Opportunities and Efforts for Commercialization of Industrial Biotechnology

2015 바이오 미래 포럼

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GS Caltex Corporation

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Contents

I. Industrial Biotechnology

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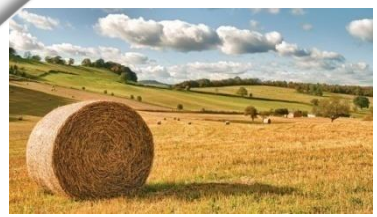
Definition Industrial Biotechnology

- Stop Pollution & Save the Earth

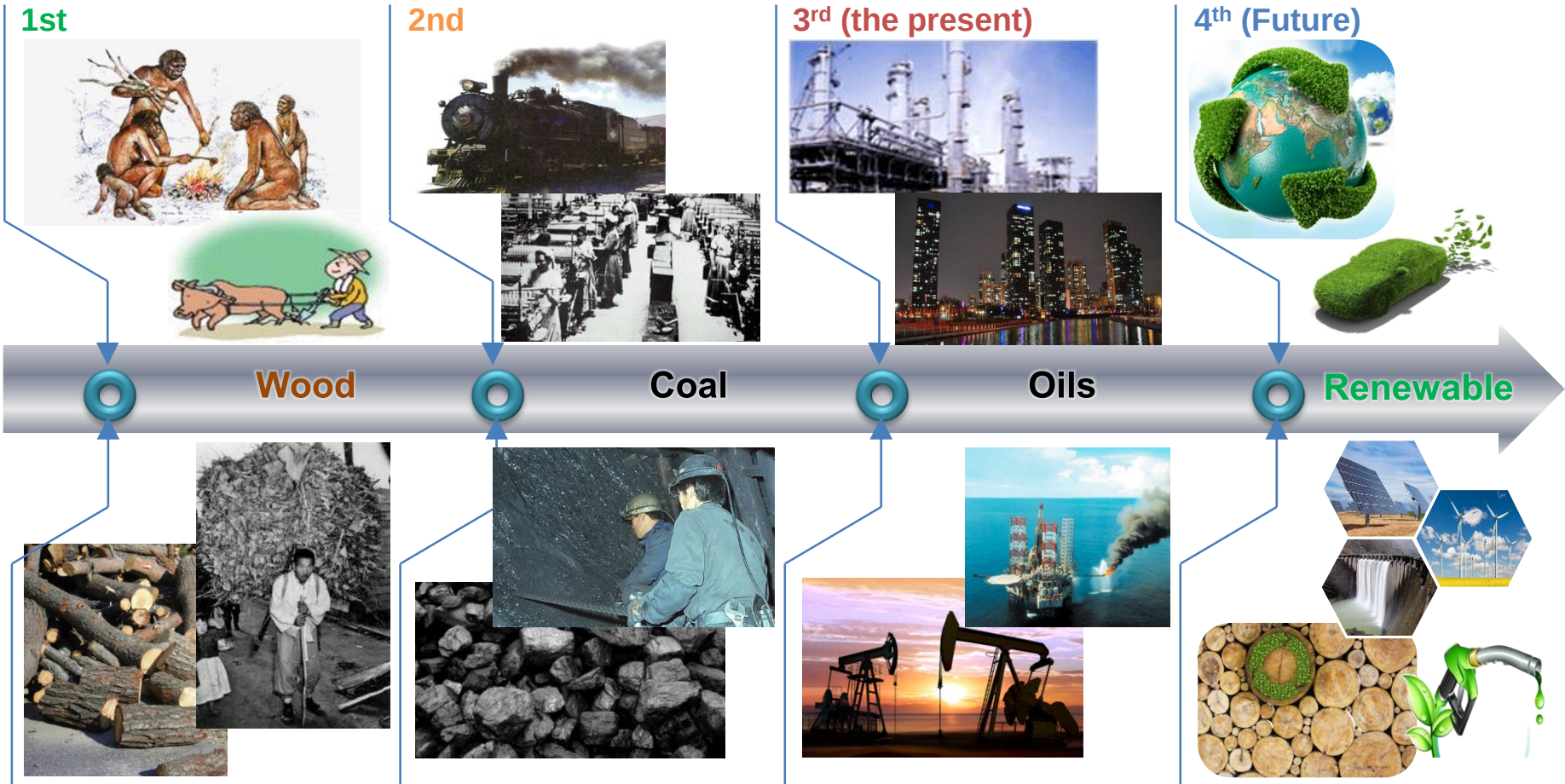
Fuels
Chemicals
Materials

Fuels
Chemicals
Materials



History Industrial Biotechnology

- **Human beings**



Characteristics Industrial Biotechnology

▪ Industrial Combination

Agricultural Industry

Bio Industry

Chemical Industry

▪ Industry Characteristics

Capitalist Large Scale Management (자본주의적 대규모 경영)	**Relatively Small Scale Management** (상대적으로 소규모 경영)	**Capitalist Large Scale Management** (자본주의적 대규모 경영)
Labor Intensive (특별한 기술이 요구되지 않음)	**Experience basis Technology** (기술 획득이 용이하지 않음)	**Process basis Technology** (Licensing을 통한기술 획득이 용이함)
High Capital Barriers	**High Technical Barriers**	**High Capital Barriers**

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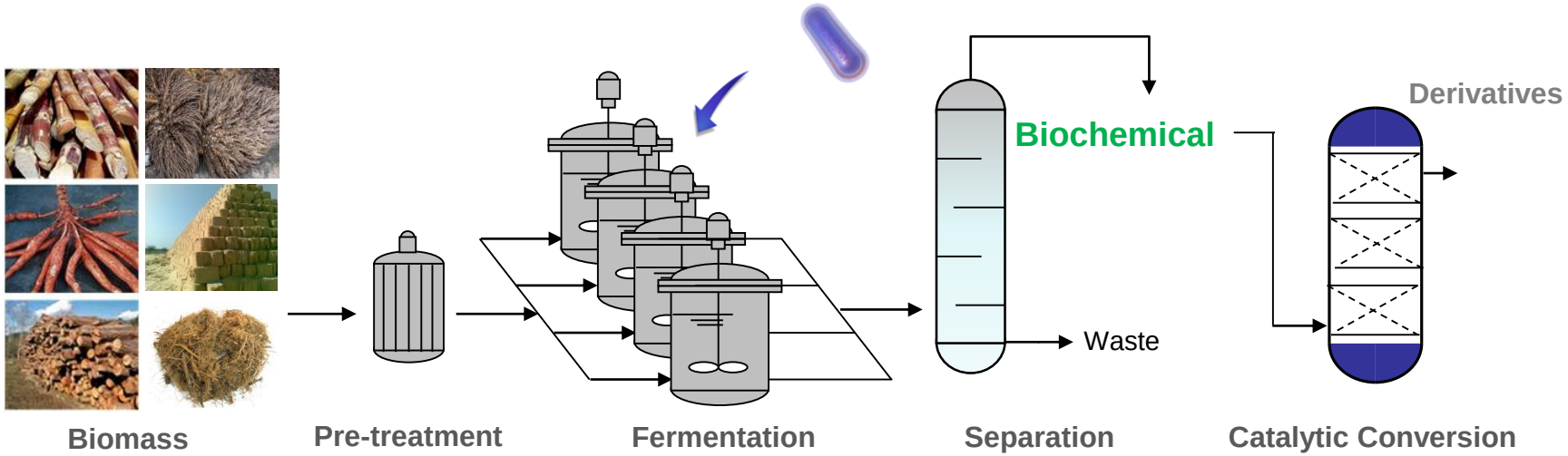
Economic Barriers Industrial Biomass & Biomass-based Industry

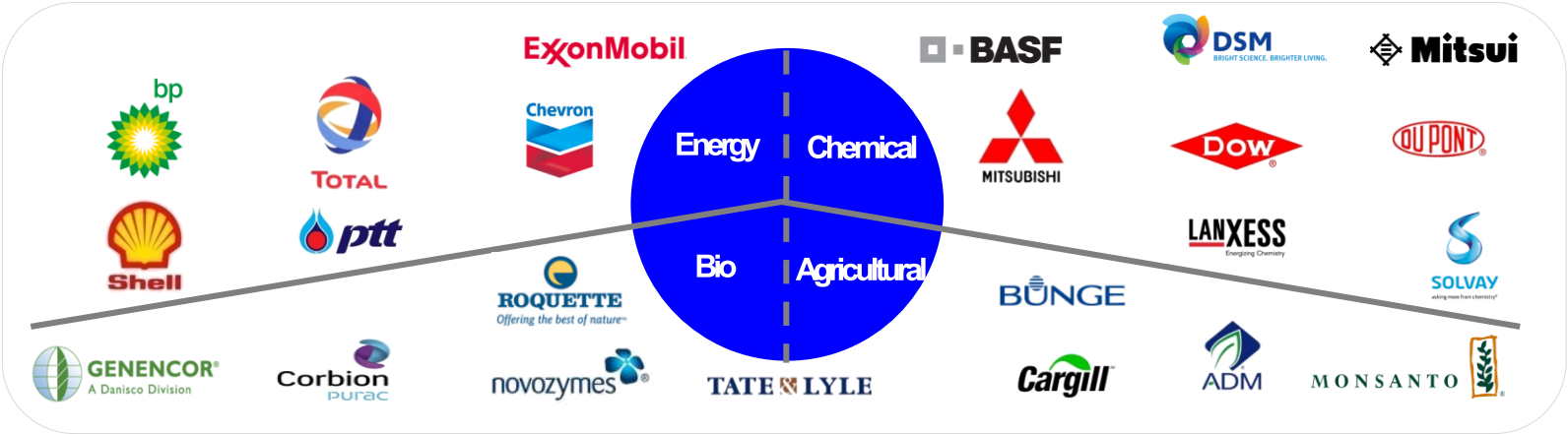
▪ Barriers for Commercialization



	Feedstock issues	Technical/Operational issues			
Eco-nomic	• Cheap resources • Availability • Transport • Labor	• Operation cost • Yield • Waste	• Cheap media • Strain development • Operation cost • Complexity of synthesis	• Operation cost • Yield, Purity • Waste	• Cheap catalyst • Effective catalyst development • Operation cost
Environ-mental	• Air : Global warming potential, Ozone depletion potential, Acidification potential, Odor • Water, Soil : Organic carbon pollution potential, Eutrophication potential, Land use • Safety and Toxicity of Organisms				
Social	• Heath and safety, Quality of working conditions, impact on employment, Education and training • Knowledge management, Innovative potential, Customer acceptance • Societal product benefit, Societal dialogue • Law, Patents, Security				

Global Companies Industrial Biotechnology

▪ Potential Global Player



▪ Global Business Model

NatureWorks	Cargill	ptt	**PLA** (140,000 MT/year)
DuPont Tate & Lyle BioProducts	TATE & LYLE	DUPONT	**1.3-PDO** (45,000 MT/year)
Succinity	Corbion purac	BASF	**Succinic acid** (10,000 MT/year)
	bioamber	MITSUI & CO., LTD.	**Succinic acid** (30,000 MT/year)
R & D	Cargill, novozymes	BASF	**Acrylic acid** (Pilot-plant)

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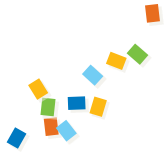
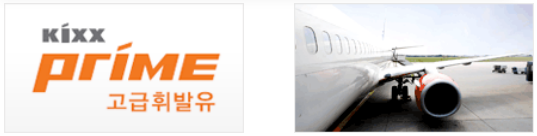
II. GS Caltex for Industrial Biotechnology



GS Caltex Corporation Industrial Biotechnology

▪ GS Caltex Business Domain since 1969

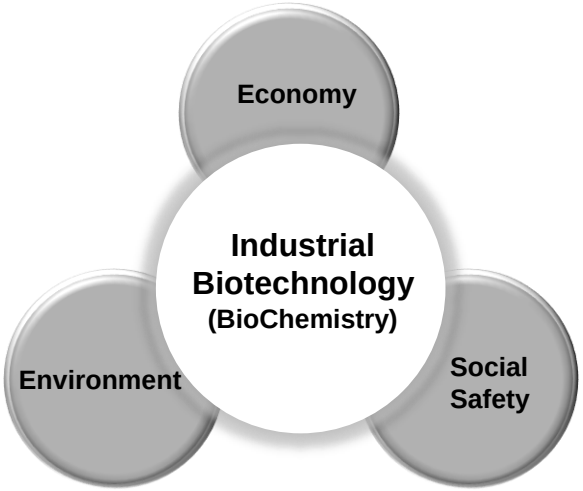
Oil Refining (정유)



Petrochemistry (석유화학)

Subsidiaries (자회사)

Plus
Biomass-based Industry



- ▪ **Fast Growing Global Market of Tremendous Size**
  - ✓ Biofuel: $106B in 2010 ➔ $1106B in 2025
  - ✓ Biochemical: $42B in 2010 ➔ $294B in 2025
- ▪ **The Game Changer in Fuel and Chemical Market**
  - ✓ Bio-based share: 3.0% in 2010 ➔ 17% in 2025

Activities GS Caltex Corporation

▪ Activities of GS Caltex for IB since 2006

2006 : Industrial Biotechnology Initiation

Propylene Glycerol project, **Glycerol Carbonate project**

2007 : n-Butanol project

2009 : 2,3-Butanediol project, **Nylon 4 project**, Collaboration with **CHANGAHE** CHANGHAE

2010 : GS Bio Establishment (Biodiesel and Glycerol), Collaboration with **DAESANG** DAESANG 대상주식회사

2012 : Polytrimethylene-tereph-thalate **PTT project**

2014 : Value No. 1 Energy & **Chemical Partner**

BioCombinat Demo-plant project initiation (2,3-Butanediol, 1,3-Propanediol, Pyrrolidone)

2015 : n-Butanol Demo-plant project initiation (02June2015) 전남창조경제혁신센터

BioCombinat Demo-plant project groundbreaking ceremony (23Sep.2015) 천년의비상 전라북도 Dream Hub GUNSAN

MK 뉴스 인쇄하기

GS칼텍스, 호남서 바이오 승부수

700억 투자 신사업으로 육성…군산·여수에 기반시설

기사입력 2015.09.24 17:49:24 | 최종수정 2015.09.24 19:56:48

GS칼텍스가 호남 지역에서 차세대 먹거리 사업인 바이오 산업을 집중 육성한다. 전북 군산과 전남 여수에 각각 바이오 기반시설과 생산공장을 건설하겠다는 구체적인 계획도 내놨다.

GS칼텍스의 호남지역 바이오사업

지역	사업 계획
전북 군산	- 바이오콤비나트 기반시설 구축 (투자비 200억원) - 2019년 9월 상업생산(목표)
전남 여수	- 바이오부탄올 실증설비 건설 (500억원 투자, 올해 말 착공) - 차세대 친환경 에너지원 육성

제조업 기반시설이 상대적으로 낙후된 호남 지역에 바이오 생산시설이 구축될 경우 지역 경제와 고용 창출에도 큰 기여를 할 것으로 보인다. GS칼텍스는 군산에 위치한 국가산업단지에 오는 2019년 9월까지 바이오·화학 클러스터를 위한 바이오콤비나트(2만5000㎡ 규모) 기반시설을 구축할 방침이라고 24일 밝혔다.

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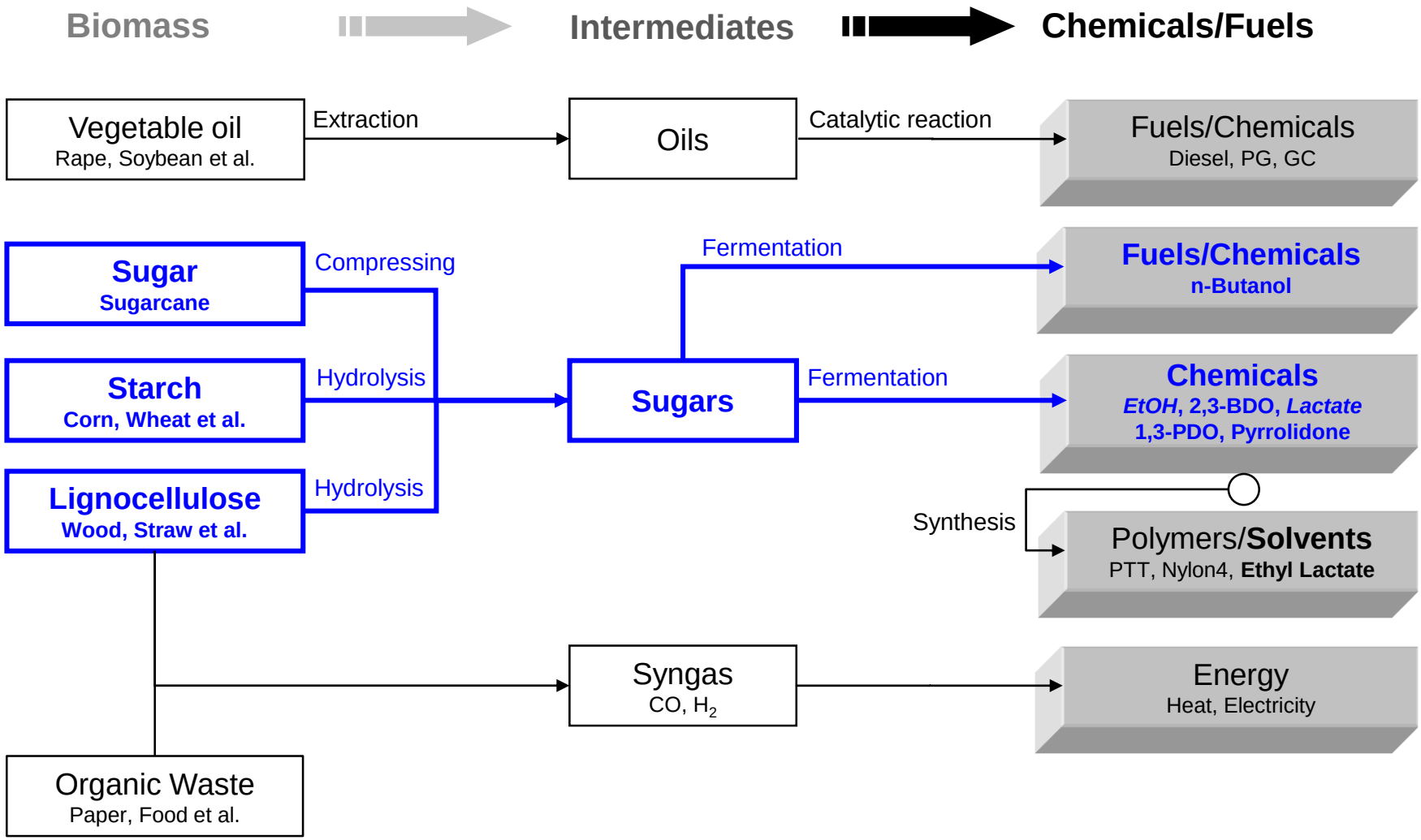
Bio-based Products GS Caltex Corporation

▪ R&D Status

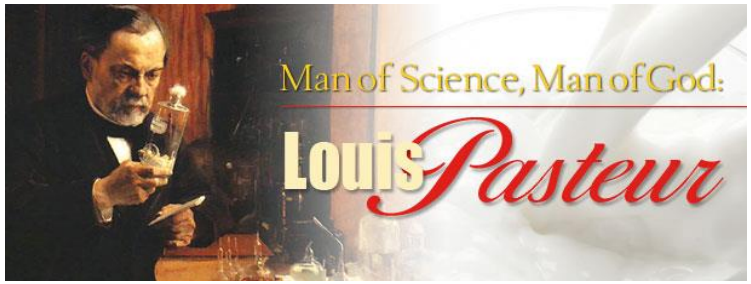


n-Butanol Properties & History

Properties

- C4 alcohol ($CH_3CH_2CH_2CH_2OH$)
- Isomers (normal-, iso-, secondary-, tertiary-)
- Normal- and iso-butanol have limited solubility

Molecular weight (g mol^{-1})	74.12
Density (g cm^{-3})	0.8098
Boiling point (°C)	117.73
Solubility in water (g cm^{-3})	9.1 mL/100 mL H_2O



History

- 2006: **GS** Caltex has started R&D for butanol fermentation
- 2005: Restarting butanol fermentation as the next generation biofuel
- 2004: Shutdown the last ABE fermentation plant in China
- 1960s: Declining ABE fermentation due to undermining its competitiveness against petro-based process
- 1950s: Developing ABE fermentation process in China
- 1939 – 1945 (World War II): Increasing acetone demand
- 1914 – 1918 (World War I): Running the first commercial ABE (acetone, butanol, and ethanol) fermentation plant in U.K., U.S.A, and Canada for manufacturing explosive powder
- 1915: Issuing the first patent on microbial butanol production from corn
- 1862: Finding microbial butanol formation by Pasteur

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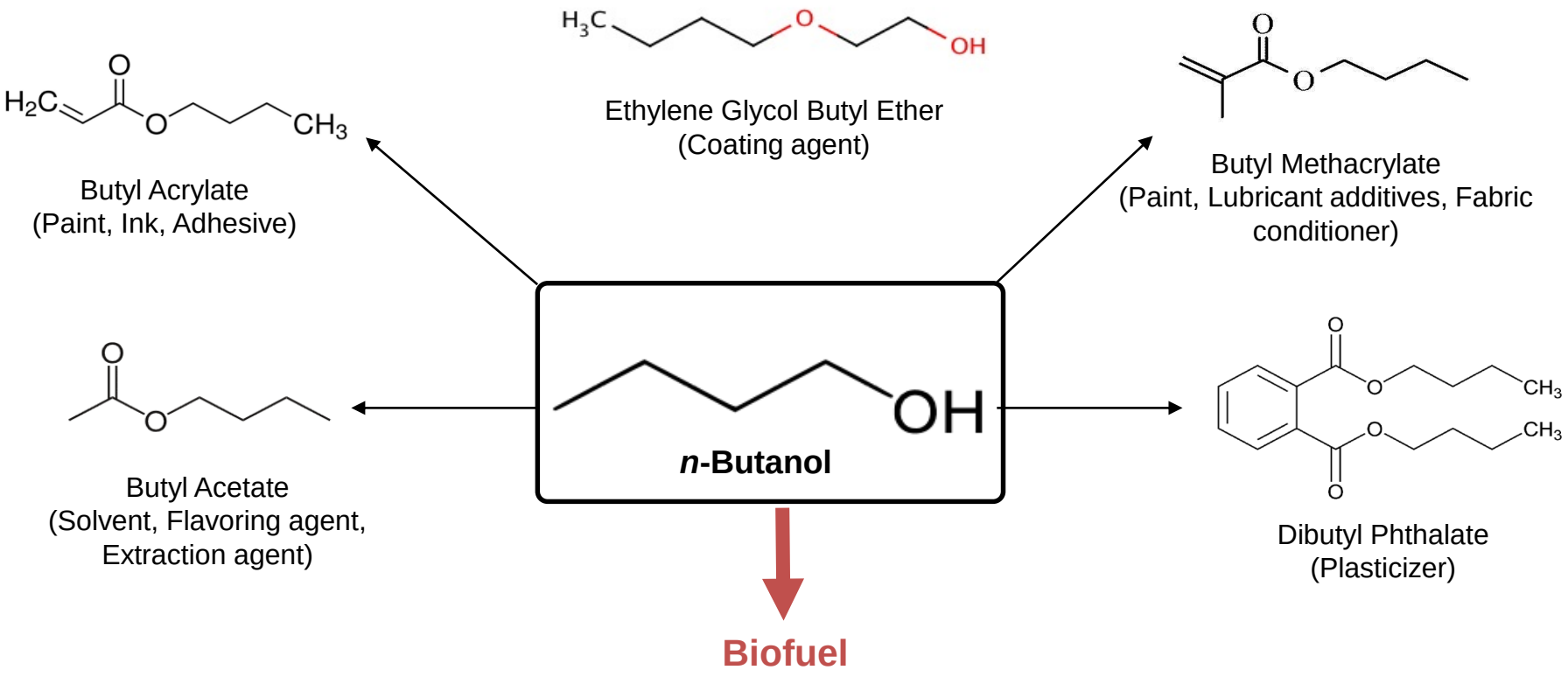
n-Butanol Derivatives & Market



Chemical Market

- World Market: around 4 million tons
- Asia Market: 50% of world market

Fuel Market

- World Market: around 85 million kiloliters
- Asia Market: around 4 million kiloliters

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n-Butanol Production _ CellLiq™

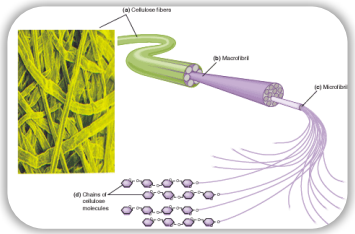
▪ Lignin for Power Generation

Empty Fruit Bunch

LIGNIN (40%)
- Heat capa. ≒ 6000 kcal/kg

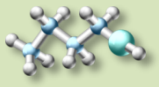
Power generation
- Steam and Electricity

▪ Hemi/Cellulose for Fuels and Chemicals



Hemi/Cellulose
(60%)

Pretreatment & Hydrolysis	Fermentation	Separation & Purification
		
- Feedstock Flexibility - High Sugar Recovery Yield - Recovery and Reuse of Sulfuric acid	- Simultaneous C5 + C6 Fermentation - High-performance Commercial Microbe	- High Energy Efficiency - High Purity Production



Butanol

2,3-Butanediol Properties & History

Properties

- C4 alcohol ($CH_3CHOHCHOHCH_3$)
- Isomers (2R,3R-, 2S,3S-, 2R,3S-stereoisomers)
- Colorless and odorless

Molecular weight (g mol^{-1})	90.12
Density (g cm^{-3})	0.987
Boiling point (°C)	177
Solubility in water (g cm^{-3})	Miscible

2,3-Butanediol Producer : Sigma-Aldrich

- Medical usage
- Laboratory usage

History

Not yet Commercially Available !!!

2009: GS Caltex start R&D for 2,3-BDO fermentation

1939 – 1945 (World War II): Starting 2,3-BDO fermentation to produce 1,3-butadiene for manufacturing polybutadiene used in a leading type of synthetic rubber

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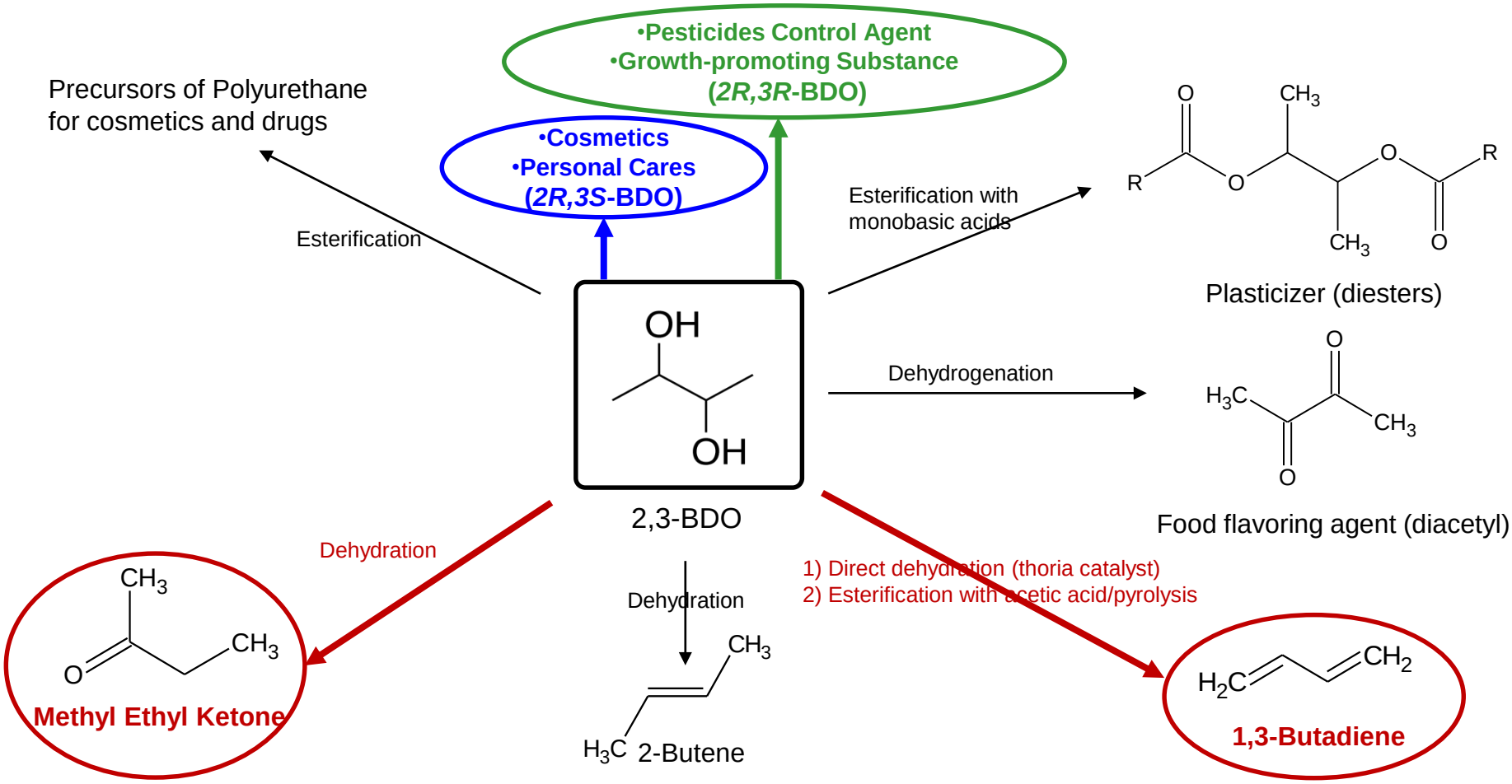
2,3-Butanediol Derivatives & Market



Bio PCA & PGA Market

- World Market: around 3.3 billion dollars
- Domestic Market: more than 103 million dollars

Bio Cosmetics & Personal-care Market

- World Market: more than 10 billion dollars
- Domestic Market: more than 100 million dollars

MEK Market

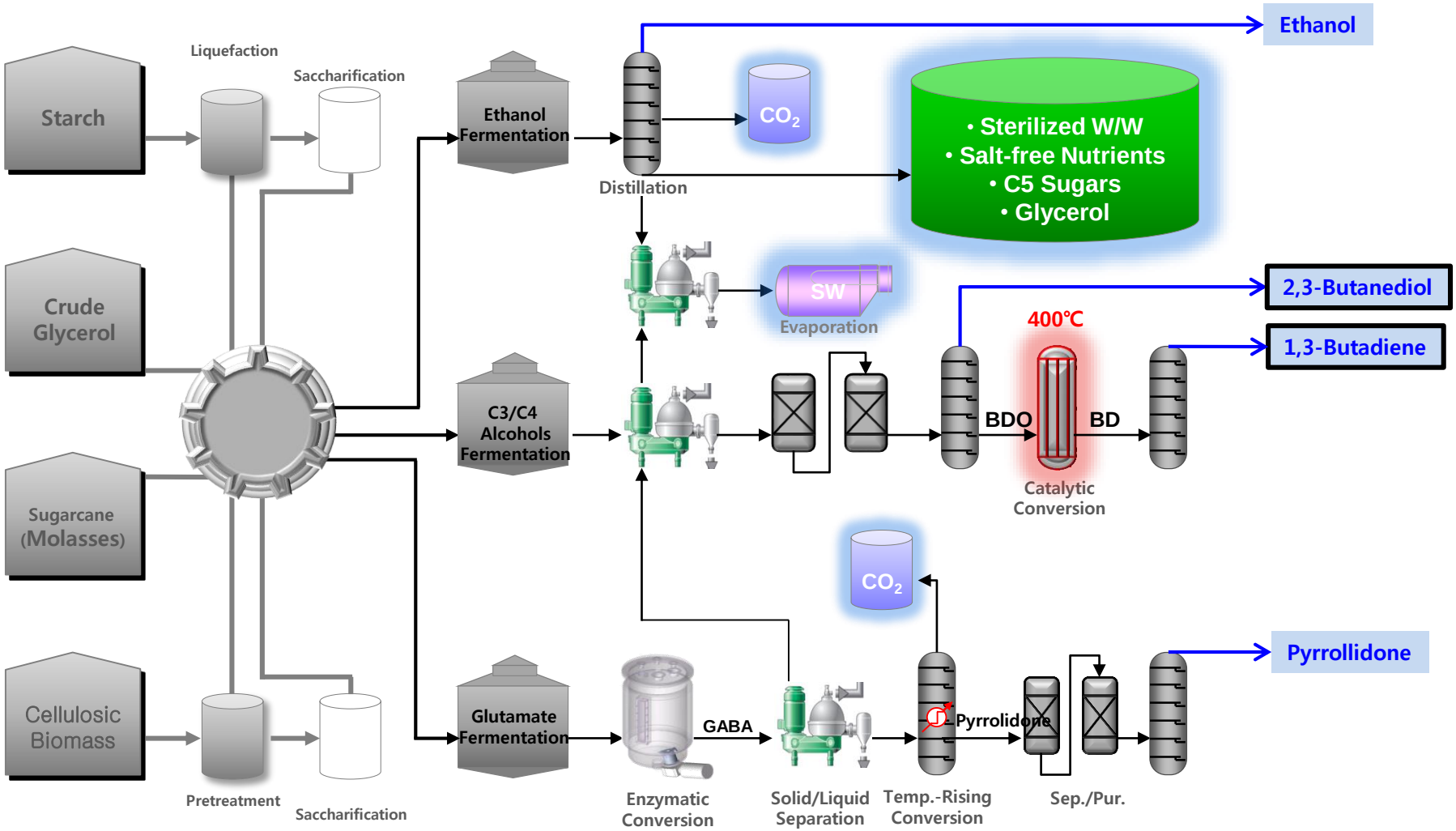
- World Market: around 1.8 billion dollars
- Domestic Market: more than 120 million dollars

1,3-Butadiene Market

- World Market: around 17 billion dollars
- Domestic Market: more than 2.4 billion dollars

2,3-Butanediol Production _ BioCombinat

▪ BioCombinat Schematic Diagram

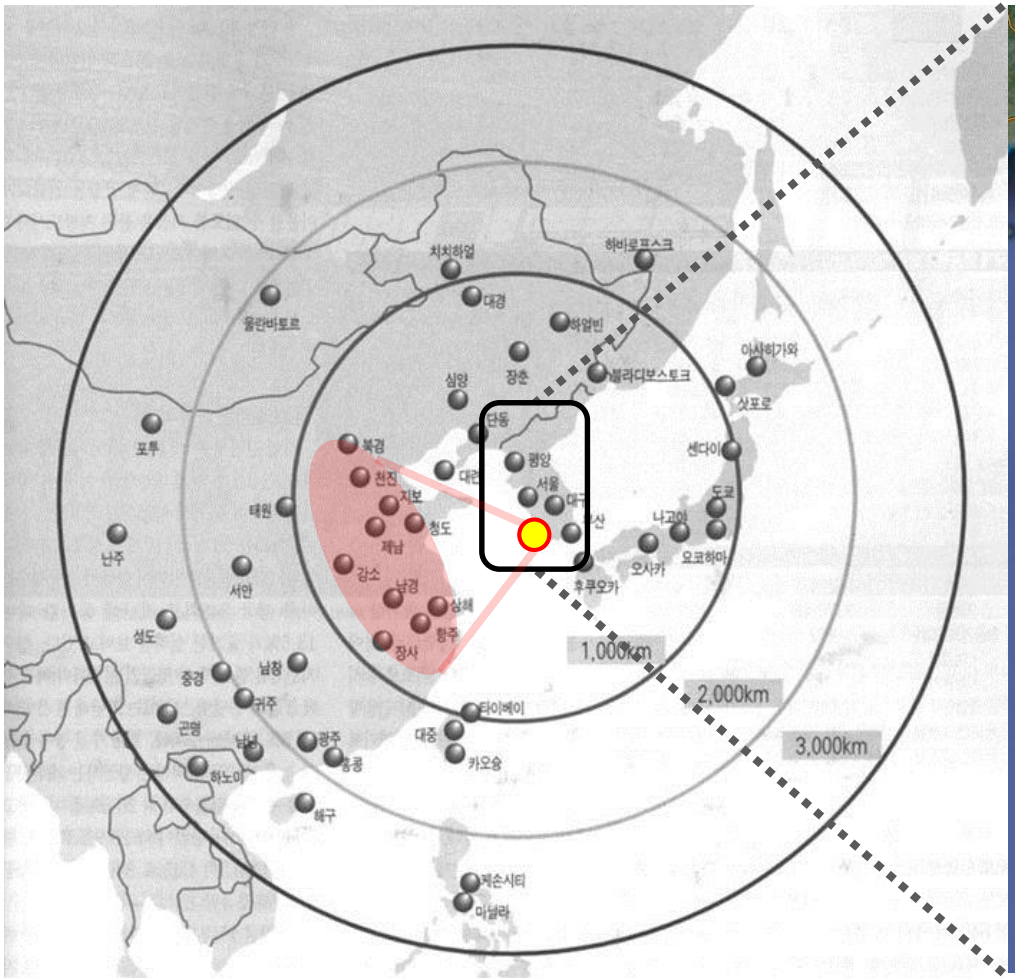


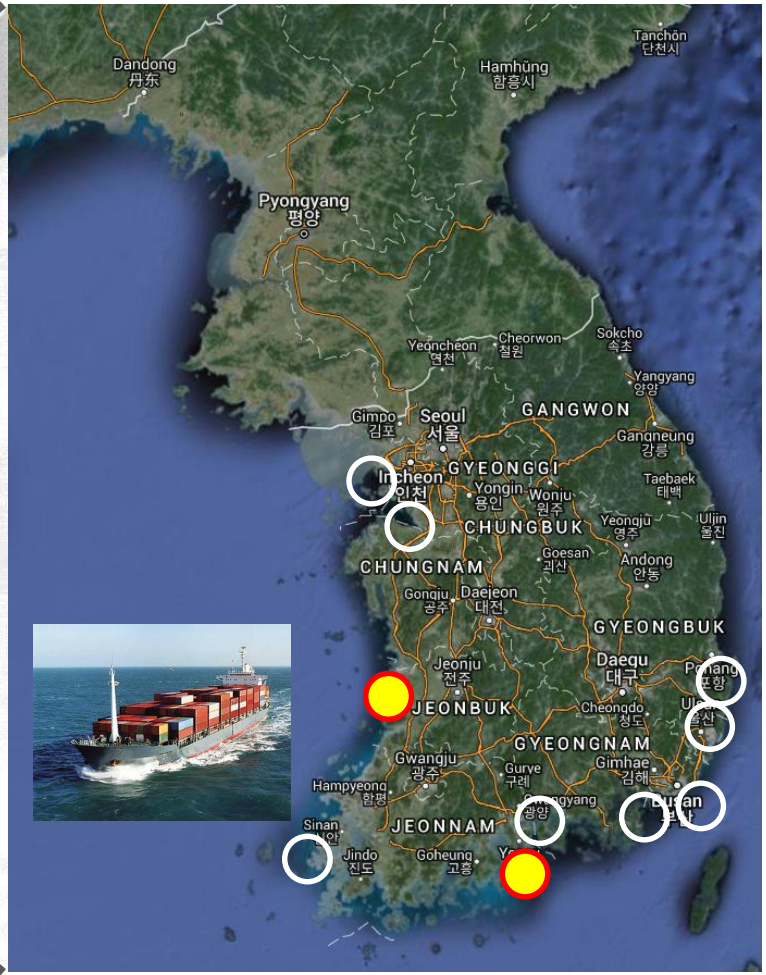
Status _ Demo-Plant

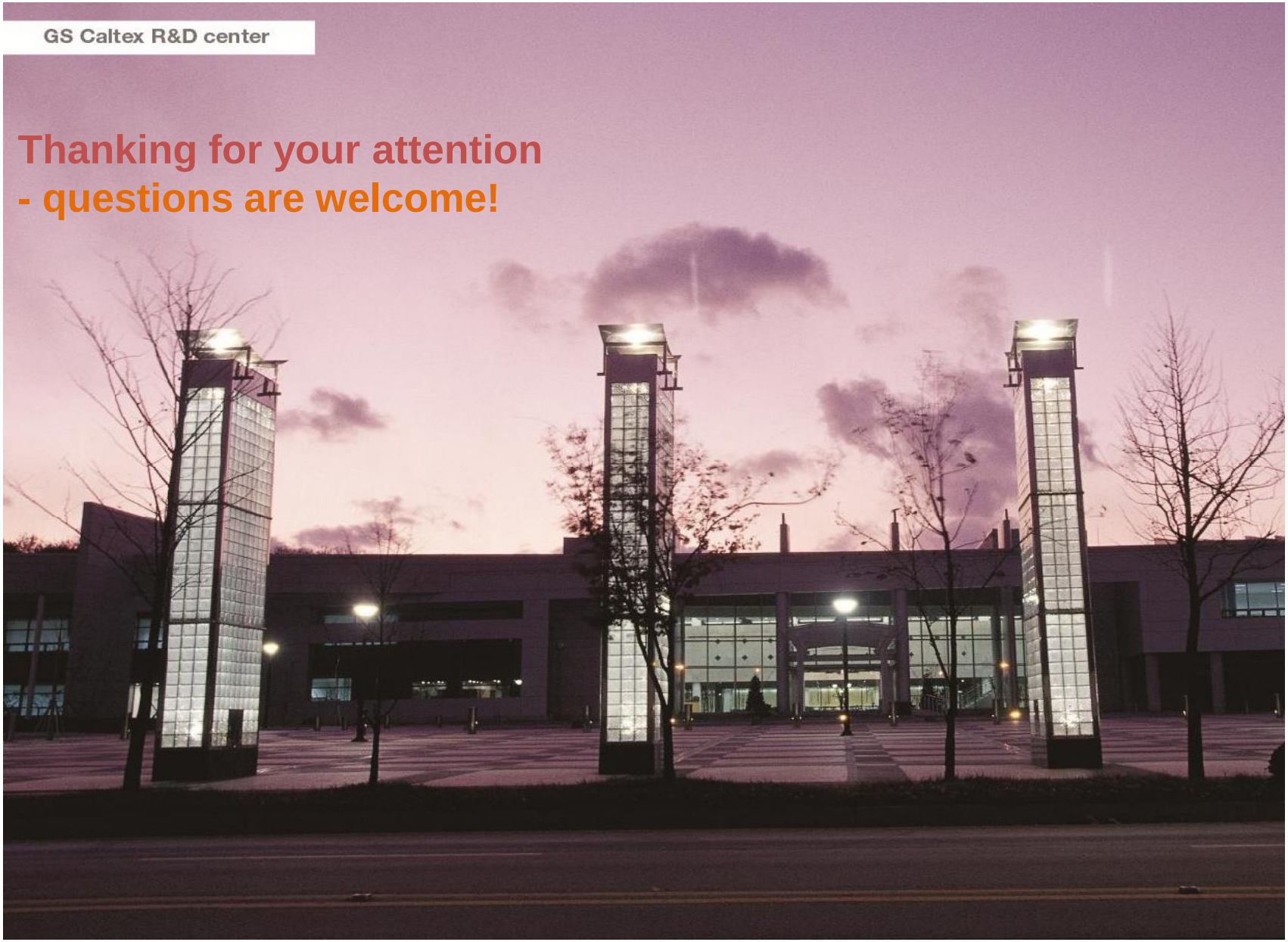
Commercialization _ Strategy

- **Exclusive Port**
- **Huge Potential Market next to Honam Region for Fuels and Chemicals**

Less than 2 days transport by ship, Two million dollars : 388 thousands (75%)







Thanking for your attention
- questions are welcome!

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