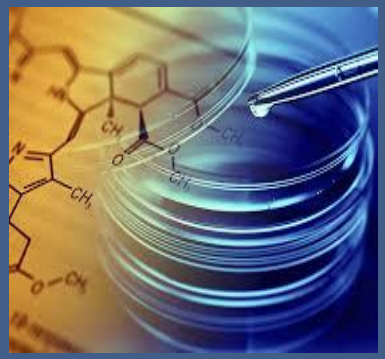


Thailand Bioeconomy: Current Status, Future Direction and Implication for Industrial Sectors

Anucha Euapermkiati, PhD

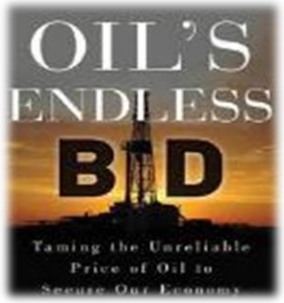
Manager Frontier Research

The 4th JASTIP Symposium, 3 July 2017

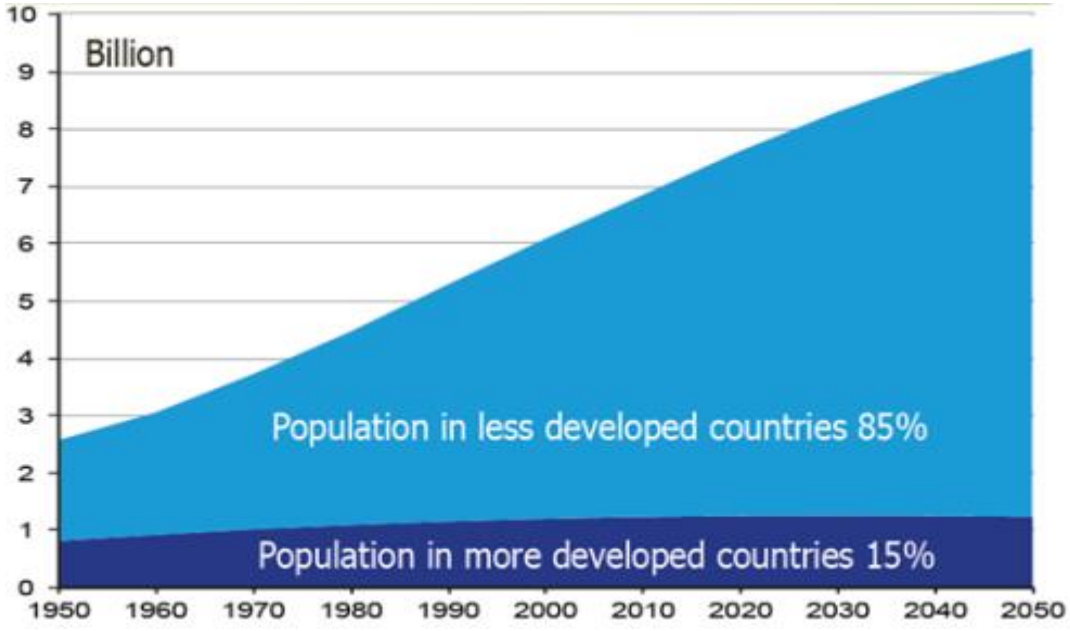
Agenda

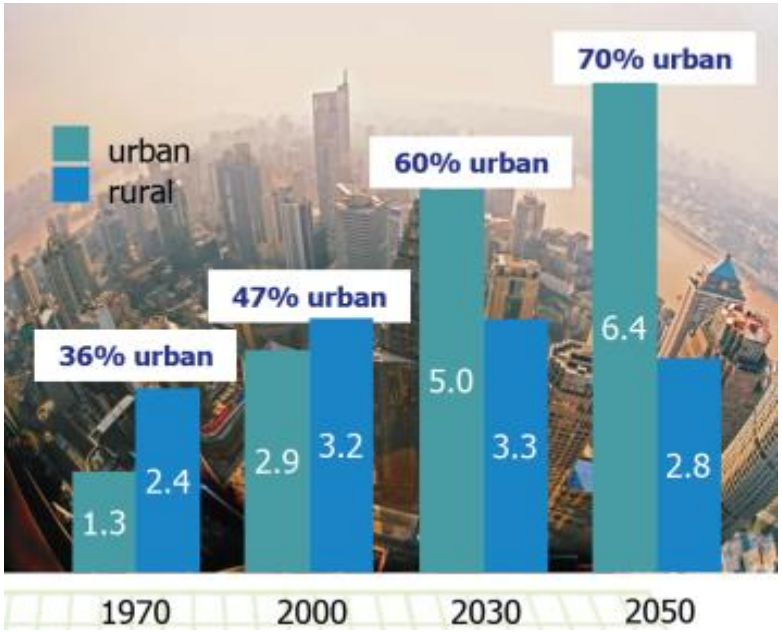
- Bioeconomy in the Context of Thailand
- Biorefinery Complex
- EECi Biopolis
- Implication for Industrial Sectors

The World in Snapshot: What will Come Next?



Supply Constraint **Climate Change** **50% Original Forest Lost**





Source: WRI and IEA

Raw Material Development

Crude Oil

Natural Gas

Renewable Resources

Coal

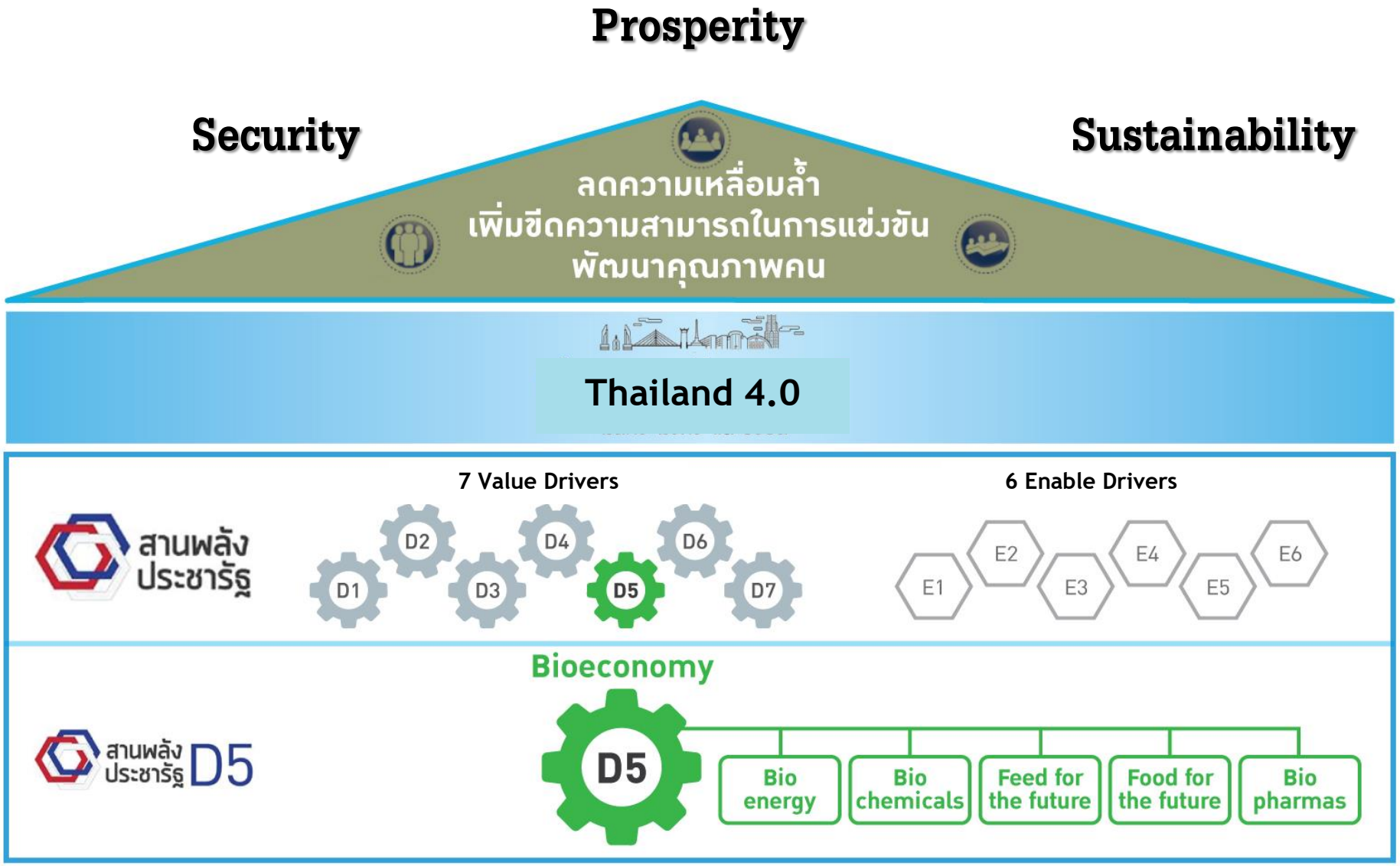
PARADIGM SHIFT?

1800 1850 1900 1950 2000 2050

Source: Adapted from BASF

Bioeconomy in the Context of Thailand

Bioeconomy in the Context of Thailand



Opportunities and Challenges

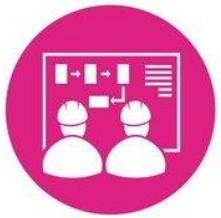
Opportunities

Energy security

New Markets

Rural economic development

Challenges



Early stage of commercialization

Policies/ Mandates

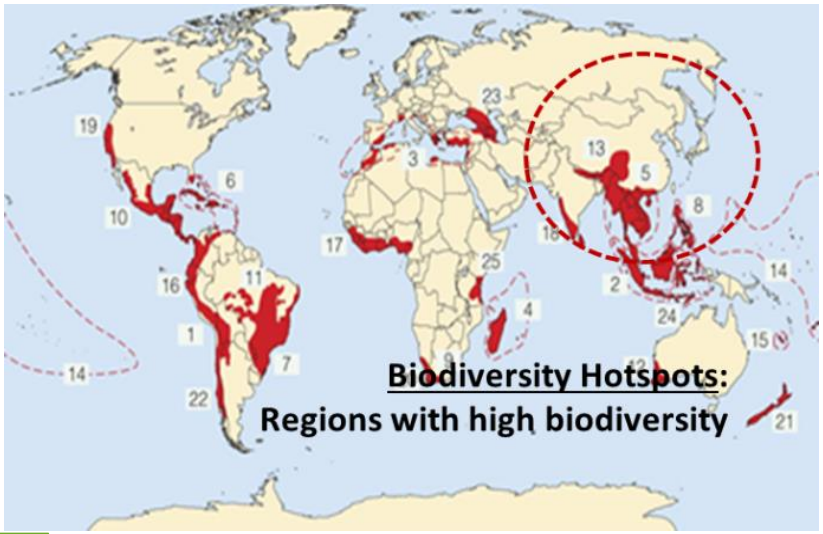
Biorefinery/ Biopharma ecosystem

Key success factors

- Leaders with common vision
- Research and Innovation
- Close collaboration with government & customers
- Inter-connection of industries in Bioeconomy value chain

Bioeconomy – A New Economic Model

1 Biodiversity in Thailand is ranked as 8th in the World



2 Development of technologies on agricultural products

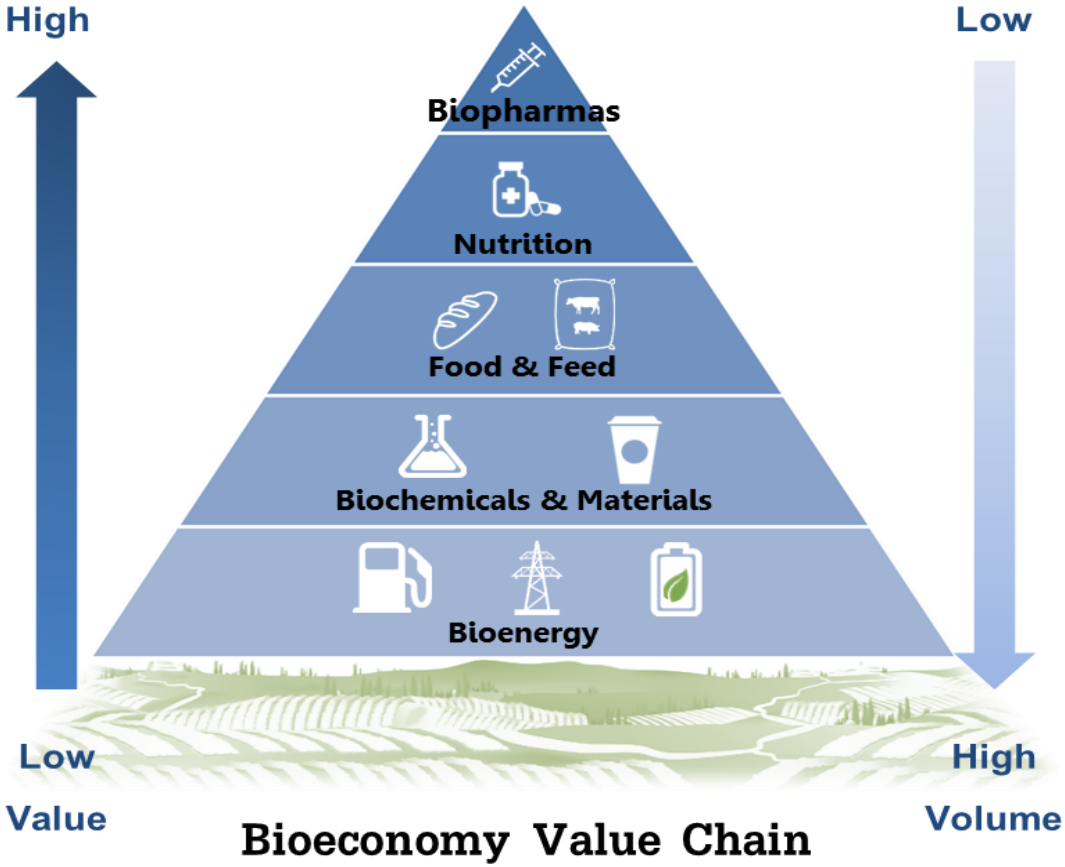

Rice


Cassava


Sugar cane


Soybean/ Peanut

3 Strong technological and industrial base to support Bioeconomy



Bioeconomy is the next generation of agricultural based economy

From resource-based agriculture → **To knowledge-based value chain**

Agricultural based economy


Sugarcane


Cassava


Palm


Rubber

- Molecular breeding
- Forecasting
- Precision agriculture
- Mechanization

Bioeconomy

- Biochemicals
- Pharmaceuticals
- Food for future
- Biofuels

	Agricultural based economy	Bioeconomy
GDP contribution	▪ 7% of GDP[1]	▪ ~8-11% of GDP[2]
Total value	▪ ~THB 950 bn total value[1]	▪ THB 1300-1700 bn total value[2] (~2x)
Core value	▪ Feedstock-based	▪ Processed food, biochemicals, biofuels
Employment	▪ ~ 20 million ppl, mainly in agriculture	▪ Employment throughout higher value sectors
GDP per capita in agri. sector	▪ ~THB 48K/capita	▪ ~THB 65-85K/ capita

1) 2014 GDP contribution from cereal and other crops

2) 2020 GDP contribution from rice, cassava, sugarcane, rubber and processed food only

SOURCE: Global Insight - Thailand real GDP forecast, team analysis

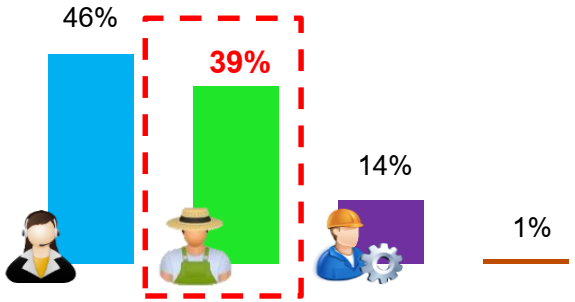
Thai's Agriculture Scenario

Agriculture - a backbone of Thailand's economic foundation

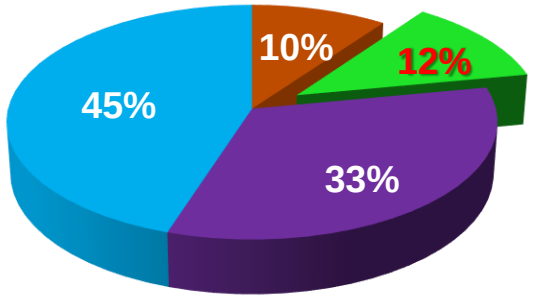
1 Large number of labor - Less productivity Create poor GDP contribution

2 Declining trend of agricultural sector

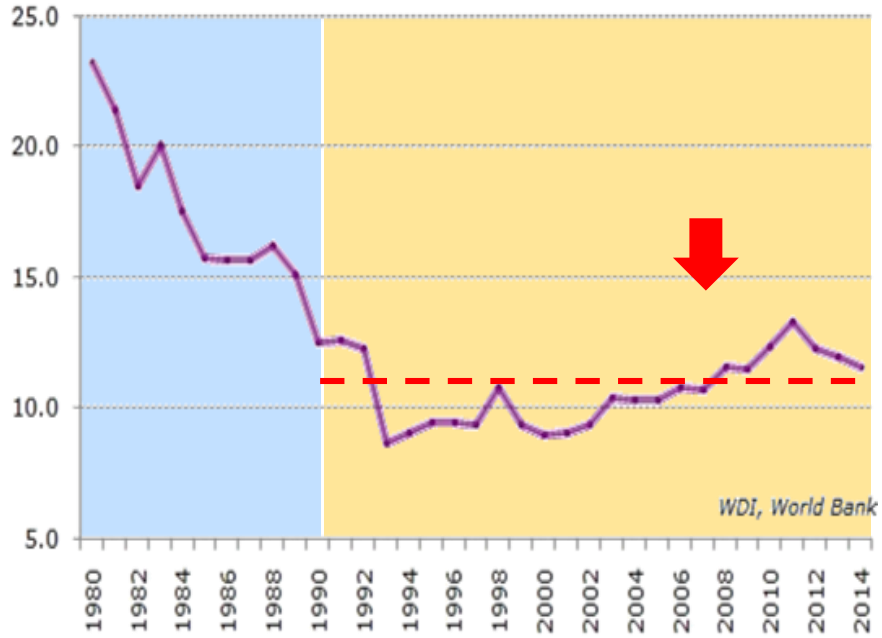
Thai's Labor Proportion



% Share on GDP (2013)



Agriculture, Value Added (% of GDP)



Services *Agriculture* *Manufacturing* *Others*

Source: 1) World Bank Data Report (www.worldbank.org), 2013

2) Emerging Markets: Analyzing Thailand's, August, 2015. (http://www.investopedia.com/articles/investing/081815/emerging-markets-analyzing-thailands-gdp.asp)

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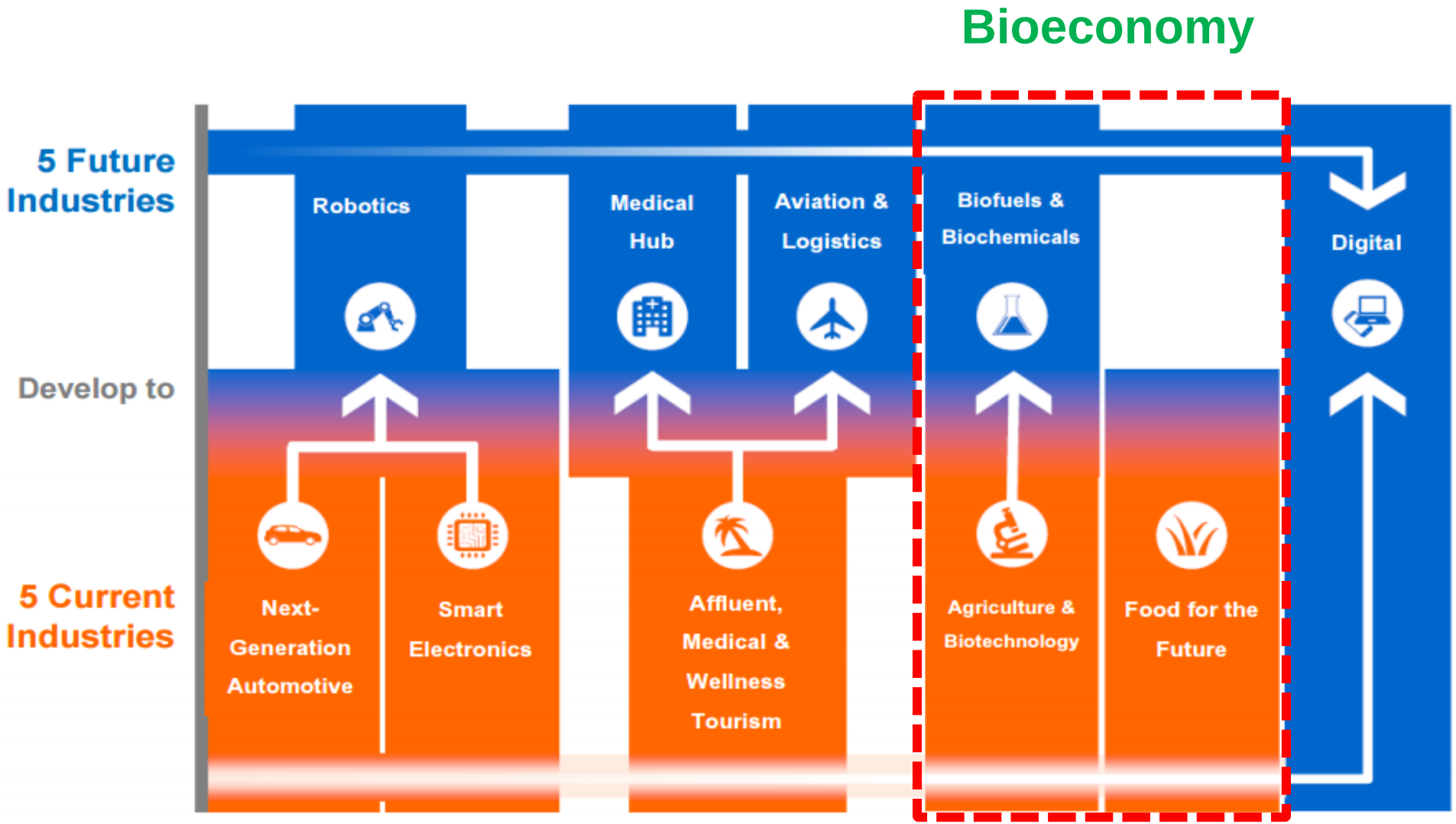
Bioeconomy will cover 3 of the 10 priority sectors of the government



Bioeconomy - Transformation's Game Changers

Two key elements: Modern farm and Biorefinery

1

Modern Farm

Sugarcane Cassava

1st Generation Feedstock

Sugarcane

2nd Generation Feedstock

Bagasse/ Cassava Waste

Cassava

2

Biorefinery
(Starch / Sugar "Fermentation" Platform)

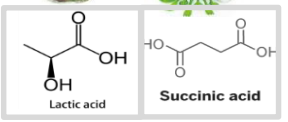
Bioenergy

Biochemicals

Bioplastics

PLA

PBS



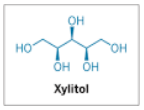
Feed for Future

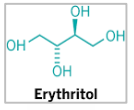
Food for Future

Biopharma

Yeast Extract

Amino Acid





Low Calorie Sweetener

Vaccine

Monoclonal antibody

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Bioeconomy: 10-Year Roadmap

Goal: Total Investment ~ 400 Billion Baht in 10 years

1 — 2017-2018

- Further develop Bioenergy as a stepping stone for the Bioeconomy
- Study and prepare the investment of Biorefinery Complex
- Create demand for investment in biochemicals/ bioplastics and biopharma sectors
- Improve breeding and provide machinery

2 — 2019-2021

- Expand the plantation area
- Develop Biorefinery Complexes and Biopolis, the smart city based upon integrated innovations and bioeconomy
- Develop the value-added bio-based products

3 — 2022-2026

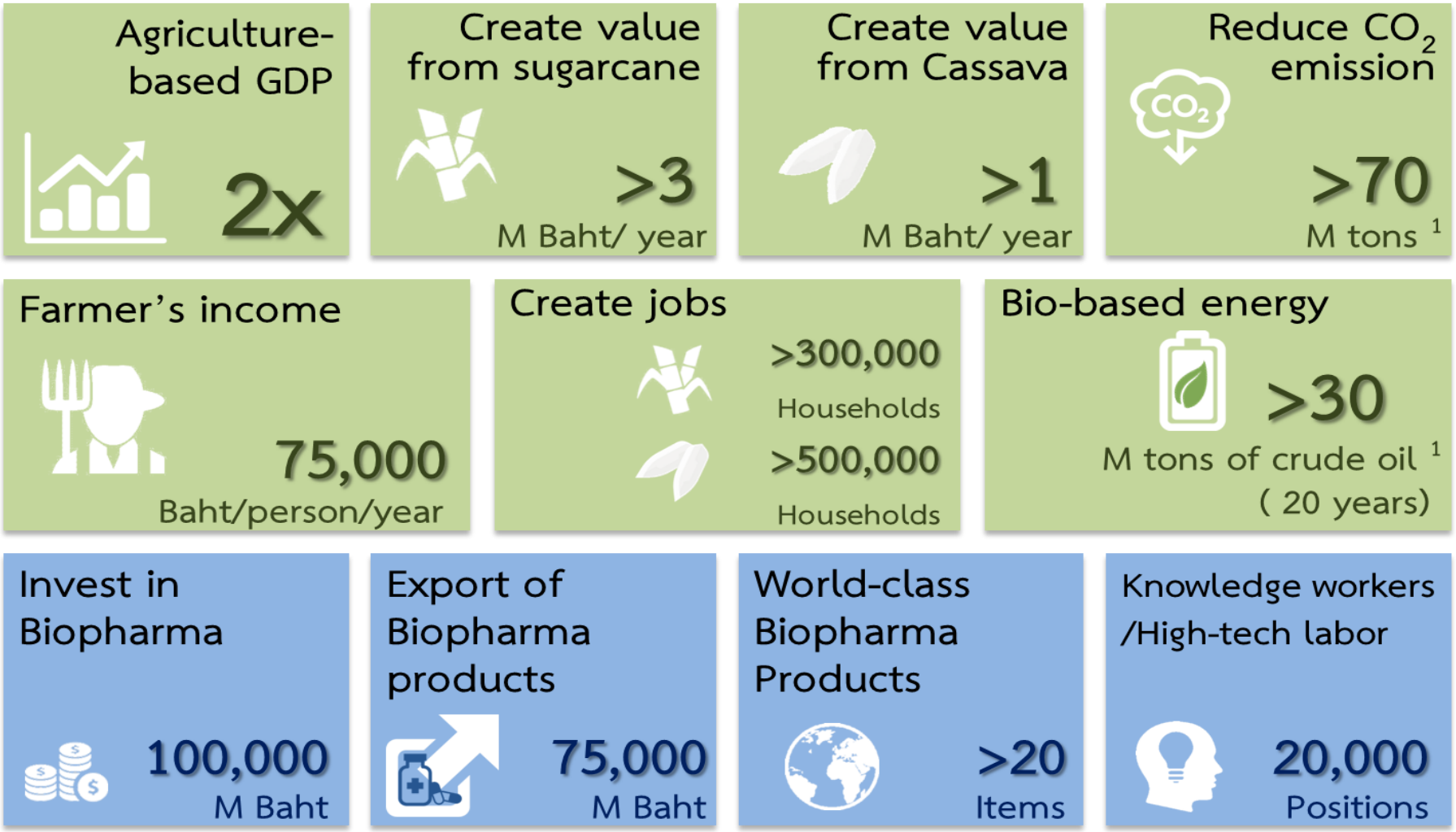
- Move towards the Regional Hub: a model for future industries
- Establish Biopharmaceutical pilot plant and commercial plant
- Implement domestic/ international full-scale Clinical Research

16 Investors

PTT Group; PTT Global Chemical; Thai Wah Public Company Limited; Mitr Phol Group; Cristalla TCC sugar industry; KTIS More Than Sugar; GPSC; GGC Global Green Chemicals; AST•ASAH; UENO; Siam Bioscience; Otsuka Thai Otsuka Pharmaceutical Co.,Ltd.; Baxter; Corbion Purac; Betagro; CPF

PTT Global Chemical

The Expected Outcomes from Bioeconomy within 10 years



[1] The Alternative Energy Development Plan (AEDP) for 2015 – 2036)

Collaboration advances "Bioeconomy"

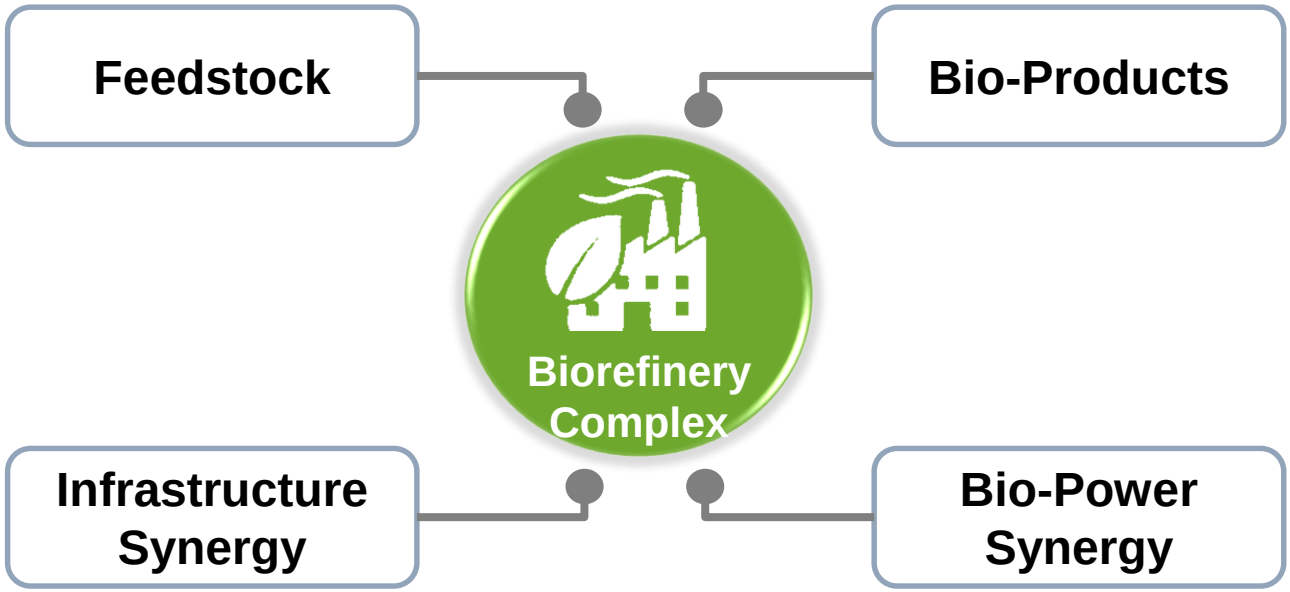
The Memorandum of Understanding Signing Ceremony in 23 January 2017

23 agencies from the public and private sectors and educational and research institutions

The beginning to drive investment for Bioeconomy of Thailand

Biorefinery Complex

Why PTTGC Group is interested in Bioeconomy?



- **Enhance competitiveness & value-added products**
- **Strengthen and expand product portfolio in Green Business**
- **Build full integration value chain with partnership with feedstock producers & professional biotechnology**

PTTGC Group's Focus

GGC is the flagship of PTTGC Group to create value in Green Business

1

Modern Farm

Sugarcane Cassava

1st Generation Feedstock

Sugarcane

2nd Generation Feedstock

Bagasse/ Cassava Waste

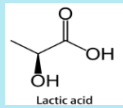
Cassava

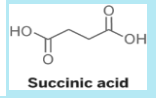
Bioenergy

Bioplastics

PLA

PBS





Biochemicals

2

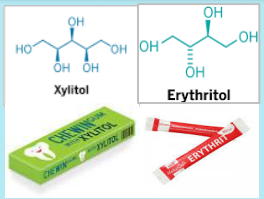
Biorefinery
(Starch / Sugar "Fermentation" Platform)

Feed for the Future

Yeast Extract

Amino Acid

Food for the Future



Low Calorie Sweetener

Biopharma

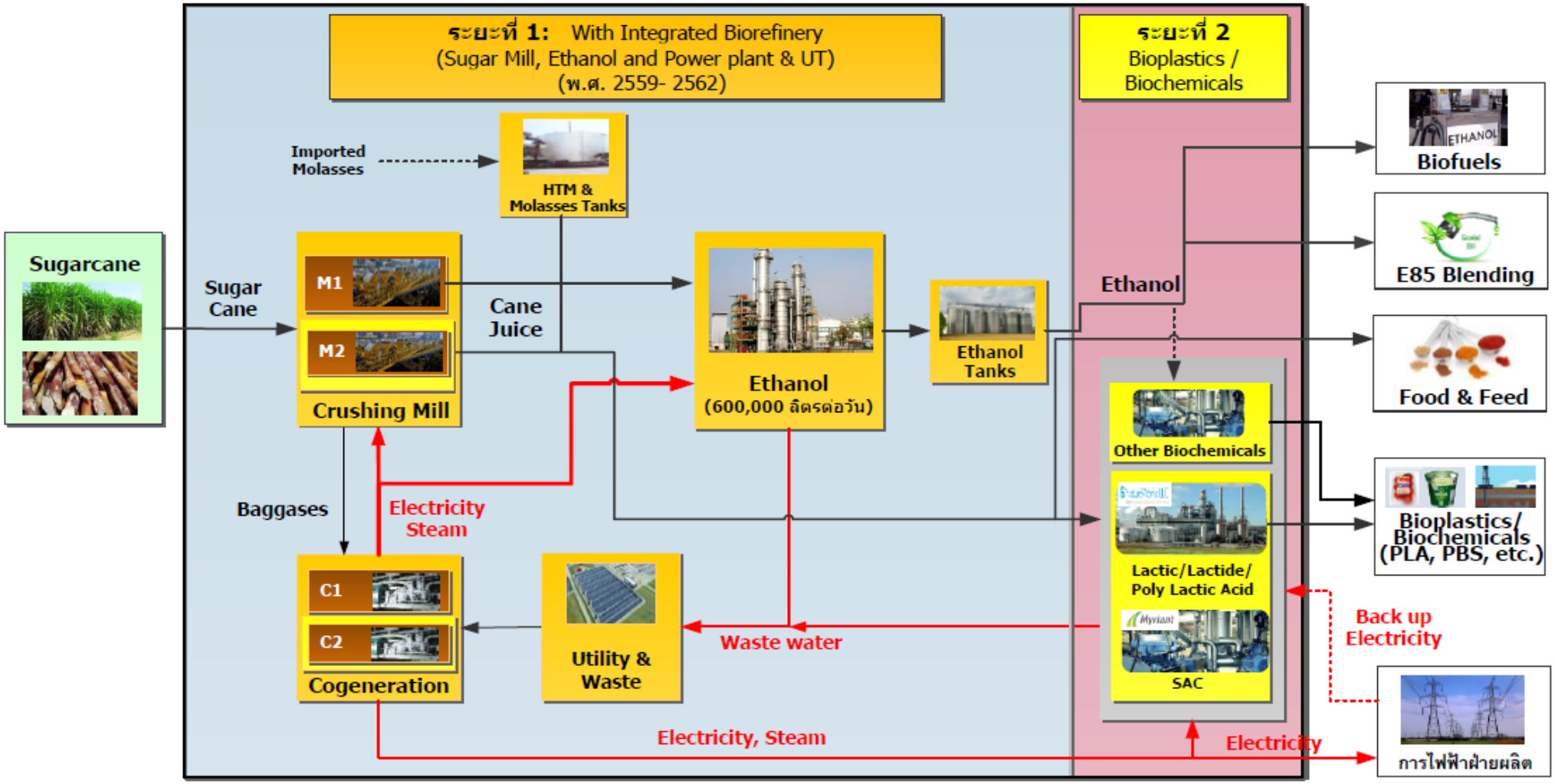
Vaccine

Monoclonal antibody

Phase 1

Phase 2

Biorefinery Complex Project

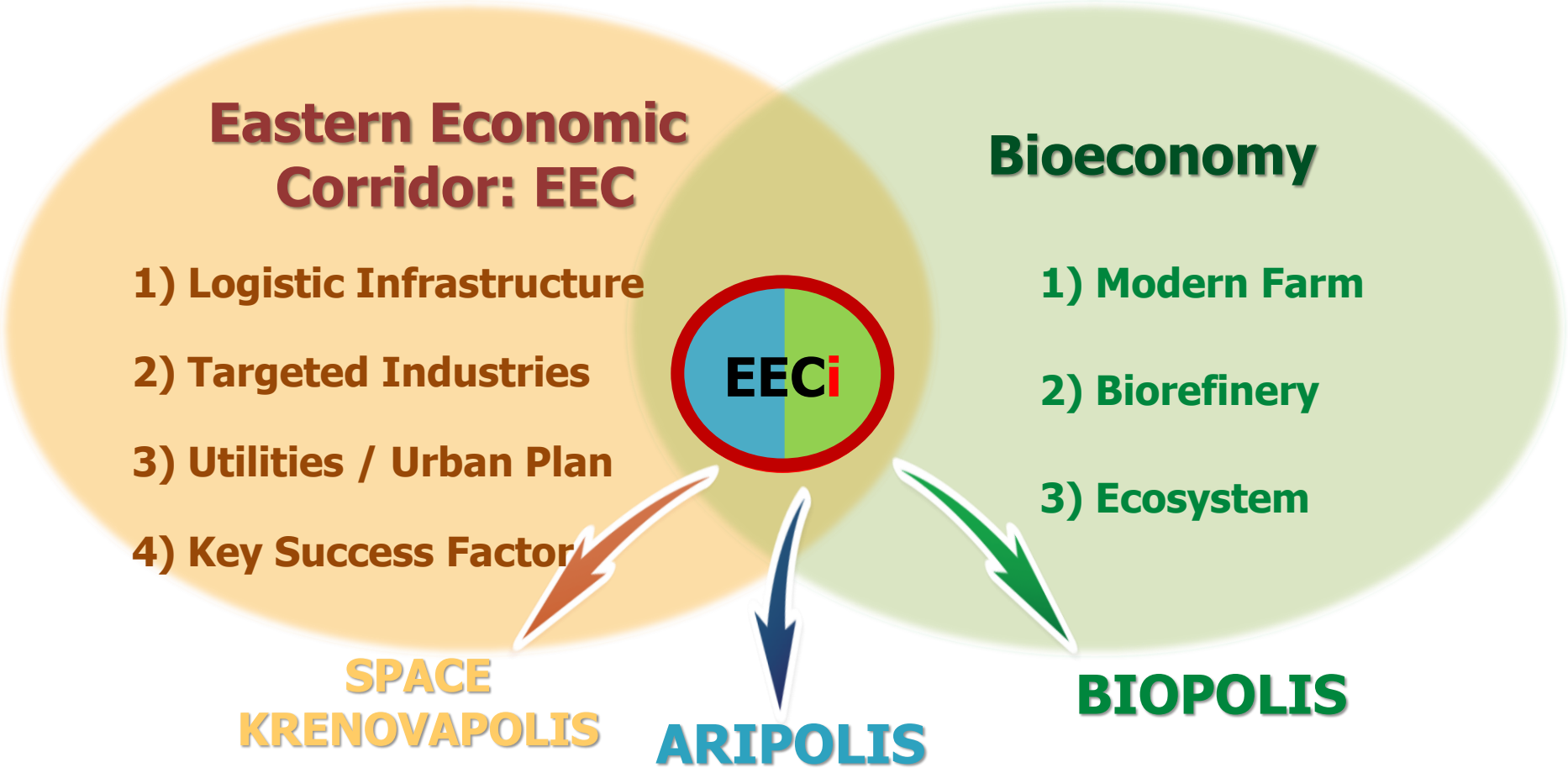


Phase 1: **2017-2019 : Ethanol Fuel Grade & Electricity**

Phase 2: **Develop Infrastructure i.e. Land, Utility, Feedstock for Biochemicals & Bioplastics**

EECi Biopolis

Background : Eastern Economic Corridor of Innovation (EECi)



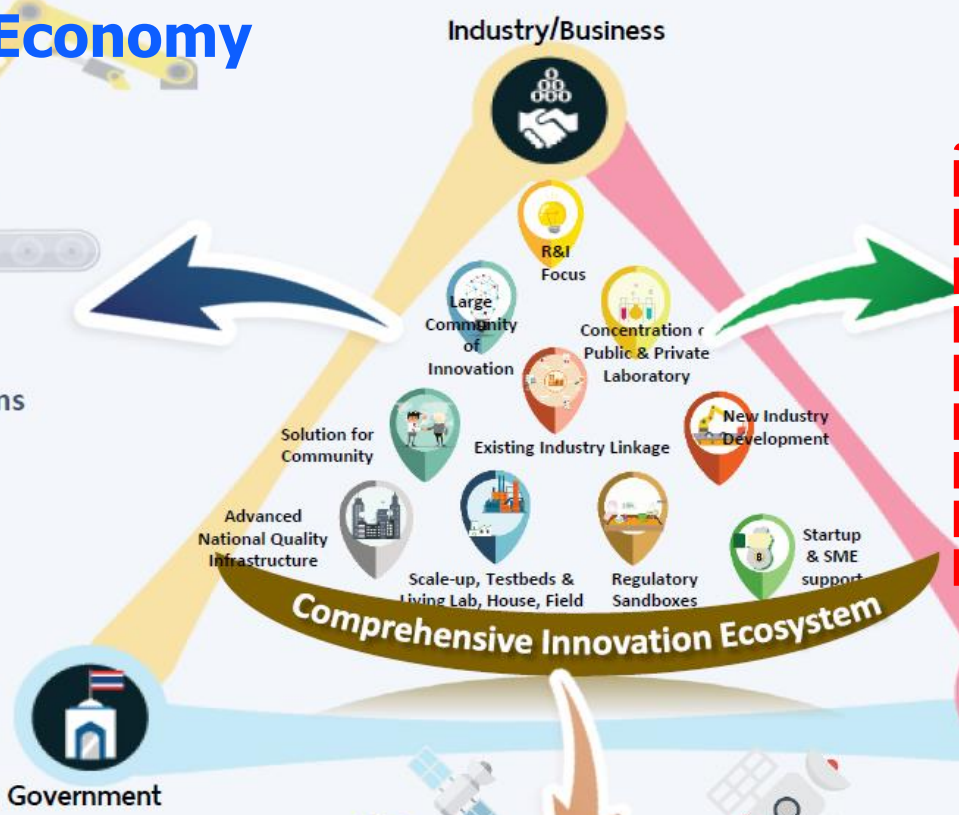
Eastern Economic Corridor of Innovation (EECi)

Conceptual Framework of EECi

Digital Economy

ARIPOLIS

- Automation
- Robotics
- Intelligent Systems
- IoT
- Sensors
- Big Data
- ICT Security



Bioeconomy

BIOPOLIS

- Smart Agriculture
- Functional Ingredient/ Nutraceutical
- Biofuel/Bioenergy
- Bioplastic/Biomaterial
- Biochemical
- Biomedical/Biopharma

SPACE KRENOVAPOLIS

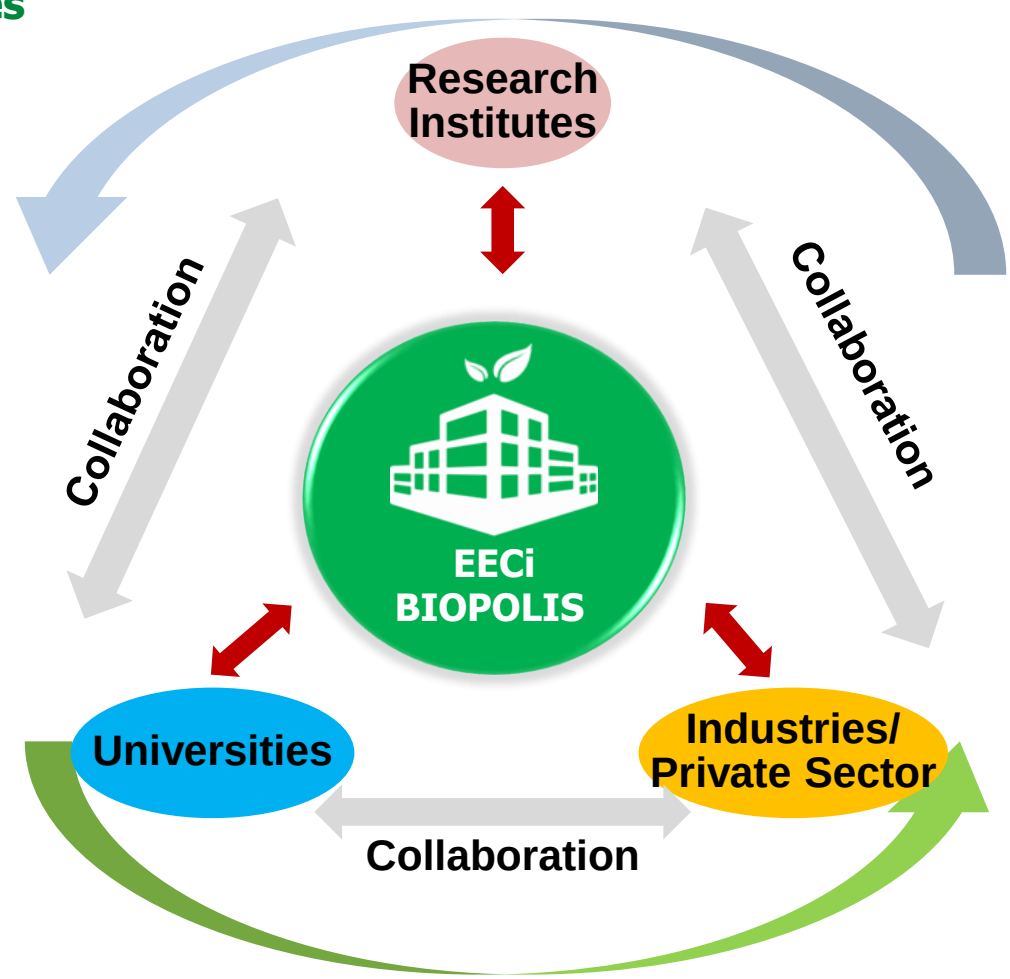
- Ground Station & Operations support
- Maritime solutions
- Agriculture solutions
- Navigation and Location-Based Services: LBS

Source: *Department of Science & Technology*

Concept Master Plan of EECi BIOPOLIS

Strong R&D Capabilities for Development of Industrial Biotech

- R&D Hub
- Pilot & Scale-up Center
- Product/ Application Development
- Start-Up Exchange Program
- Open Innovation Center



Regional Sustainable Growth Model

- Smart Agriculture
- Technology Transfer
- Technology Transfer
- Potential Market Growth

Value-added Bio-based Industry

Innovation Center of Life Science & Biotechnology

The Expected Outcomes from EECi BIOPOLIS

EECi BIOPOLIS

Innovation ecosystem

Access to R&D funding from the private sector

Promote R&D collaboration among academia, research institutes and private industries

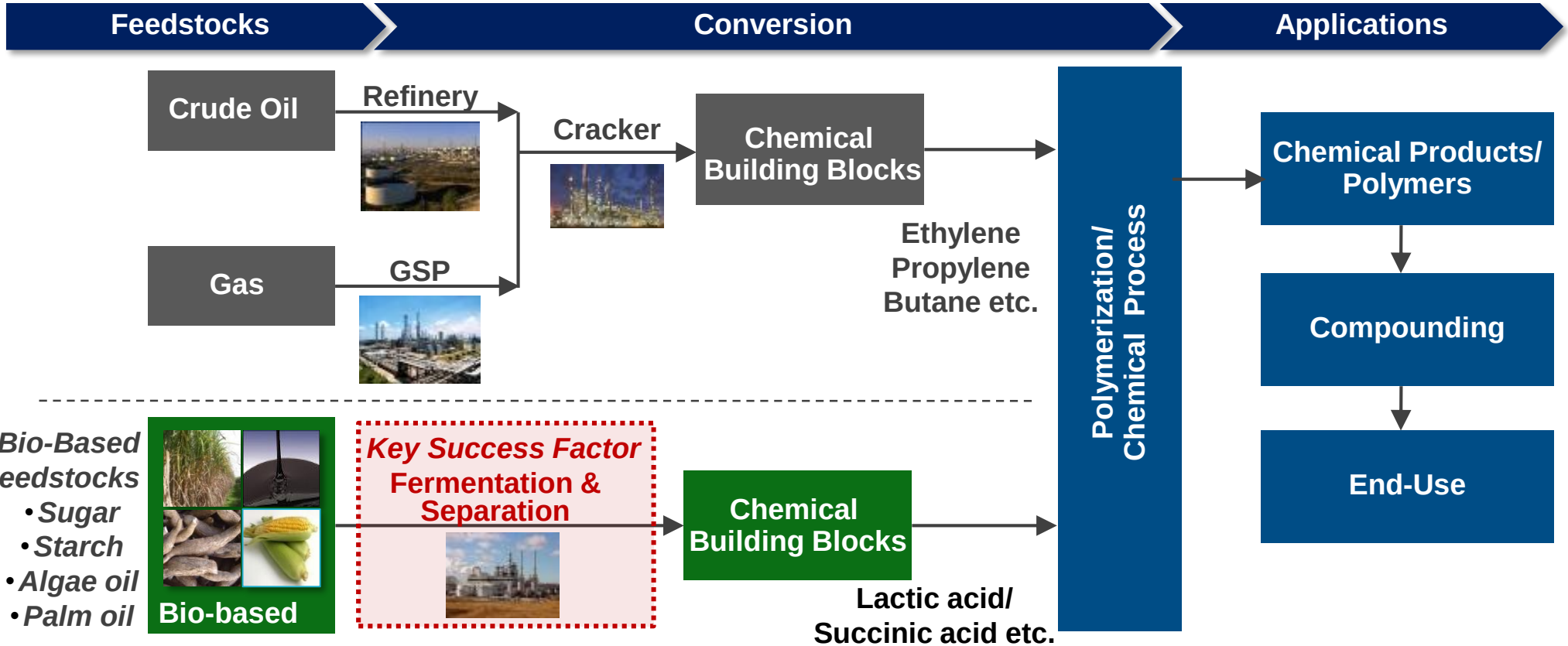
Employ knowledge workers/ hi-tech labor

Encourage investment and develop innovation & technology in Green Business

Support SMEs and large entrepreneurs to expand economic growth into rural area

Implication for Industrial Sectors

Comparison of Chemical Production from Petro-based vs. Bio-based route



Value Added (Estimated)			
Petro-based*	1X	5X	6X
Bio-based**	1X	7X	13X

Based Calculation: *1 ton of Naphtha produce 0.083 ton HDPE
**** 1 ton of Sugar produce 0.5 ton PLA**

Growth Potential of Bio-based Products

	Total Market Sales, USD	Biotech Today Sales, USD	Biotech Products Current Examples
Fuel	~ 500 billion	~ 20 billion	▪ Ethanol ▪ Biodiesel **BP-DuPont Chevron PTT**
Polymers and Petro-chemicals	~ 500 billion	~ 1 billion	▪ PLA, PBS ▪ Glycols ▪ Ethylene ▪ Acrylic acid
Specialty Chemicals	~ 300 billion	~ 5 billion	▪ Enzymes ▪ Flavors, fragrances ▪ Oleochemicals **P&G, Cargill/Natureworks, ADM, DSM, DuPont, BASF**
Fine Chemicals	~ 100 billion	~ 15 billion	▪ Pharma intermediates ▪ Amino acids ▪ Vitamins ▪ Citric acid

Already 5% of Chemical sales depend on Biotech today

Key Growth Drivers

- **Technology breakthroughs**
- **New bio-based building blocks**
- **Cheap biomass feedstock**
- **Regulatory push**
- **Recognized need for innovation**
- **Major private investments**

Potential for Major Discontinuities

Source: McKensey

Chemicals from Renewable Feedstocks

Now 1 – 5 years

Sugarcane

Molasses

Palm

Cassava

5 -10+ Years

Bagasse

Cassava Waste

Advantages:

- Potential Low Cost
- Feedstock Diversification
- Reduced Environmental Impact
- Potential for Better Performance
- Expanded Business Models
- Growing Consumer Demand

Challenges:

- Complex Supply Chain
- Distributed Business Model
- In-kind Petrochemical Products
- Conversion Technologies
- Competitive Feedstocks e.g. Coal
- Cost

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Biochemicals from Palm Oil-Based

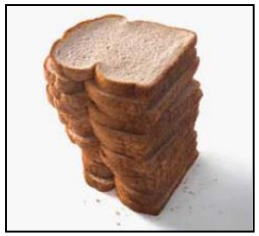
Animal Feed:
- Nutritional supplements
- Emulsifiers for calf milk replacers

Personal Care:
- Shampoos
- Soaps
- Creams & lotions
- Make-up

Soaps & Detergents
- Industrial and domestic

Leather:
- Softening, dressing, polishing and treating agents

Food:
- Emulsifiers & specialties for bread, cakes and pastries
- Margarine
- Ice cream and confectionery

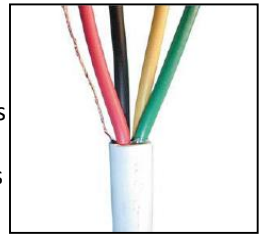


Paints & Coatings:
- Alkyd and other resins
- Drying oils
- Protective coatings

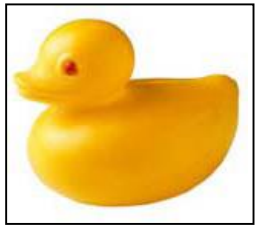
Rubber Production:
- Vulcanising agents
- Softeners
- Mould release agents

Industrial Lubricants:
- General and specialty lubricants
- Base oils for non-toxic biodegradable lubricants

Electronics:
- Wire insulation
- Insulating varnishes
- Special-purpose plastic components



Plastics:
- Stabilisers & plasticisers
- Mould release agents
- Antistatic & antifogging aids
- Polymerisation emulsifiers



Printing:
- Printing inks
- Paper coatings
- Photographic printing

Metalworking & Foundries:
- Cutting oils
- Coolants
- Buffing and polishing compounds

Health Care:
- Tabletting aids
- Drugs

Paper Recycling:
- Removal of printing ink

Mining:
- Froth flotation of ores
- Surface-active agents for oil-well drilling muds

Waxes & Candles:
- Ingredients in waxes and polishes

Oleochemicals Based Products

Fatty Acids

Glycerin

Triacetin

Azelaic Acid

PVC Lubricants

Biodegradable Oilfield Esters

Candles, Soap, Shampoo	Moisturizer: Toothpaste	Plasticizer: Cigarette Filters	Jet Engine Lubricants	PVC Lubricants	Drilling Mud

PTTGC Sustainability Agenda

To simultaneously **drive profit** through sustainable growth, **advance social** and **minimize environmental impact**

THANK YOU FOR YOUR ATTENTION