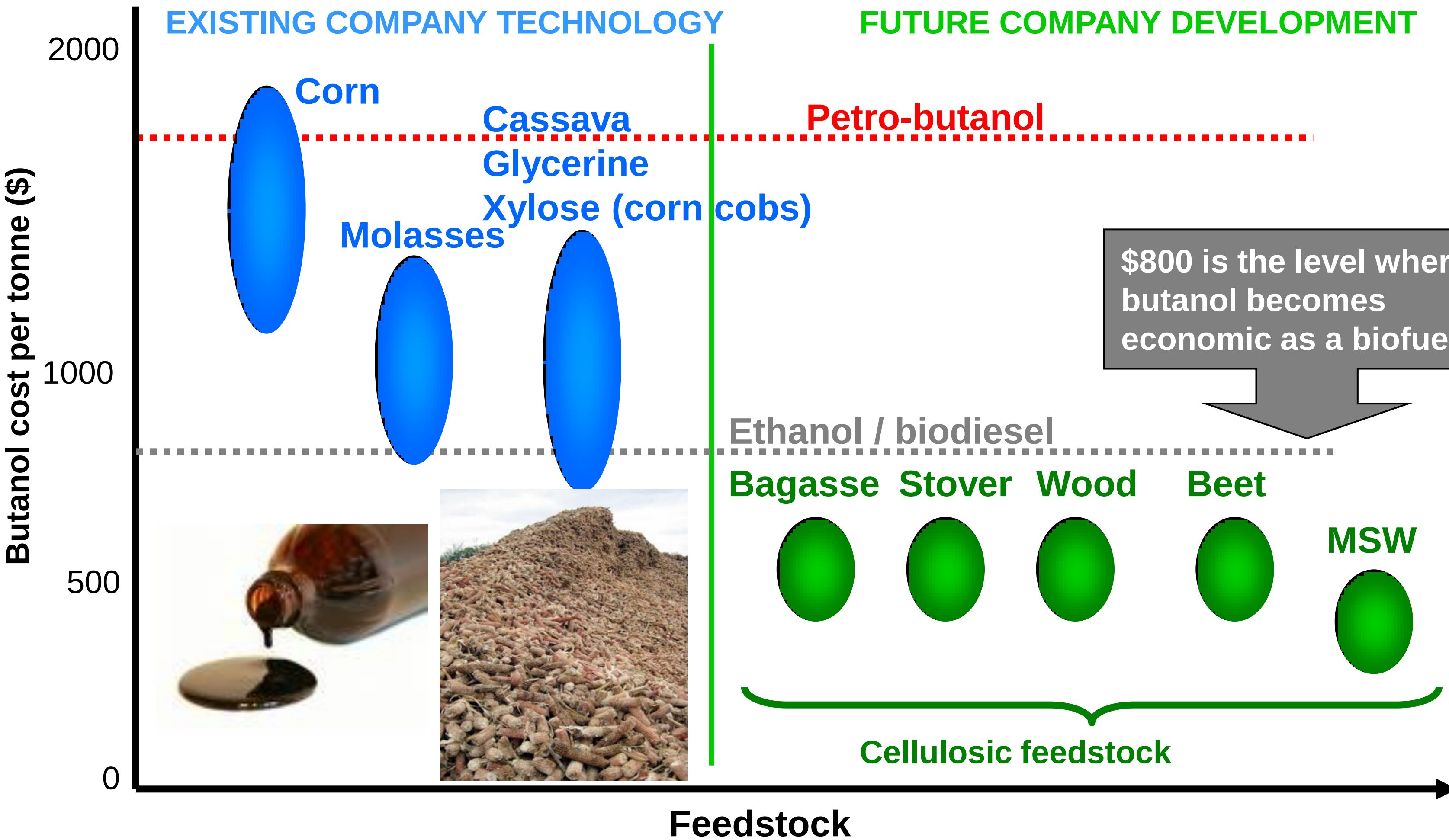
Tianzhiguan Renewable Energy,
Nanyang City, Henan
Current: 20ktpa
(Future: 40ktpa ABE)

Jinmaoyuan Biochemical,
Lianyungang, Jiangsu
Current: 50 Ktpa

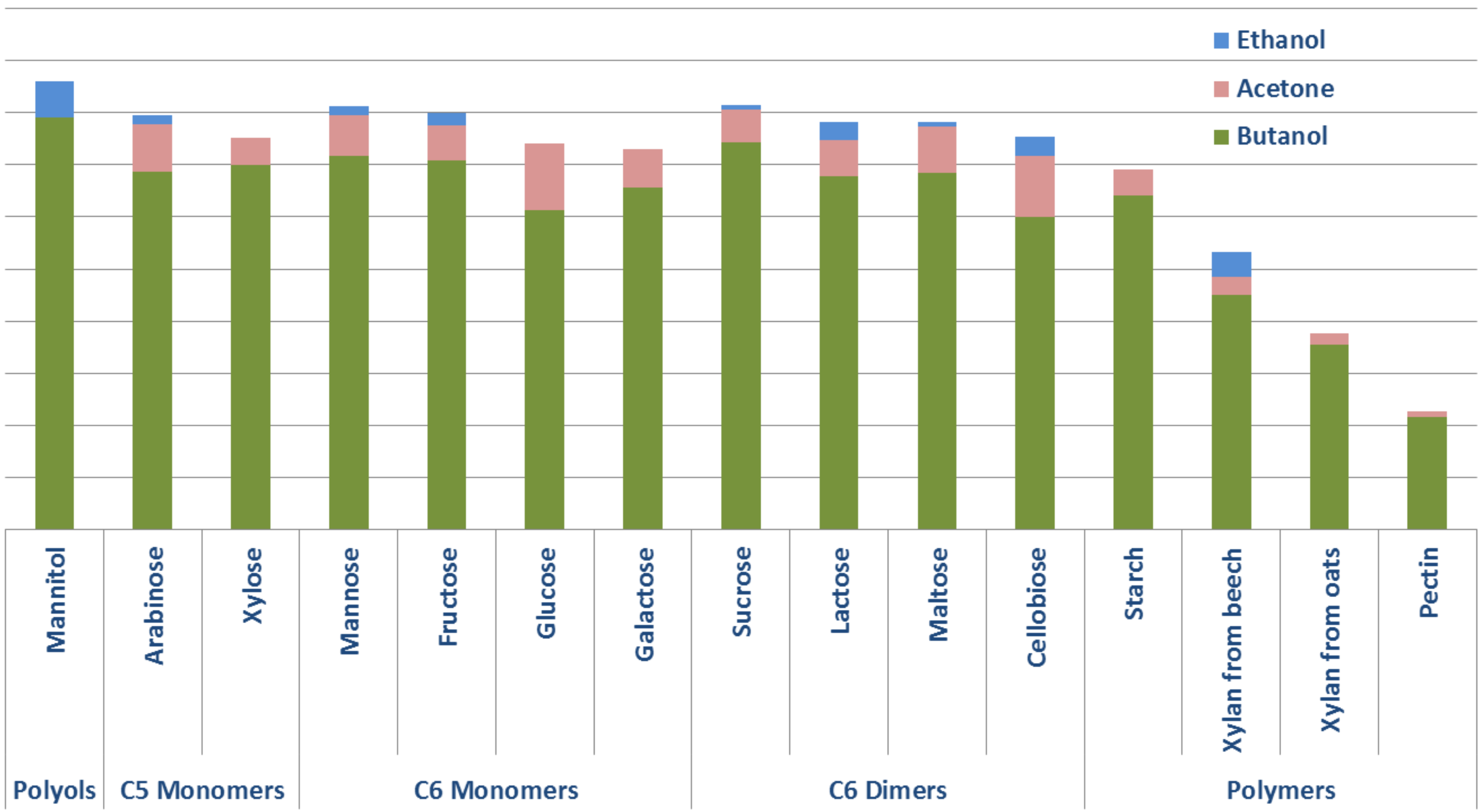
Guangxi Guiping Jinyuan Alcohol
Guiping, Guangxi
Current :30 Ktpa
(Future: 100 Ktpa)

Jiangsu Lianhai Biological
Technology,
Haimen, Jiangsu
Current:100 Kpta
(Future:600 Ktpa)

Cost Reduction (with cellulosic feedstocks)



GBL strains have a broad substrate range



Economic Yields on Industrial Feedstocks

Feedstock	Country	Pre-treatment/ Hydrolysis	ABE Yield	B:ABE Ratio
Molasses	India/China	Sugar mill	34%	69%
Cane & beet sugar	UK	Juice extraction	35%	79%
Corn starch	US	Thermal (cooking)	35%	79%
Corn shells	China	Mild acid (C5)	35%	78%
Corn stover	US	Steam explosion, enzymatic	37%	67%
Sugar cane bagasse	Brazil	Thermal-mechanical, enzymatic	34%	64%
Wheat straw	EU	Steam explosion, enzymatic	35%	66%
Rice straw	EU	Conc. Acid	31%	72%
Mixed hardwoods	US	Supercritical CO2/water	29%	83%
Paper pulp waste	US	Kraft pulp mill (C5)	29%	80%
Municipal solid waste	UK	Thermal (autoclave), enzymatic	25%	70%
Sugar beet pulp	UK/Canada	Mild acid, enzymatic		

Cost Reduction Matrix

	2010	2011	2014
Bio-butanol (corn)	$1450		
Fermentation (molasses)	$1140	$960	$870
Energy Efficiency		$940	$830
Cellulosic Feedstocks			$490

Productivity

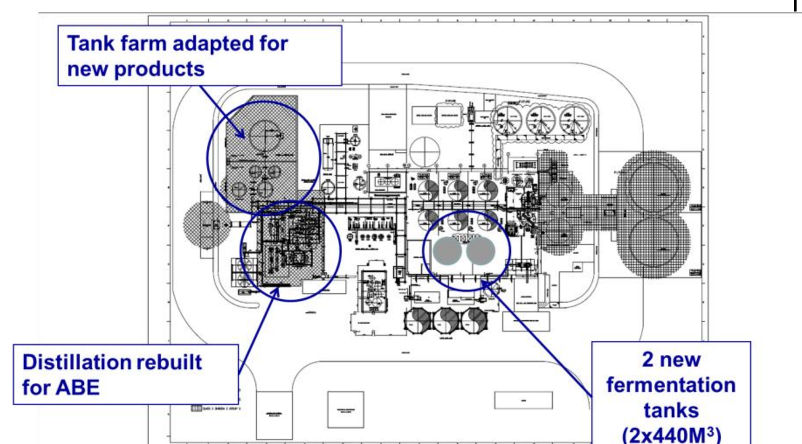
A two-fold increase can reduce CAPEX by 20%
($5 million for a 50,000t /a solvent plant)

GBL Today	**Molasses (India)**	$862
	Bagasse (Brazil)	$759

GBL Summary

Technology	• Butanol (ABE) • C4 chemical platform	Differentiated & superior
Focus	• Commercial reference sites • Demo sites (cellulosic feedstock)	Economic today Drive down costs Create low cost leadership for renewables
Markets	• Chemicals • Biofuels	Two stage
Commercialisation Strategy	• Butanol retrofit • Ethanol retrofit • Ethanol bolt on	Capital light Rapid Allows technology upgrades
Geographies	• China & US • Brazil & India	Available Assets Feedstock availability Chemical/biofuel markets
Business Model	• Technology licence/royalty • Product marketing/off-take • Own & operate	Develop with Company maturity

Commercial Projects

Butanol Retrofit		
Ethanol Retrofit		

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