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SCB Economic Intelligence Center

Bioplastic investment analysis

March 2016

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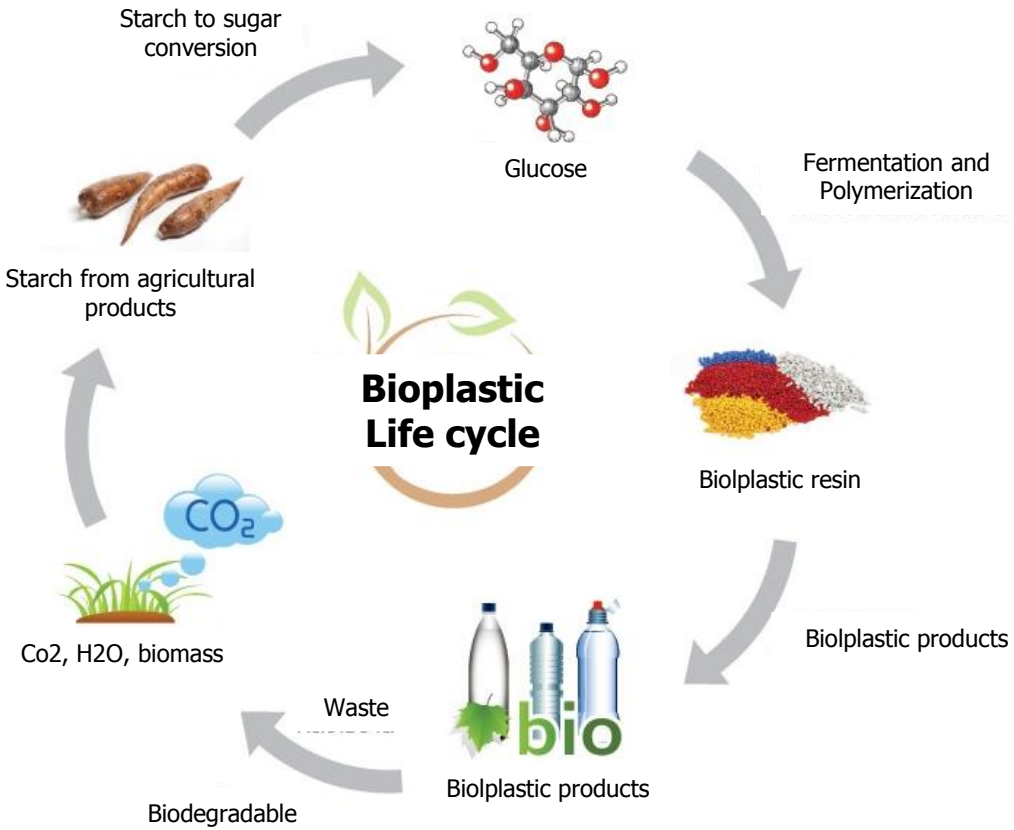
Bioplastic is an eco-friendly and sustainable alternative of conventional plastic

Life cycle of bioplastic produced from agricultural feedstock



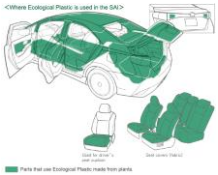
Source: EIC analysis based on data from European bioplastics

Global companies in Food&Beverage and FMCGs have replaced conventional packaging with bioplastic such as PlantBottle or shampoo containers as sustainability efforts

	Company	Sustainability involved	Product
Food & Beverage	Coca-Cola	Coca Cola plans to replace 100% petro plastic to bioplastic in 2020 called PlantBottle using resin named "BioFormPX". Coca Cola is actively working in collaborating with partnerships around the world to create a global supply chain for the PlantBottle material eg. Heinz, Ford etc. - 5 million bottles produced from bio-plastic in 2011 - replaced 100% with bioplastic within 2020	 PlantBottle (BioFormPX)
	PEPSICO	PepsiCo is set to launch bio-PET or plantbottle project using 100% bottles derived from plant materials. Under brand Sun Chips, it has also announced that it will use biodegradable chip bag from its potatoes waste	 PlantBottle  Biodegradable chip bag
FMCGs	P&G Procter&Gamble	P&G and other partnerships are the co founding BFA members (Bioplastic Feedstock Alliance), focusing on making plastic from agricultural feedstock.	 Pantene shampoo using 100% bio-HDPE made by sugarcane
	Unilever	Unilever is also involved in BFA. The company has launched a new strategic business direction called the Sustainable Living Plan aiming to double size of its business while reducing environmental impact through its entire value chain by 2020. They try to reduce the weight of packaging by one-third and also increase the recycle material content of packaging to maximum possible levels.	 Dove packaging with recycled material

Source: EIC analysis based on data from bioplastic players

Retail sector has used bioplastic for packaging particularly bag and food package, while automotive has looked into material part such as seat back

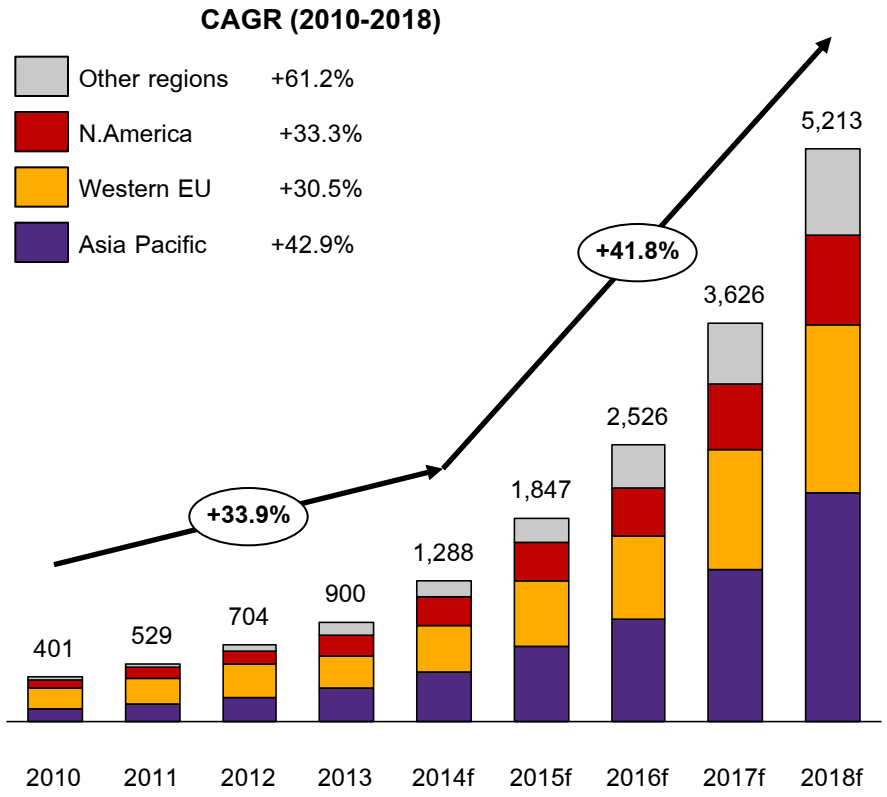
	Company	Sustainability involved	Product	
Retailer	Walmart	Walmart is setting its goal of achieving zero waste across its global value chain by 4 R's of sustainability; reduce, reuse, recycle and rethink. They use corn-based bio-plastic wrap in food packaging for 37% of its package produce.		Biodegradable bag
	Tesco	Tesco is actively working with its suppliers to reduce carbon footprint of the product through its supply chain with using fully home-compostable packaging		Tesco 100% degradable bag
Automotive	Ford	Ford is a member of PTC (Plant PET technology Collaborative); is a strategic group working in development and use of 100% plant-based PET materials and fiber in their products. They used renewable materials such as soy-based polyurethane foams in seats and seat back of most vehicles.		Ford eco-friendly car using bioplastic and soy-based polyurethane foam
	Toyota	Toyota designed eco-friendly Prius by using bioplastic made from corn or sugarcane in the Prius frame interior as door trim, seat cushions and scuff boards. Toyota aims to apply 20% of ecoplastic in its material part and to reduce 20% of carbon footprint by 2016		SAI Toyota's initial model of ecoplastic

Source: EIC analysis based on data from bioplastic players

Bioplastic global demand is set to rise driven by Asia, in need to diversify feedstock

Bioplastic consumption by region

Unit: thousand tons



Source: EIC analysis based on data from ICIS

Why key consumers are Asia and Europe?

Asia:

- Majority are net oil import, strong bioplastic demand to enhance energy security
- feedstock supply and cost advantage

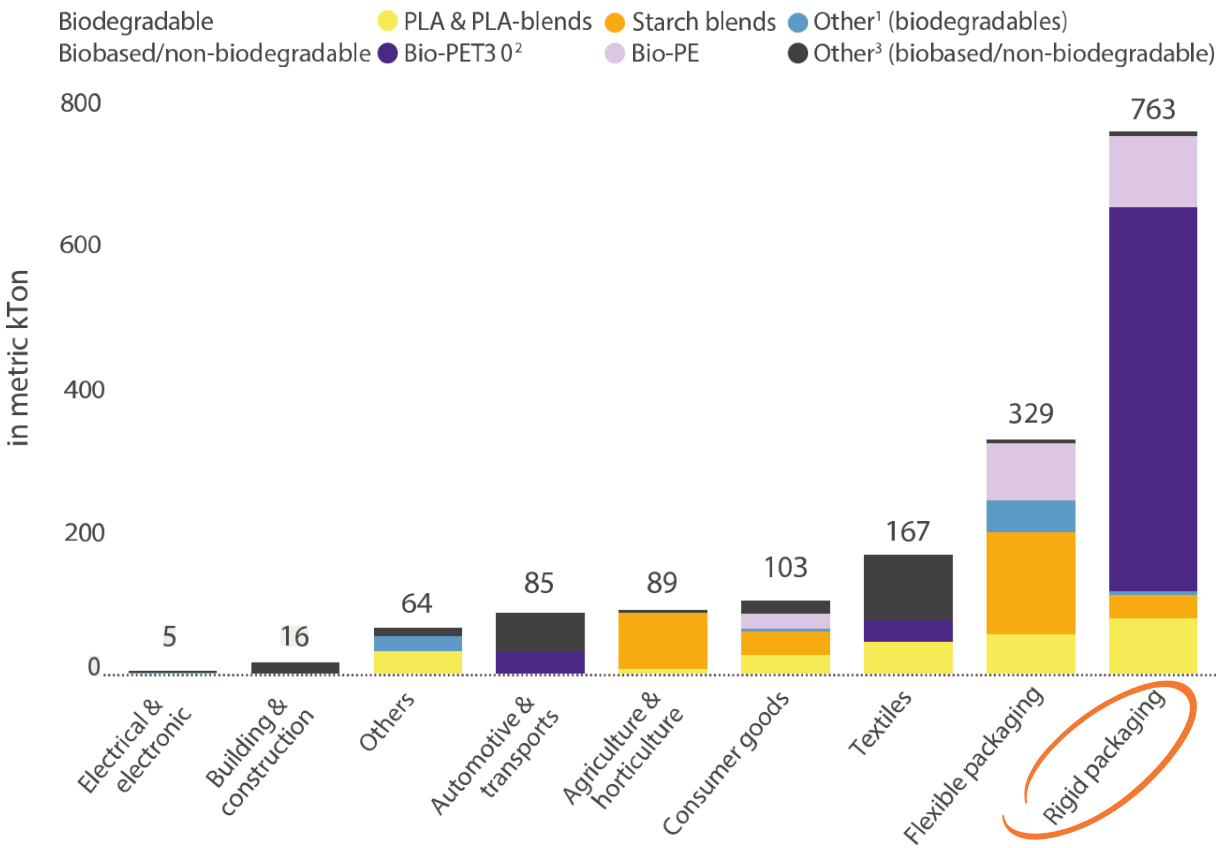
Europe:

- Environmental concern, carbon emission reduction policy
- Majority are net oil import, strong bioplastic demand to enhance energy security

On the supply side, Bioplastic is often produced for short-lived applications such as biowaste bags or packaging of fresh produce

Global production of bioplastic in 2013 by market segment

Unit: thousand tons



Note: [1]Contains regenerated cellulose and biodegradable cellulose ester[2]Biobased content amounts to03%[3]Contains durable starch blends, Bio-PC, Bio-TPE, Bio-PUR (except thermosets), Bio-PA, PTT

Source: EIC analysis based on data from European bioplastics

However, Bioplastic technology is being developed for more durable goods application in response to shift in demand

Bioplastic development

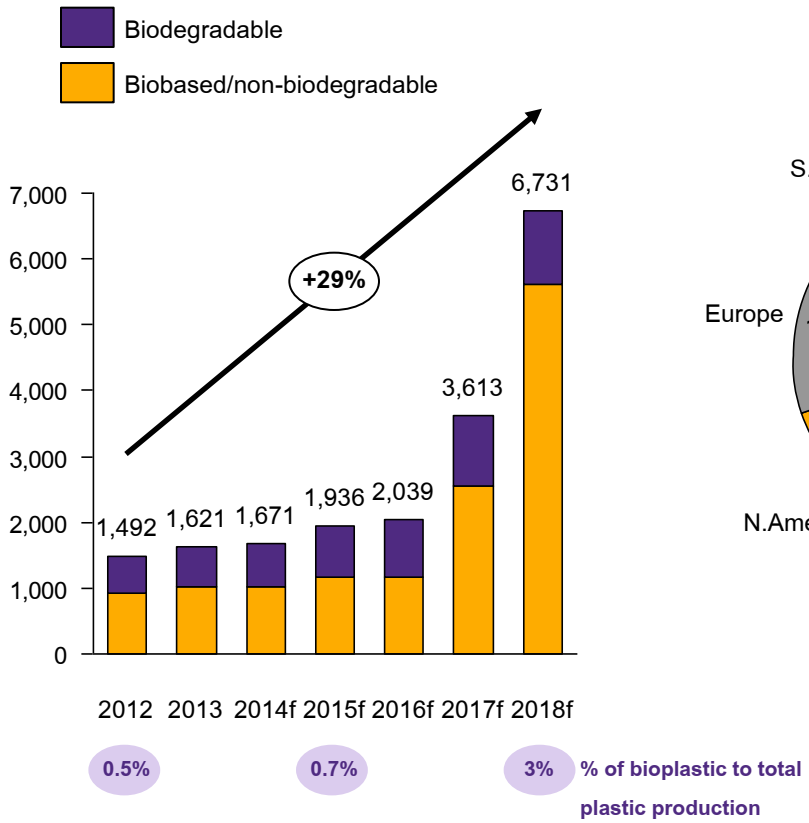
Source: EIC analysis based on data from Chemical Market Resources NatureWorks, Inno Bioplast Meeting 2013

Bioplastic global production capacity is set to grow to nearly 7 mil tons by 2018, capacities are growing fastest in Asia

Asian countries are actively developing technologies to monetize their feedstock-rich agricultural economies

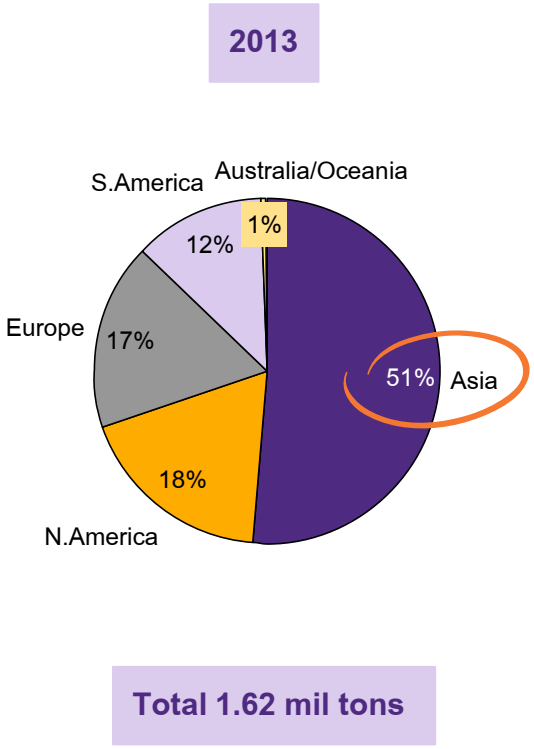
Global production capacity of bioplastic

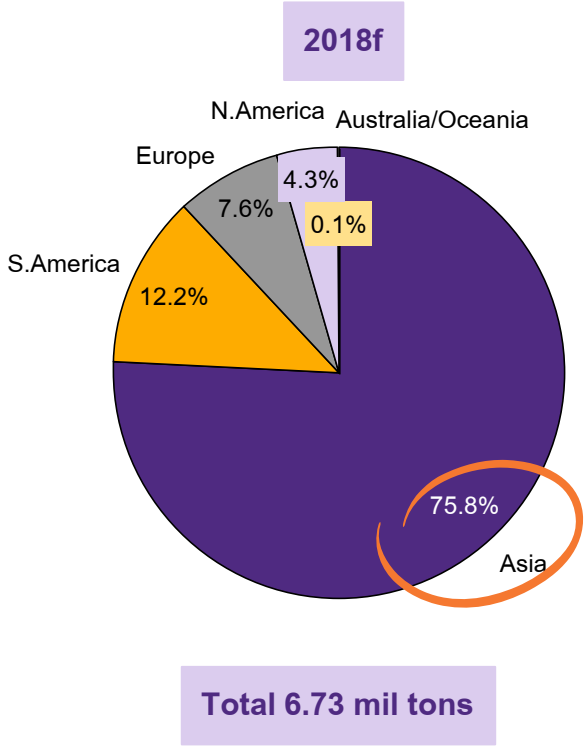
Unit: thousand metric tons



Global production capacity of bioplastic by region

Unit: %

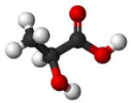




Source: EIC analysis based on data from European bioplastics

For Thailand, upstream bioplastic along the value chain is more ready than downstream; however, production has not reached commercial scale

Bioplastics value chain

	Agricultural feedstock	Biomonomer	Bioplastic resin	Bioplastic compound	Bioplastic products	End users
						
	- Sugarcane and sugar, Thailand ranks the 2nd as world sugar exporter, 69 sugar companies **- Cassava**, Thailand is the world's largest exporter of tapioca product, 113 starch companies	**- Lactic Acid** production in Thailand with capacity 100,000 tons/yr, currently not used in bioplastic resin production (but used for export)	**- PBS pilot plant** project with total capacity of only 20,000 tons will start at the end of 2015 - Bioplastics resin (PLA) 2014 imports to Thailand around 422 tons/yr	- Lack of bioplastic compound domestically	- Plastic converter (>3,000 companies) can partly develop machine or newly invest in bioplastic converter - Production cost is now relatively high - Converter lacks bioplastic knowledge, so having problem with product development	- Domestic market of biolplastic is small - Consumers are concerned about price over environment - Big market is in EU, US and japan
Current players	MITR PHOL Sugar, PURAC	PURAC	ptt MCC Biochem		SUNFLOWER GROUP, Unity Thai Products Co.,Ltd	Café Amazon, MAJOR CINEPLEX
Thai Readiness	●	●	◑	○	◔	◔

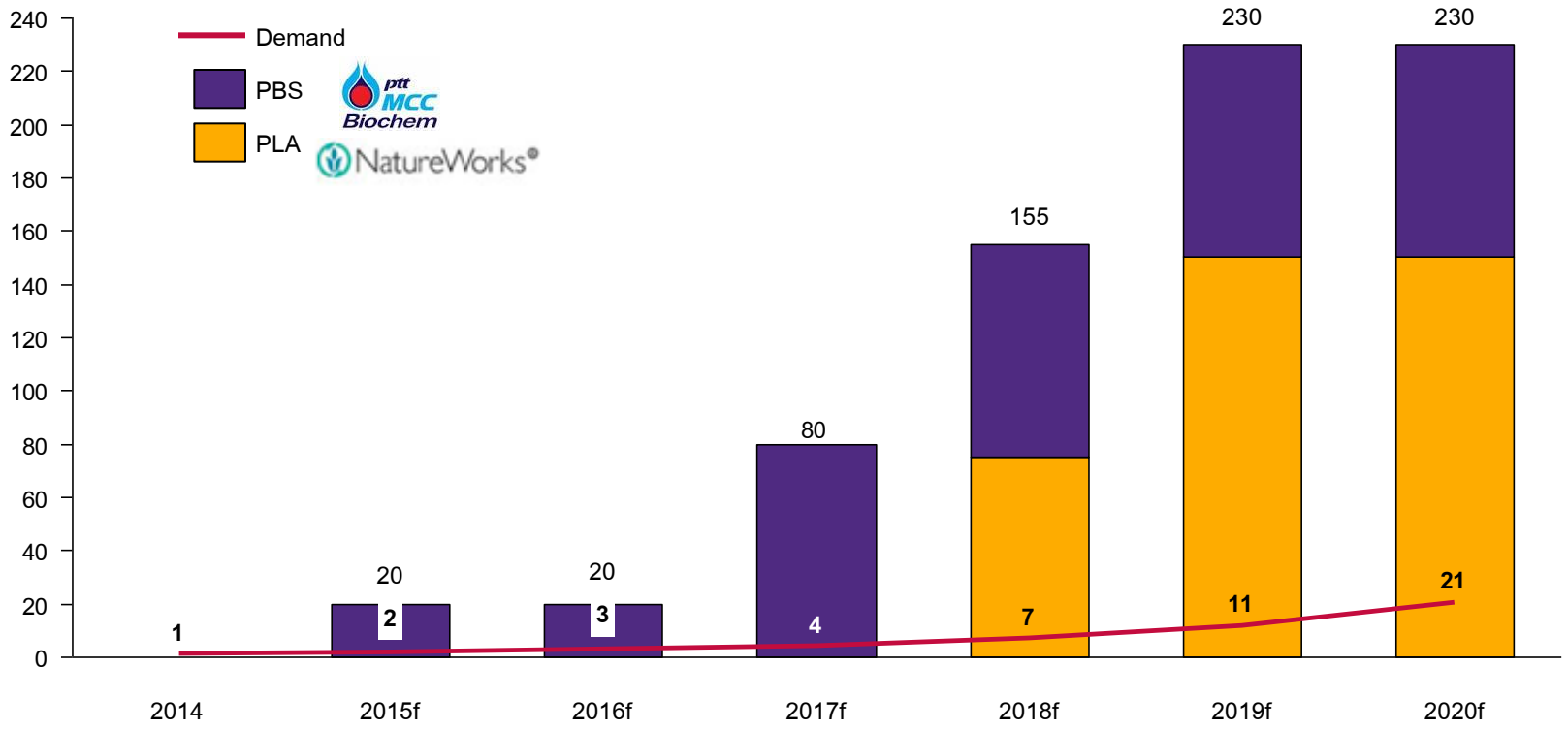
Note: Thai readiness ranks from ● = ready ○ = not ready

Source: EIC analysis based on data from FTI

Expect Bioplastic demand in Thailand to be far less than potential capacity growth, thus production will be export oriented

Bioplastic demand and supply in Thailand

Unit: thousand tons



Source: EIC analysis based on data from FTI

In Thailand, bioplastic is still made for packaging, converters need to develop product applied to other sectors e.g. auto, medical

Bioplastic producers example

Company	Bioplastic
PTT MCC Biochem	 BioPBS
NatureWorks / PTT Global Chemical	PLA
SCG Chemicals	 Bio-PET
Indorama Ventures	Bio-PET, Bio MEG, Bio fiber

End customers example

Company	Product
Major Cineplex	 Major Ciniplex bioplastic popcorn bucket
Café Amazon	 Café Amazon bioplastic cup
Dairy Home	 Dairy home Yogurt packaging

Source: EIC analysis based on data from bioplastic players

Government support is one of key driving factors for bioplastic demand and supply

Demand driving factors		Supply driving factors	
Go green	The demand for sustainable products is growing significantly, being sustainable can drive new growth that capitalizes on a rising demand for environmentally friendly and energy-efficient products	**Feedstock advantage**	Thailand has plenty of agricultural products that can be used as biomass feedstock for bioplastic such as cassava, and sugarcane
Price reduction	Cost and price reductions will be achieved through economies of scale, using less expensive feedstocks and technical improvement	**Plastic industry strength**	Thailand has strong suppliers across bioplastic value chain from upstream to downstream, 3,000 converters have potential to effectively manufacture biomass into high-value-added bioplastic
Gov support	Thai government is considering policy to encourage bioplastic demand of end users by offering green tax credit 300%	**Gov support**	Bioplastic is a priority sector involving BOI incentives e.g. import duties on machinery exemption and an 8-year exemption of corporate income tax, The government is also considering a soft loan (2% for 8 years) providing to investor

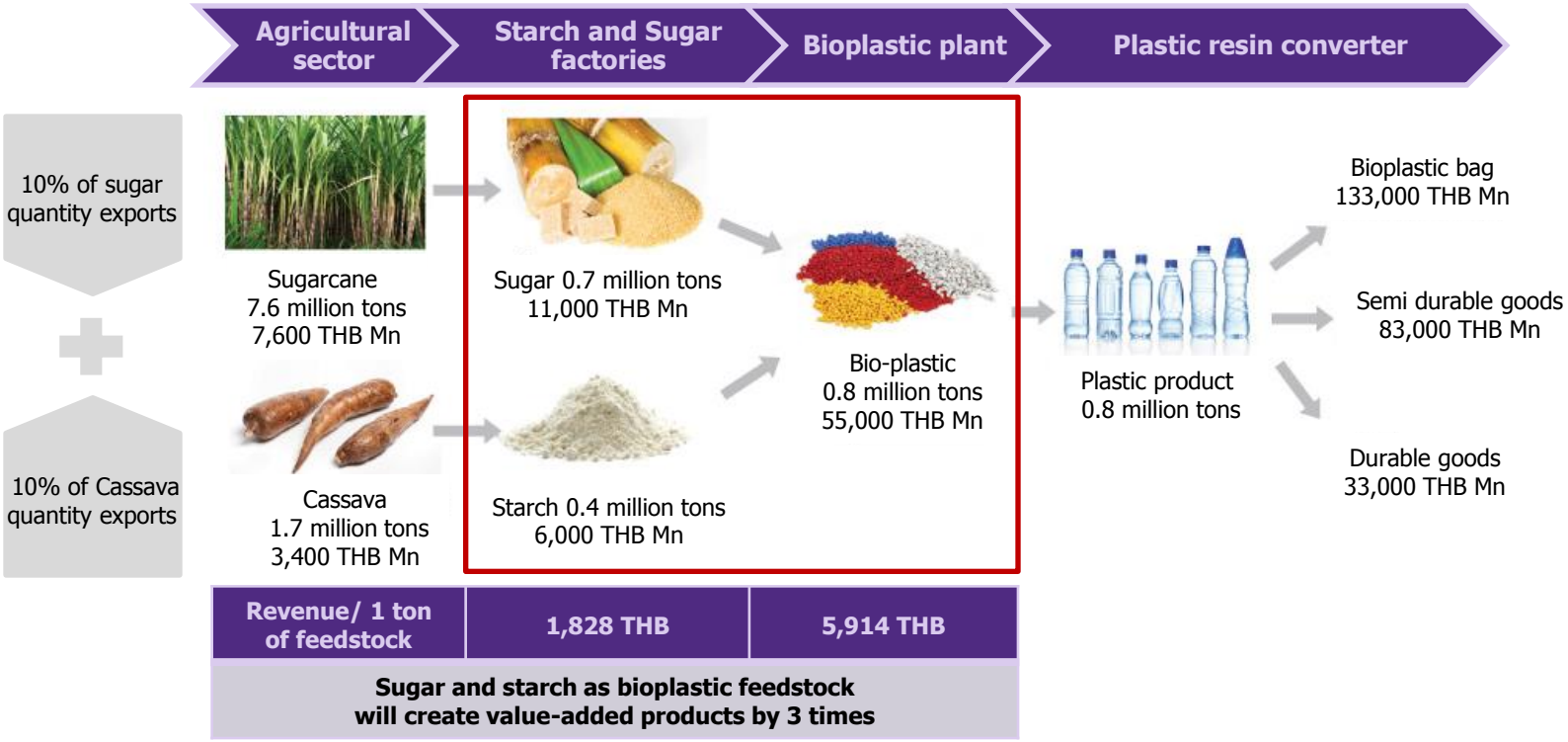
Source: EIC analysis

Market opportunity

- **Environmental friendly market**
  - bio-packaging, premium products e.g. auto, E&E
- **Niche market e.g. Health concern market**
  - Orthopedic, Dental devices
- **Carbon emission reduction market**
  - Opportunity to export bio-products to countries (e.g. Europe) with carbon footprint reduction strategy requiring bio content

Bioplastic can enhance value in agricultural sector by 3 times

Value added in agriculture from bioplastic



Source: EIC analysis based on data from Plastic Institute of Thailand and European bioplastics

First generation feedstocks are high on the cost curve, but second generation could be competitive

Feedstock generation

1st generation

1st generation is readily available in sufficient quantities to allow early commercial development of bio-based downstream chemicals, but doesn't provide much diversification given relatively high correlation between oil and commodity price

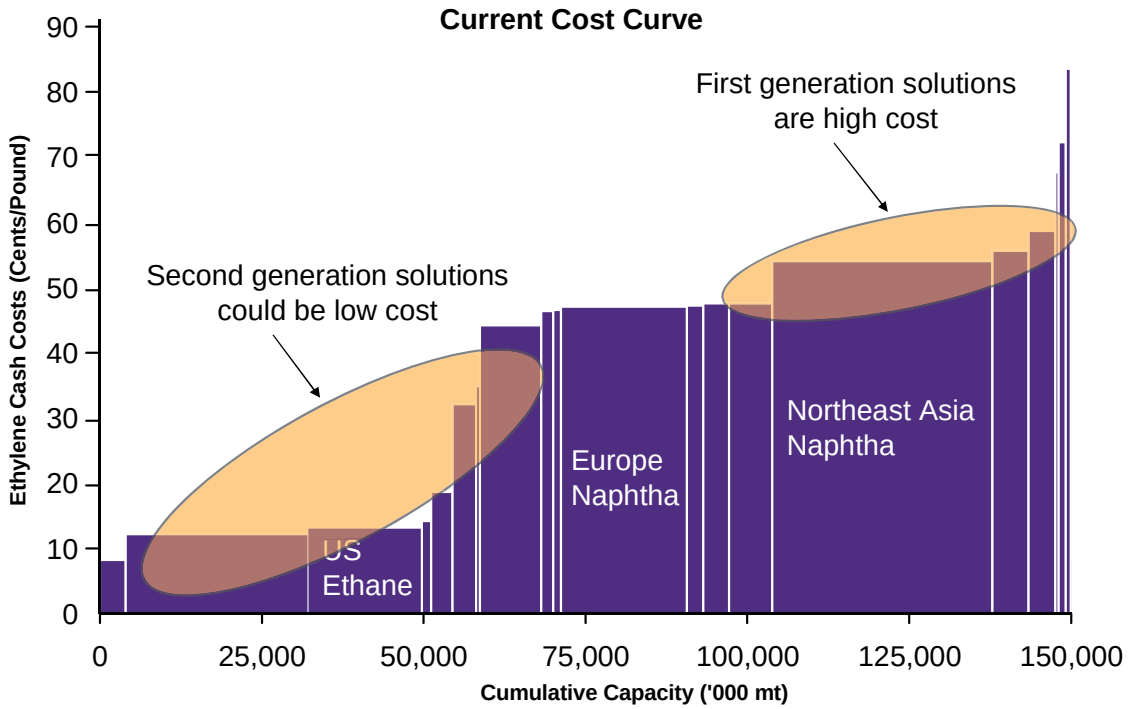
2nd generation

Breaking down cellulosic biomass

2nd generation is still in the relatively early stages of development and likely to be the long-term direction of the renewable industry (to avoid competition with food), as this is the easiest way to minimise raw material costs and boost commercial viability

Ethylene cash cost

Unit: cent/lb



Source: EIC analysis based on data from IHS Chemical, Morgan Stanley

NatureWorks investment plan is to set up a PLA plant in Thailand due to the strong agricultural-based feedstock supply and the existence of some 3,000 plastic convertors

- **NatureWorks is world's leader in bioplastic market**
  - Production capacity 150 ktpa in Neblaska, USA
  - World's largest bioplastic production plant
- **Project of PLA plant in Thailand accounts around $300mn (exclude land cost) with maximum capacity 150 ktpa per year**
- **Main feedstocks being considered are tapioca starch and sugar**
- **80%-90% of production for export mainly to Asia such as Japan, China, South Korea and Taiwan**
- **Location: Asia Industrial Estate**

Major Shareholders

Cargill™ 50%

ptt GLOBAL CHEMICAL 50%

NatureWorks®

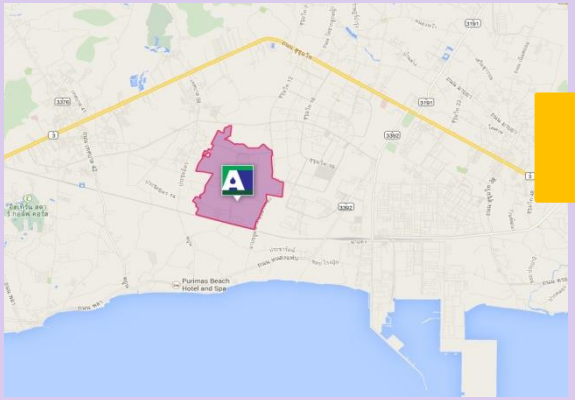
Advantage

- Potential soft Loan from gov (100bil THB in 5-10 years)
- Green tax credit
- R&D tax Credit 3x
- Sustainable business from renewable sources
- Promote CSR (waste management, GHGs emission reduction)

Consideration

- Higher cost of production than conventional plastic
- Cannibalization of current offering of PTTGC
- Currently, low domestic and global demand
- Feedstock security

Asia Industrial Estate



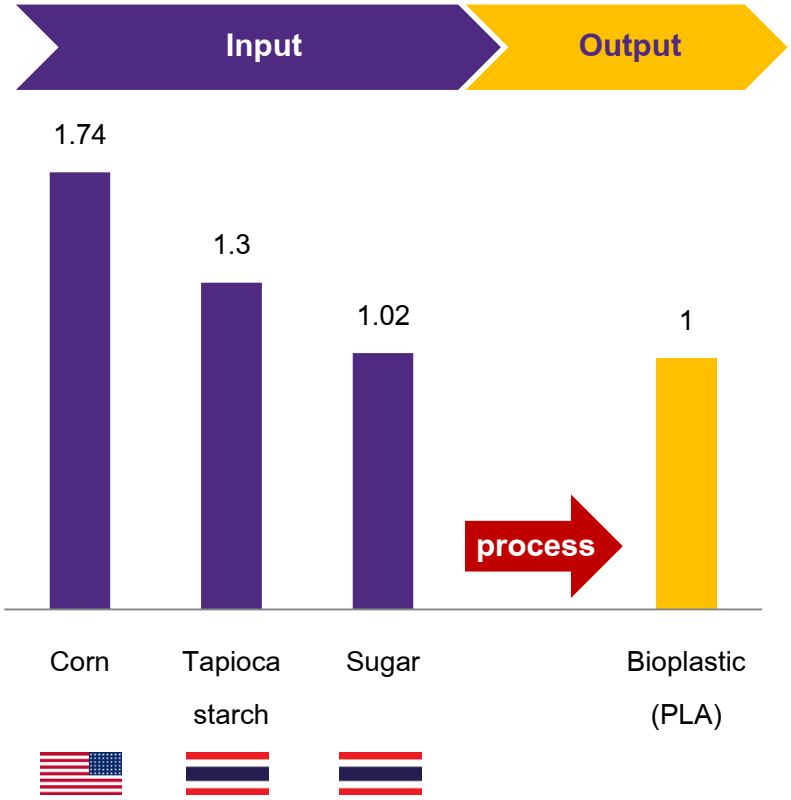
Map-ta-phut, Rayong

Source: EIC analysis based on PTTGC

Domestic players prefer sugar as feedstock for yield maximization and cost volatility minimization

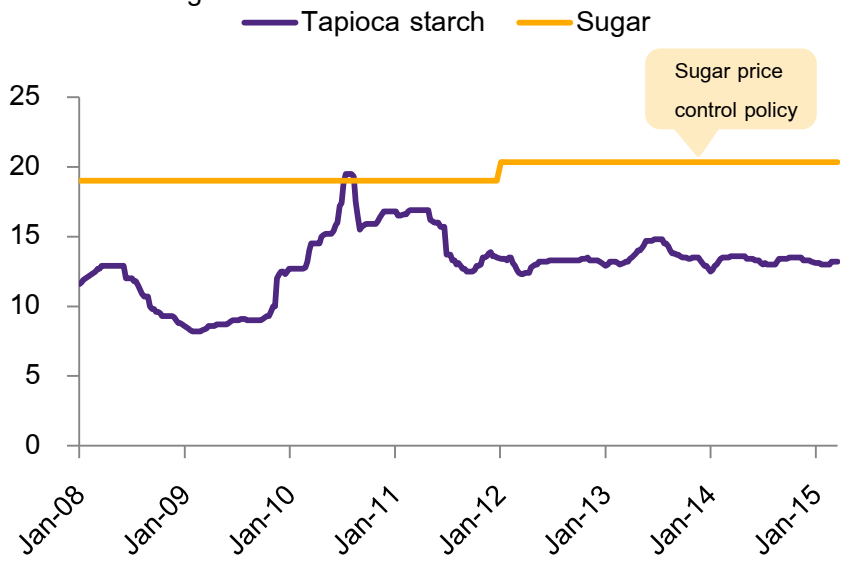
Tapioca starch and sugar yield

Unit: kilogram



Tapioca starch and sugar domestic price

Unit: THB/kg



- Sugar sold to Bioplastic industry has lower price than Food&Bev industry due to sugar quality
- Tapioca starch price between sectors is the same, it is expected that Cargill (which has tapioca starch plant in Makasarakam) can provide tapioca feedstock to NatureWorks if sugar price increases

Source: EIC analysis based on data from Bloomberg, EEPSEA, OCSB, Mitr Phol

High cost of production and plunge in oil price are currently key threats to bioplastic causing it to be less competitive

Threats	Detail
High cost of bioplastic	- The high costs of research and development and uneconomy of scale have kept the cost and price of bioplastics high (2-3 times of conventional plastic), and volumes low. As demand increases, availability becomes more reliable and performance rises, bioplastics prices will fall
Low level of crude oil price	- Market potential for bioplastics is heavily dependent on the crude oil price. Under the current situation of low level in oil price, bioplastics made from agricultural products have become less competitive - If oil prices stabilize around $90/bbl, then technologies for bioplastics have potential (ICIS)
Quality of bioplastic	- Though bioplastic can be an alternative for almost conventional plastic, with the same quality, it comes with the high price - Bioplastic functional limitations have so far restricted widespread application e.g. thermal instability, low melt strength, high vapor and oxygen permeability, stiffness and poor impact resistance
Interest in environment not yet widespread	- The environment is a problem that is less visible than other social problems e.g. poverty, people are less likely to realize its effect e.g. using more petroleum plastic creates more CO_2 in the air causing more global warming - Consumers appear to be unwilling to pay premium for green products
Supply chain complexity	- Biochemical industry has a much greater variety of feedstocks, production routes and end products, and therefore much greater complexity, It requires the combination of a number of different areas of expertise, e.g. agricultural, for the collection and transportation of biomass and commercialization of agricultural co-products

Source: EIC analysis based on data from Morgan Stanley

Success in bioplastic investment in Thailand hinges on stringent cost-quality management and consumer demand understanding

Technology transfer is necessary for a sustainable development

Key factors for successful bioplastic development

- Reduce production cost and develop bioplastic quality to compete with conventional plastic
- Access to expertise and technology from the bioplastic industry leader, and develop our own
- Understanding how new bio products can be used, customers' specification requirements, will determine the likelihood of a bioplastic product gaining commercial success

If successful, benefits to the Thai economy can be significant

- Value creation from agricultural product by 3 times: FTI estimated value added more than 42,000 mil THB/year from 8-10% of sugar export value
- Stable sugar and cassava market
- Labor employment (approximately 15,000 employment)
- Technology transfer from abroad
- Support downstream converter and SMEs to develop eco-friendly products

Source: EIC analysis

End of document

Appendix

Policies support in western countries have helped driving bioplastic demand

Bioplastic policy by country group

- **USA** has continually invested in R&D of bioplastic industry and set goal to increase share of bioplastic demand to total plastic demand from current 12% to 20% by 2020
- USDA Biopreferred government purchase program, current 9,000 products from bioplastic in government procurement
- Oxo-Bio Degradable advertising is prohibited in California

- **European Union** announced a mandate for auto industry that, from 2006 more than 85% (by weight) of the vehicle parts must be made of reusable or recoverable materials
- **German**y has exempted the tax for the compostable packaging
- **France** requires that by 2010 all trash bags must be compostable, proposed tax on non-biodegradable "single-use" plastic bag with biobased content < 40% (0.06€)
- **Italy** has banned on non-biodegradable plastic bag since Jan 2011**; Florence, Italy**, all food packaging must be made from degradable materials
- **UK**, discuss a charge on single-use bags with an exemption for biodegradable bags
- **Portugal**, legislation in preparation to reduce single-use bags (biodegradable bags amongst suggested replacements)
- **Romania**: tax on bags from non-renewable sources (0.25€)

Source: EIC analysis based on data from Plastic Institute of Thailand and 2013 Inno Bioplast meeting, NatureWorks

Potential Thai bioplastic export markets are China, Japan, South Korea and Taiwan, driven by their conventional plastic control policy

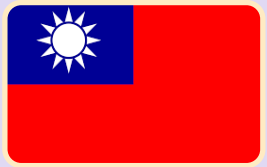
Bioplastic policy by country

- **China** realized a value of renewable energy and announced a plan including environmental sustainability among its main political targets, a five-year plan (2011-2015) aimed to reduce carbon intensity such as banning on free plastic bags. Moreover, Chinese's government also encourage of developing polylactic acid (PLA) material in 2009

- **South Korea**'s statue of environmental recycle contribution in 2009 indicated that bioplastic has exempted the waste tax which means they can save 15 cent per kg from bioplastic using. They also had a regulation of decreasing packaging consumption from conventional plastic in 2013.

- Japan was one of the first Asian countries having advanced bioplastic development. Japanese major players of E&E e.g. Sony, Panasonic, Toshiba have changed their packaging to bioplastic packaging and increasingly used biolplastic in some computer parts

- In Japan an industry-wide commitment is in place which sets the biomass content at 25% renewable material



- Taiwan has released a waste management and environmental relieve regulation in 2002 which reduced and prevented packaging from conventional plastic and foam at supermarket, government institute and fast food. Moreover, in 2006, this regulation also affected to public hospital and public university and school. Taiwan also launched new regulation to limit conventional plastic using in bakery packaging and food packaging in supermarket with the target of 15% reduction in 2008 and 25% in 2009 then 35% in 2011

Source: EIC analysis based on data from NatureWork LLC and Morgan stanley

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