For internal discussion only

SCB Economic Intelligence Center

Biofuel landscape

March 2016

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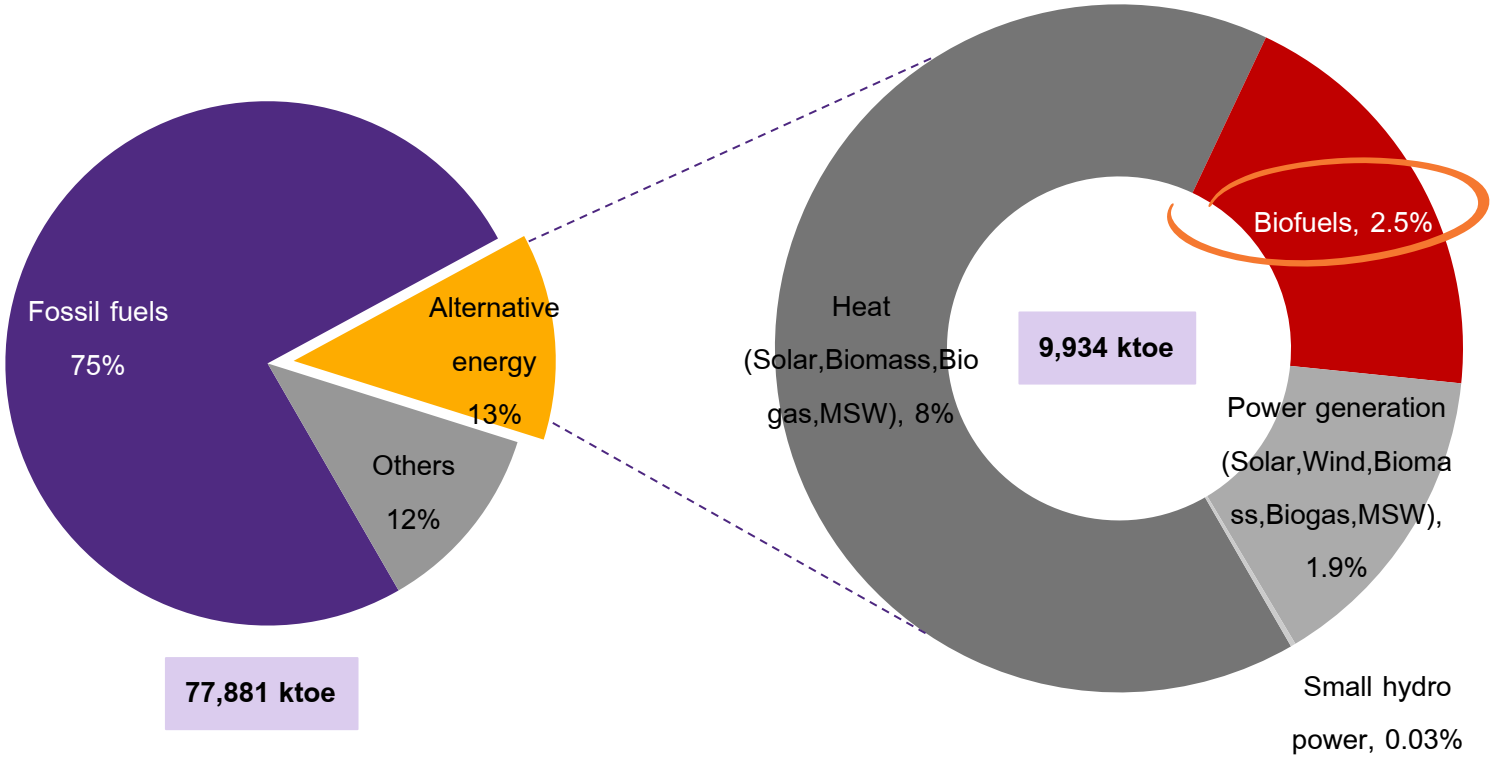
Biofuels account for only 0.3% of total final energy consumption in Thailand

Final energy consumption in Thailand 2014

Unit: %

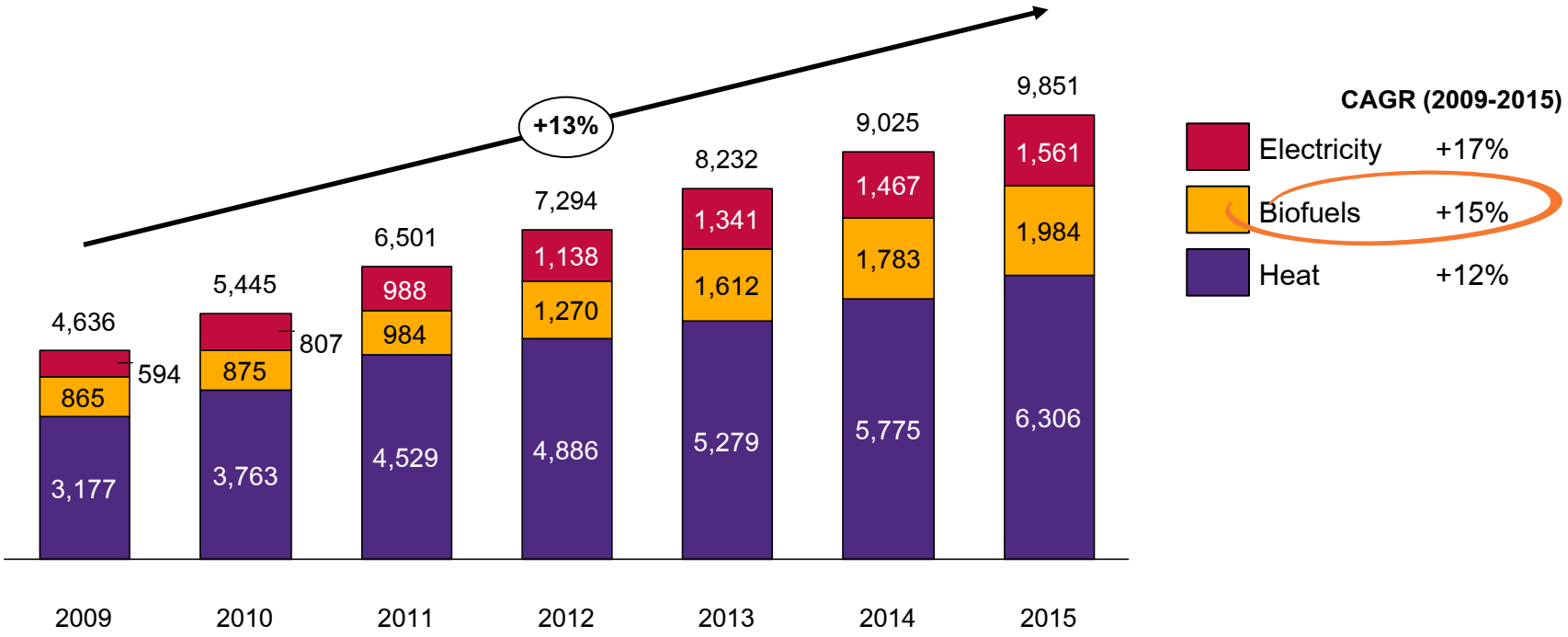


Source: EIC analysis based on data from DEDE

For final alternative energy consumption, biofuel is growing with double digits growth

Final alternative energy consumption in Thailand

Unit: ktoe

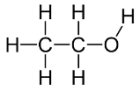


Note: Electricity include Solar, Wind, Small hydro power, Biomass, Municipal Solid Waste (MSW) and Biogas
Biofuels include Ethanol and Biodiesel
Heat include Solar, Biomass, MSW and Biogas

Source: EIC analysis based on data from DEDE

Thai biofuel players have upstream and downstream supports along value chain

Biofuel value chain

	Agricultural feedstock	Fermentation	Biofuel	Biofuel products	End customers /users
Ethanol	 **- Sugarcane** Thailand ranks the 2nd as world sugar exporter **- Cassava**, Thailand is the world's largest exporter of tapioca product	 **- Sugar** 69 sugar companies **- Tapioca starch** 113 starch companies MITR PHOL Sugar, PURAC	 **Ethanol** 21 ethanol plants with capacity 5.04 mil litres/day (as of Jan 2016) MITR PHOL Bio Fuel, UBON BIO ETHANOL group	 **Gasohol** E10, E20, E85 Thaioil	 **Gas station/ Motor vehicle**
B100	 **Palm** Total area 2015 = 4.4 mil rais (3rd in the world after Indo and Malaysia) with total production 12.6 mil tons, 75% of plantation belong to small farmers	 **Crude palm oil** 2014 palm oil crunching mills = 108 with capacity 25 mil tons palm/yr (> 12 mil tons palm oil supply, so CAPU < 50%) UPOIC	 **B100, Fatty acid methyl ester** 14 B100 plants with capacity 5.21 mil litres/day PATUM VEGETABLE OIL CO., LTD., TOL A Subsidiary of PTT Chemical, E@ Energy Absolute, Bangchak BIOFUEL	 **Biodiesel fuel** Oil trader section 7 blend B100 with HSD according to the mandate Thaioil	 **Gas station/ Motor vehicle**

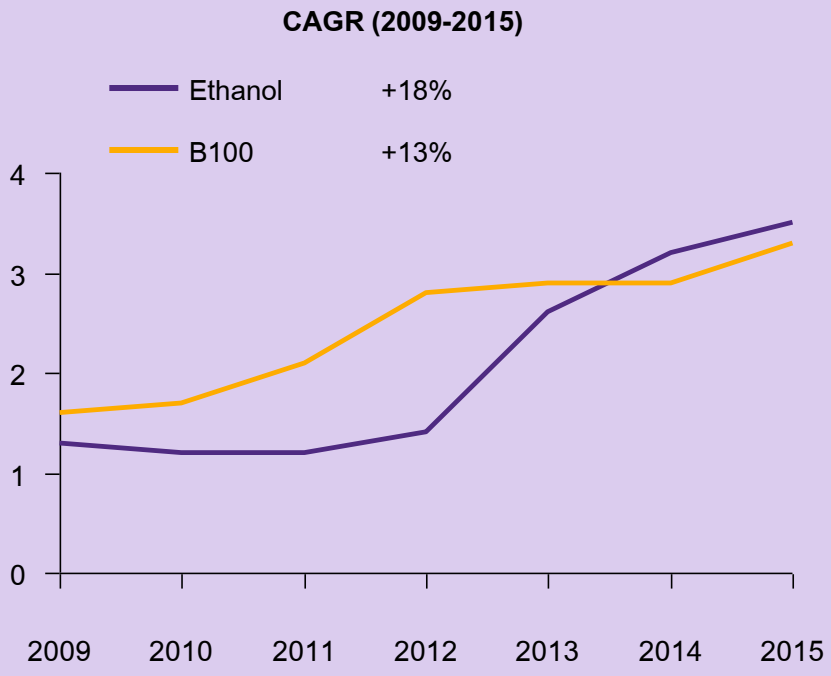
Source: EIC analysis

Market snapshot: Strong growth of ethanol and B100 consumption ~ 16-19%/year, driven by gasohol and diesel sales

Biofuel (Ethanol, B100) | **End product (Gasohol, Biodiesel)**

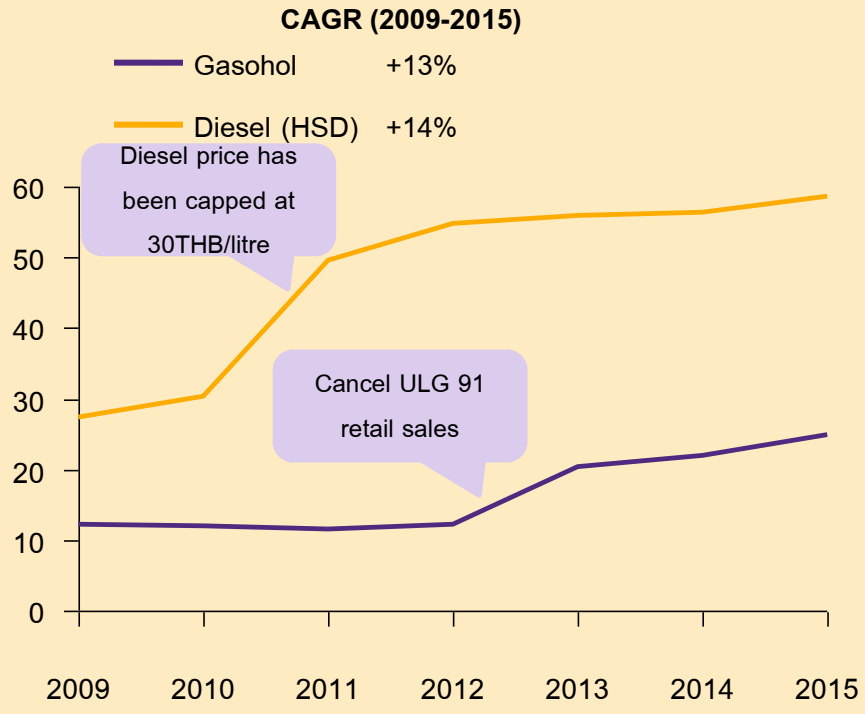
Biofuels consumption by type

Unit: million litres per day



Petroleum product domestic sales by type

Unit: million litres per day



Source: EIC analysis based on data from DEDE, CEIC

Feedstock advantage and government policy are key drivers of biofuel in Thailand

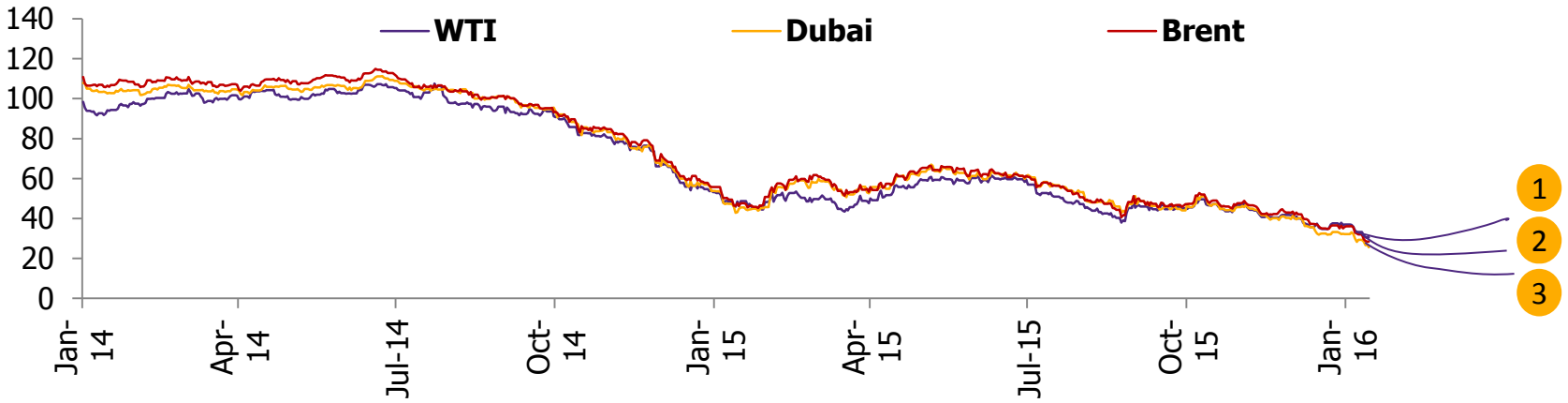
Driving factors	Detail
Feedstock advantage	- Thailand has plenty of agricultural products that can be used as feedstock for biofuel such as cassava, sugarcane to produce ethanol, and palm oil to produce B100
Gov policy Energy security	- Biofuel consumption helps reduce fossil fuel dependency over the long term - Government has set ethanol and B100 consumption target at 7 and 10 mil litres/day by 2026 respectively - Several measures to be implemented e.g. increase mandate of B100 blended with diesel, subsidize E20 and E85, increase price gap between gasohol and benzene and increase feedstock yield
Go green	- Environmental concerns, particularly with regard to global warming driving adoption of “cleaner and greener” alternatives. - A wider push to biofuel sources is viewed as a major step towards reversing the pattern of global warming and green house gas emission
Transport and auto growth	- Growing transport and logistics sector and auto sales driven by economic and trade growth, AEC, transport infrastructure projects, to drive liquid fuel consumption in Thailand - Advanced technology of motor vehicles to accept higher proportion of ethanol and B100 blending - However, higher shifting mode to rail transport will pressure ethanol demand
Technology to reduce cost	- Development and subsequent scale-up of cellulosic biofuel technologies to unlock non-food feedstock and reduce input cost volatility

Source: EIC analysis

However, with low oil price environment, can the biofuel business be sustained?

Historical crude oil prices and forecast trajectories

Unit: USD/bbl.



1 Rebound to 45-50 USD/bbl (2016 Avg: 45 USD/bbl)

- US and Europe economies show clear signs of growth leading to higher oil demand (outweighing a slowdown from China)
- Supply falls from OPEC production freeze, industry lay-offs, CAPEX cuts, and lower rig count
- Slow and strategic export from Iran

2 Fluctuate around 30 USD/bbl In 2016 and beyond

- Oil demand slows from slower growth in China that outweighs recovery in the US and Europe
- Iran fights for market share and export oil immediately and in large amount
- Fed continues raising rate in 2016, prompting a risk-off situation

3 Plunge further to 15-20 USD/bbl (2016 Avg: 20-25 USD/bbl)

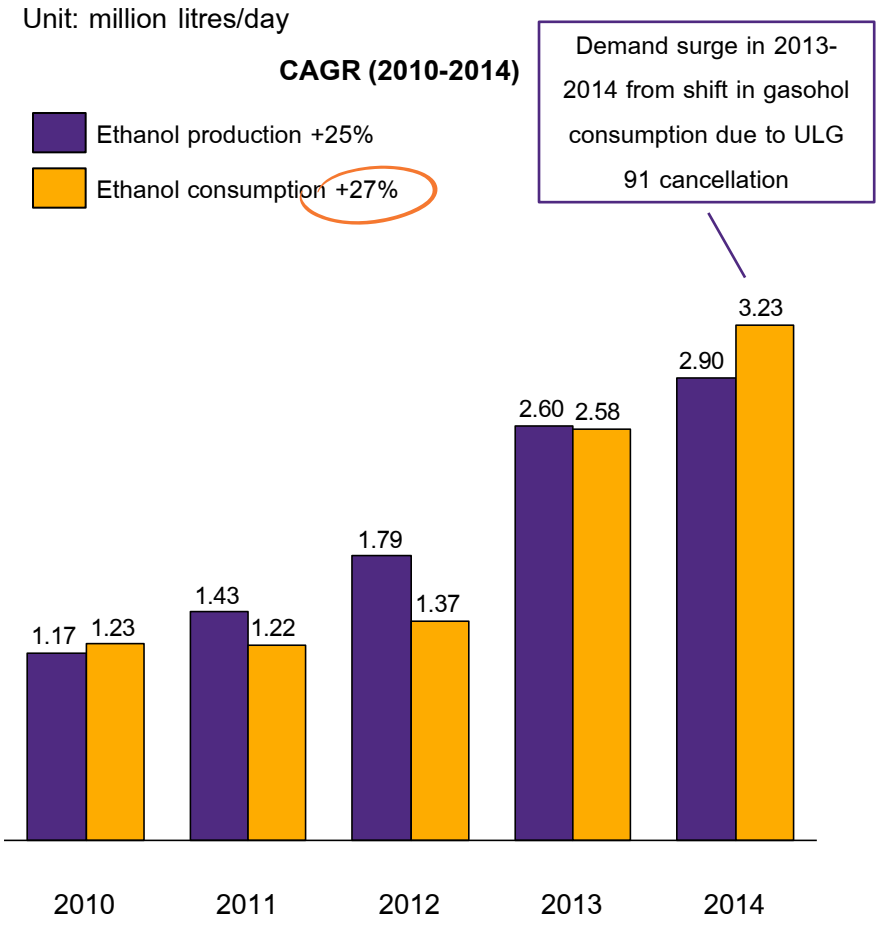
- China's economy collapses
- OPEC cartel ends, causing aggressive open market competition (e.g. price war)

EIC analysis based on data from Bloomberg

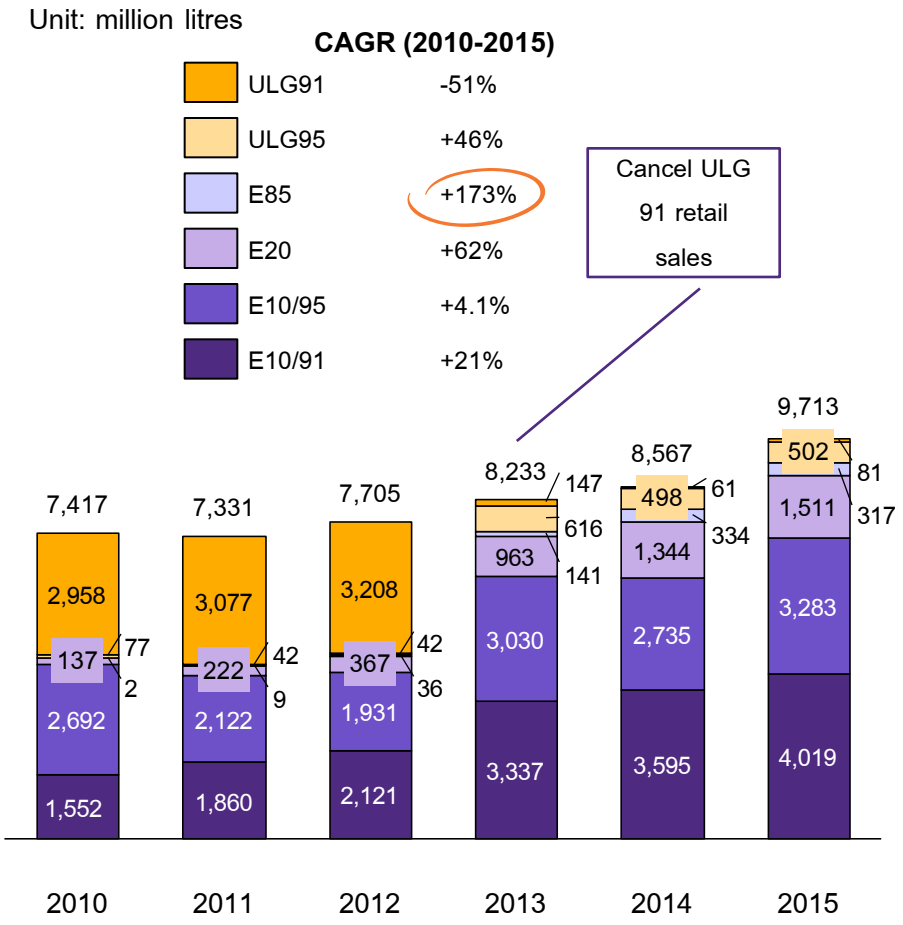
Ethanol for gasohol

Strong growth of ethanol demand driven by high growth of gasohol consumption especially E85 and E20

Ethanol production and consumption



Benzene and gasohol domestic sales

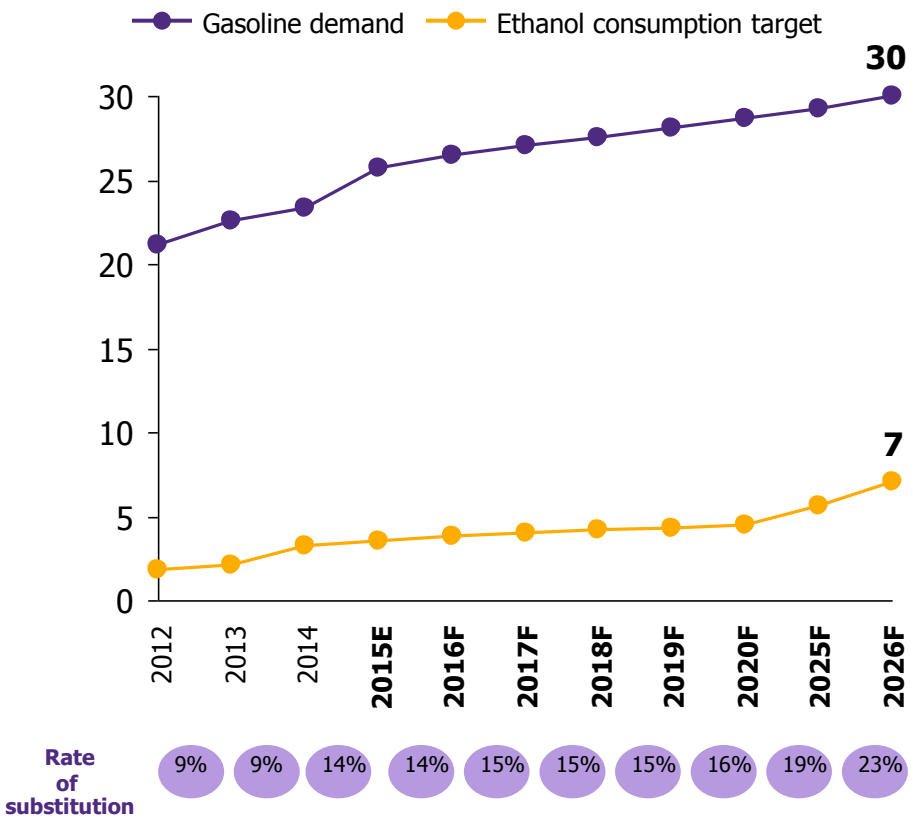


Note: Consumption volume over production in 2014 came from inventory in the past
Source: EIC analysis based on data from CEIC, DEDE

Government policy subsidizing in E20 and E85 price could help to drive domestic ethanol consumption

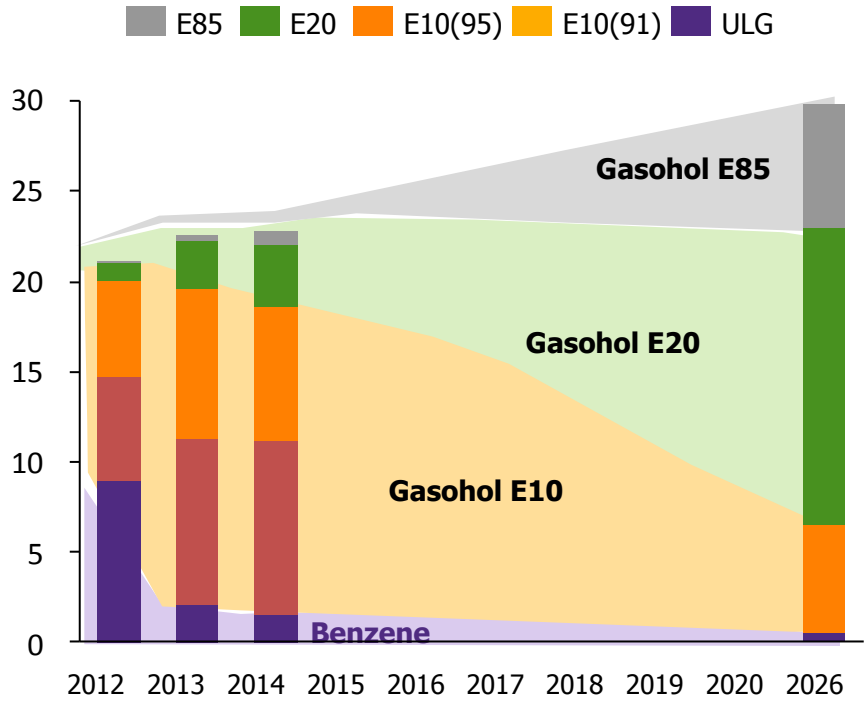
Estimated gasohol-ethanol target

Unit: million liters/day



Estimated gasohol by type

Unit: million liters

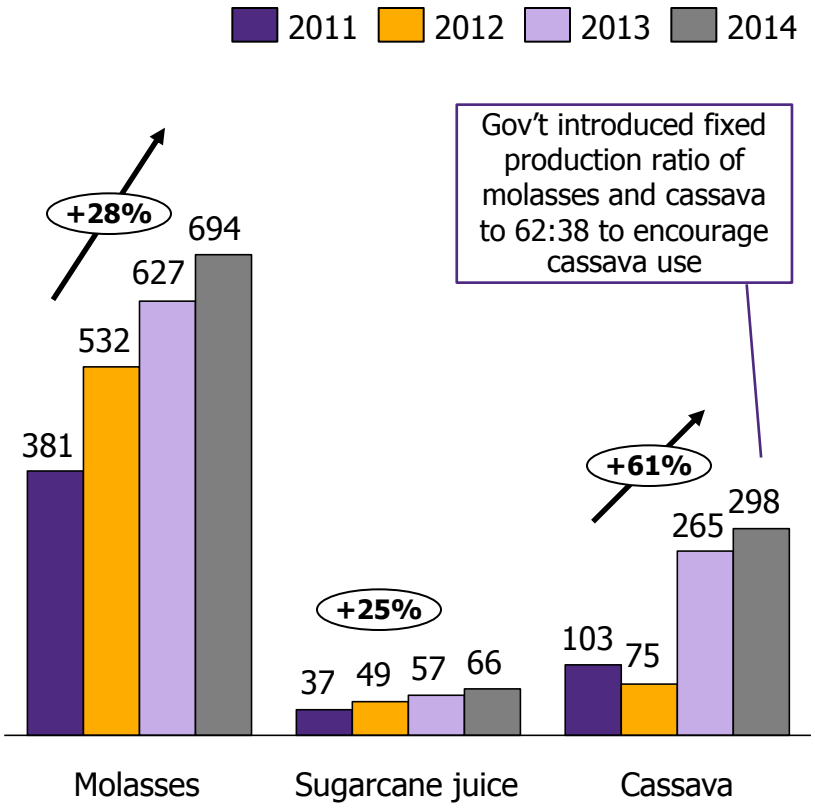


Source: EIC analysis based on data from DEDE

Ethanol produced from cassava has the strongest growth positively affected by the government policy

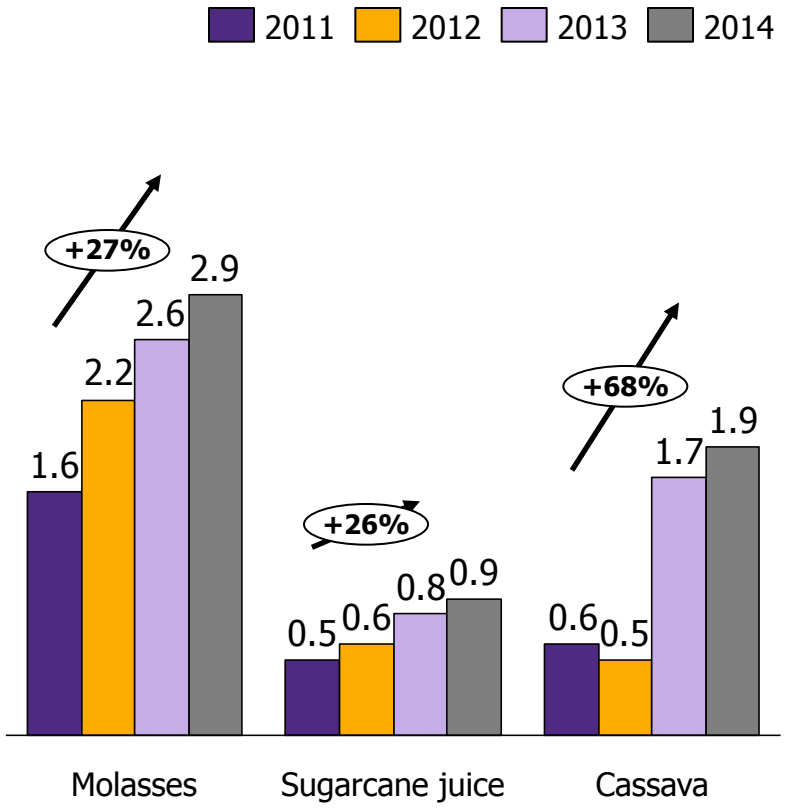
Ethanol production by feedstock

Unit: million liters



Feedstock supply to produce ethanol

Unit: million tons

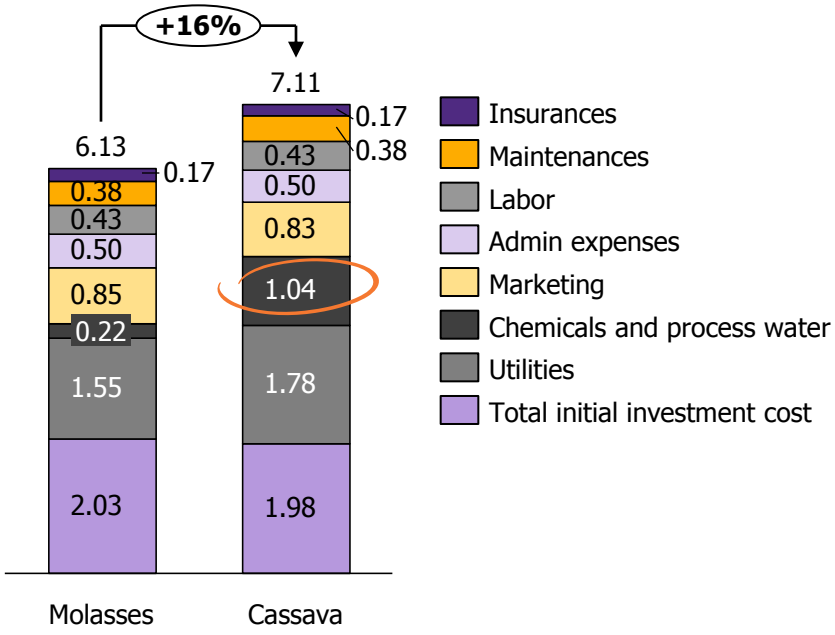


Source: EIC analysis based on data from BOT

Although ethanol operating cost by using cassava as feedstock is higher than molasses, the overall production cost is still lower

Ethanol operating cost

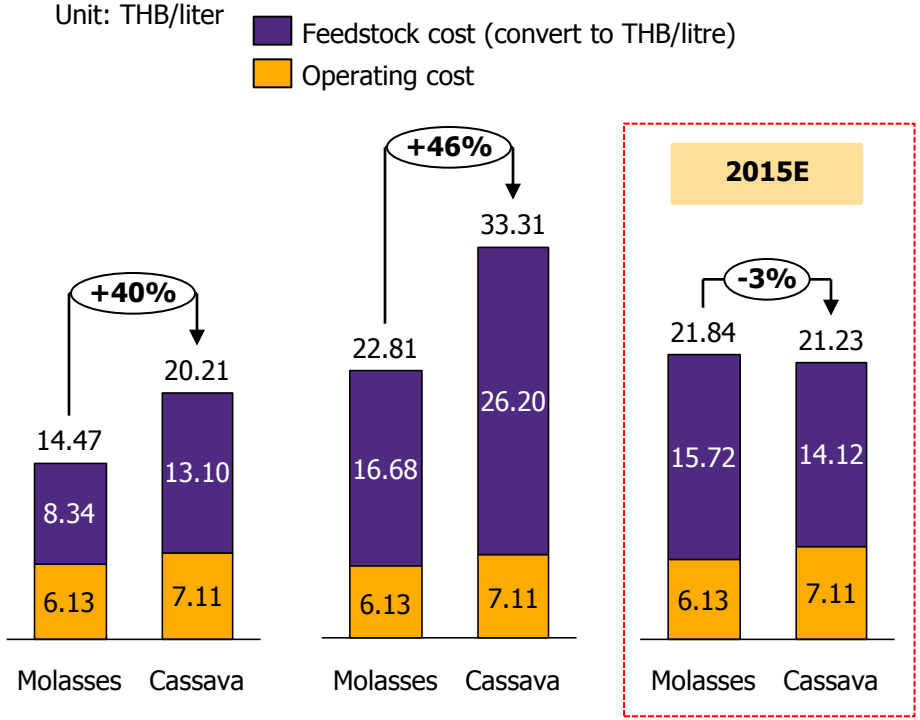
Unit: THB/liter



Ethanol operating cost produced from Cassava is higher than from Molasses due to high numbers of production processes

Total ethanol production cost

Unit: THB/liter



Feedstock 2 THB/kg | **Feedstock 4 THB/kg** | **Feedstock (Averaged price)**

Feedstock price sensitivity

Note: Total initial investment cost includes machinery, land, building, environmental cleaning system
Ethanol conversion rate for Molasses = 4.17kg/liter, for Cassava = 6.55 kg/liter

Source: EIC analysis based on data from EPPO, TTSA

Rising FFV and ethanol mandate around the globe are game changers positively affecting ethanol players

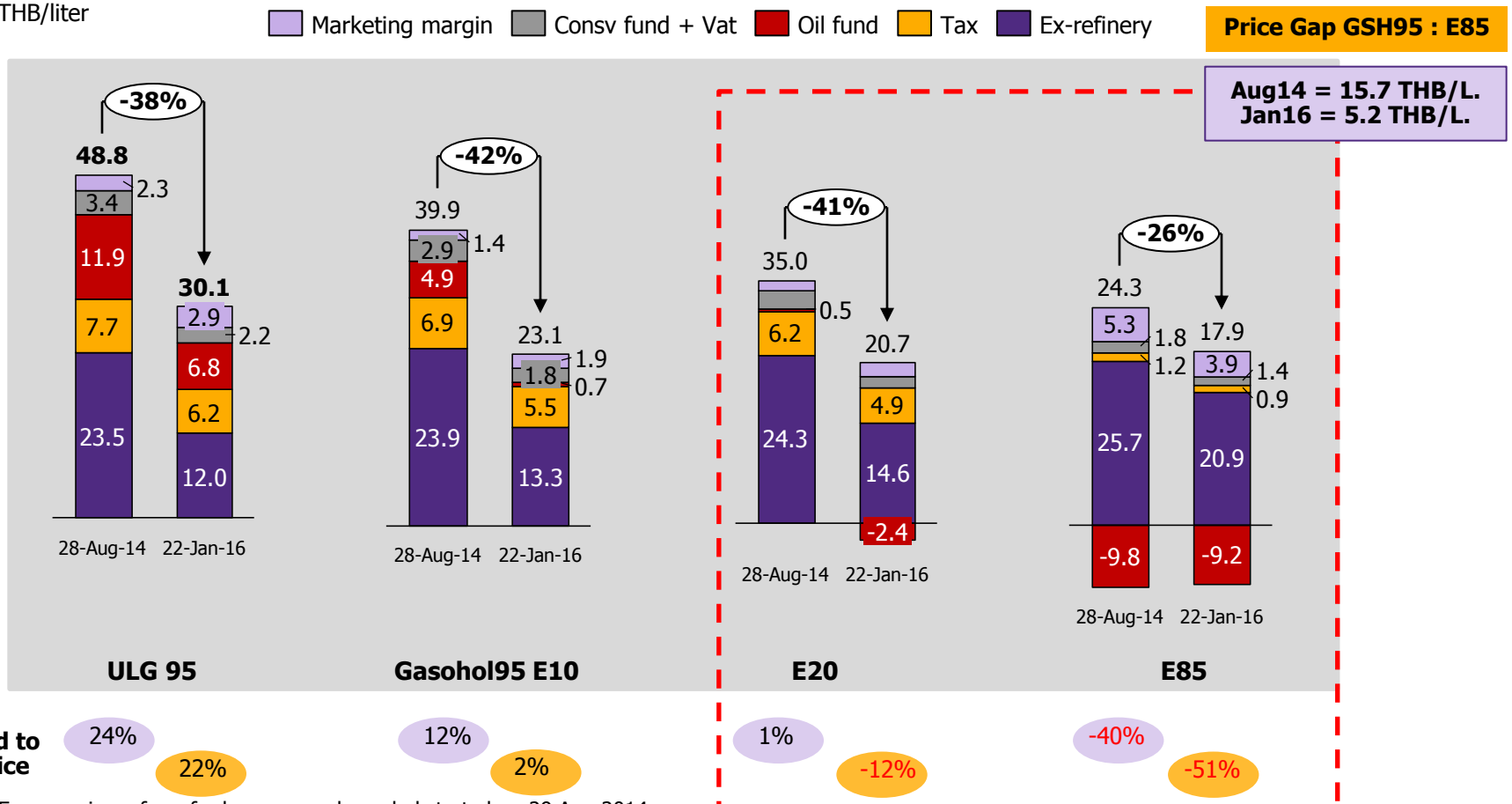
Game changer	Impact to industry	Detail
Plunge in oil price	Ethanol producers: Less competitiveness, need to reduce production cost	- Oil price fall leads to lower competitiveness of biofuel production - Customers prefer ULG and E10 instead of E20, E85 due to a narrow price gap between ULG-gasohol, and fuel efficiency
Rising FFV and gasohol gas station	Serge in ethanol demand to serve FFV, producers need to secure feedstock and gain logistics efficiency	- Increase of E85 and flexible fuel vehicles (FFV), as well as strong growth of E20 and E85 gas station (CAGR 2008-2014 = 55%, 130% respectively), E20 and E85 fuel is easy to find than before causing higher potential for motorist to consume E20, E85
Global ethanol mandate	Opportunity for Thai ethanol producers (if domestically excess supply) to export to world market especially Asia (Japan, India, Philippines)	- Government policy mandate requiring minimum percentages of ethanol to be blended with non-renewable fuel drives ethanol demand - Asia remains the key deficit region with increasing ethanol import and competition to supply markets

Source: EIC analysis

Demand is shifted from E20 and E85 to GSH95 E10 due to lower price gap and fuel efficiency

Gasoline price structure

Unit: THB/liter

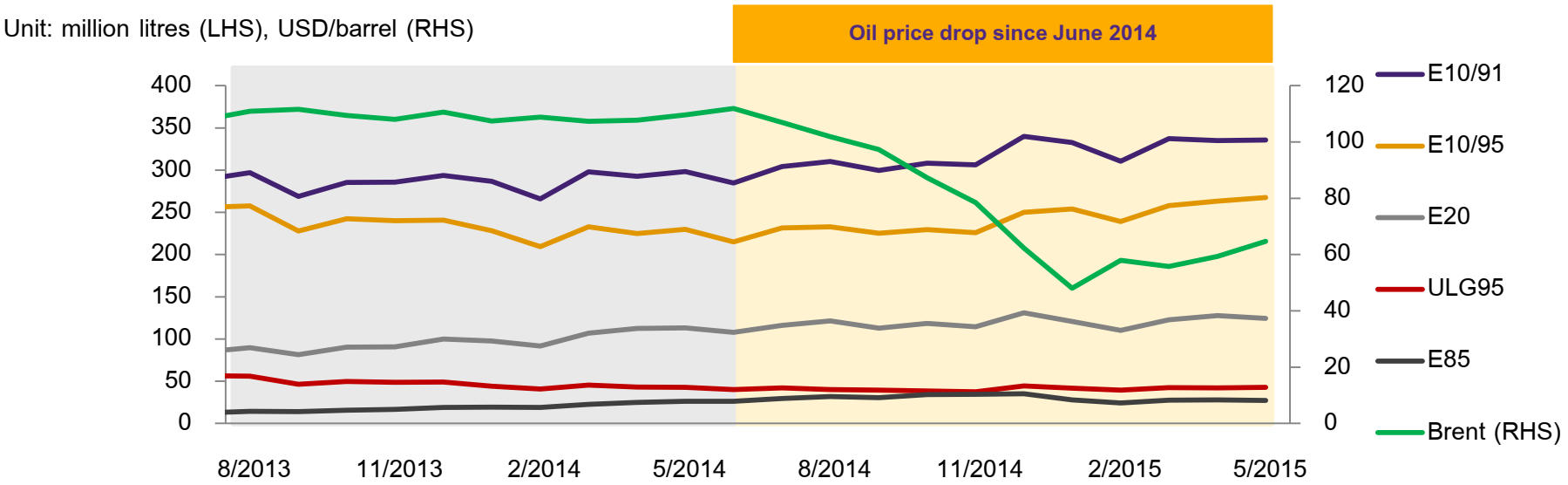


Note: Energy price reform for benzene and gasohol started on 29 Aug 2014
Source: EIC analysis based on data from EPPO

Plunge in oil price is a threat of gasohol and ethanol demand

Consumers have shifted from E20, E85 to E10 and ULG 95 due to lower price gap and fuel efficiency

Petroleum product consumption by type and Brent crude oil price



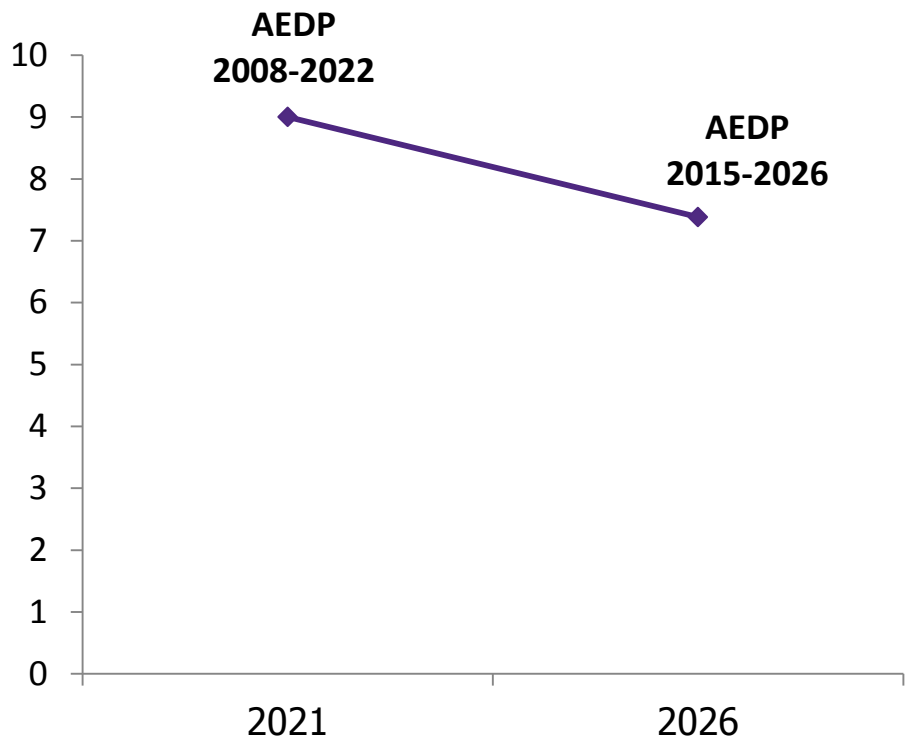
Fuel	Monthly growth (June2013-May2014)	Monthly growth (June2014-May2015)
E10/91	+9.2%	+19.6%
E10/95	-10.4%	+27%
E20	+53.2%	+16.9%
ULG95	-25.2%	+7.8%
E85	+155.8%	+3.2%

Source: EIC analysis based on data from Bloomberg, CEIC

Ethanol target was set to drop due to oil price fall and mode of transport shift

Ethanol target

Unit: million liters/day



Source: EIC analysis based on data from EPPO

Why the ethanol target was reduced and duration was extended?

Plunge in oil price

- Oil price fall has caused ethanol production less competitive compared to conventional energy

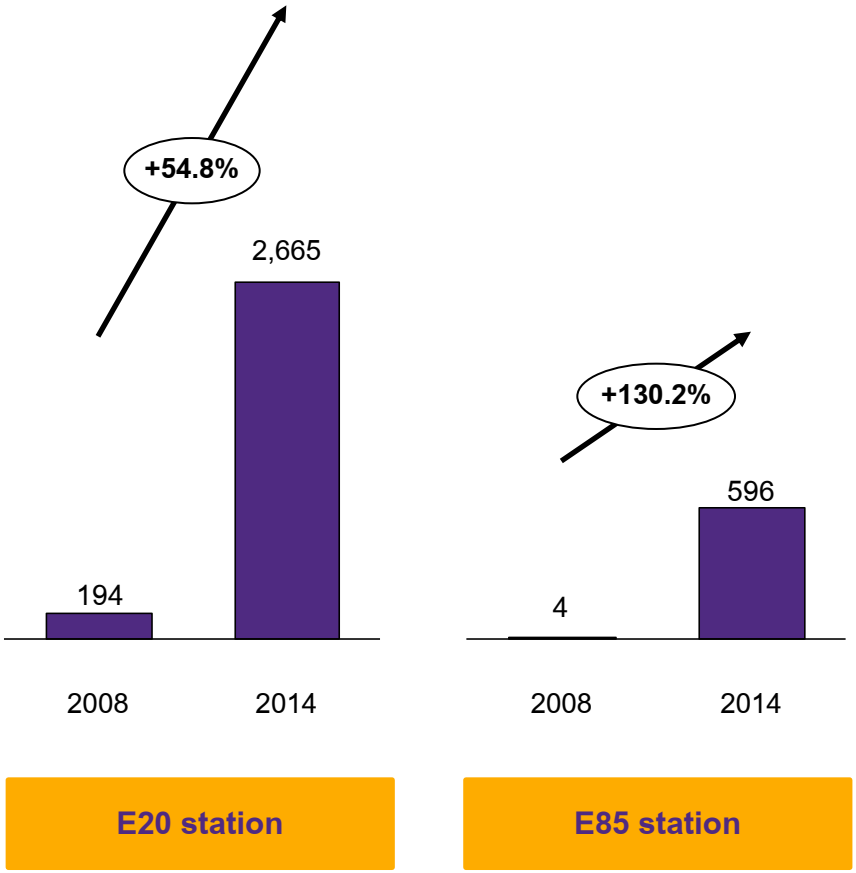
Shift mode of transport from land to rail

- Government support to construct rail infrastructure would partly shift demand from land transport to rail which pressure demand of gasoline, gasohol and hence ethanol

Rising E20, E85 gas stations and car model e.g. FFV to support ethanol consumption

Cumulative E20 and E85 gas station

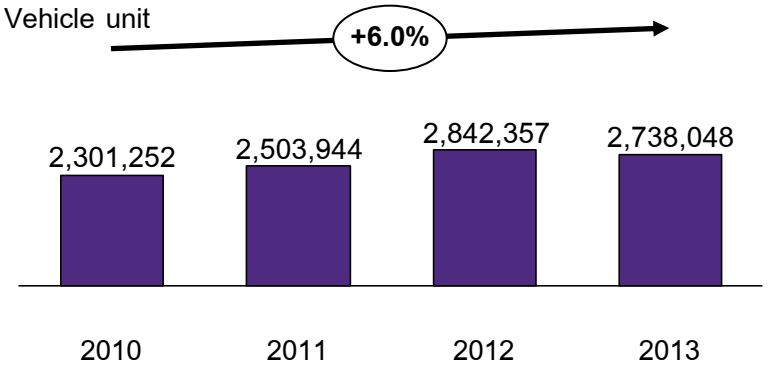
Unit: Station



E20 station | **E85 station**

Newly registered vehicles consuming Benzene

Unit: Vehicle unit



Expect rising ability of car model consuming E85

Mitsubishi Lancer EX

Volvo S80, C30

Chevrolet Captiva

2011

Honda City, Civic, Accord, CR-V

Toyota Corolla Altis

2015

Source: EIC analysis based on data from DOE, DLT

Ethanol players need to secure feedstock, integrate along value chain and manage cost reduction in order to gain competitiveness

Key success factors	
Feedstock security and diversification	Ensure and diversify feedstock supply against feedstock scarcity and price volatility
Technology	Good technology base for high efficiency of conversion and feedstock flexibility
Integration	Cluster formation and integration to create synergies and build strategic partnership both upstream and downstream
Economy of scale	Large scale of operation to exploit the economy of scale

Source: EIC analysis

Winner or Loser?

Winner

- MITR PHOL — Strength: Key player of sugar industry, upstream integration to secure feedstock, R&D, Technology, Economy of scale
- Thai Agro Energy Public Company Limited — Strength: Having French technology for high ethanol quality, feedstock flexibility, and Cost management (use biogas instead of fuel oil and substitute labor with automated machine
- UBON BIO ETHANOL group — Strength: Fully integration along supply chain range from cassava plantation, R&D of starch production, integrate logistics facilities for export with IRPC

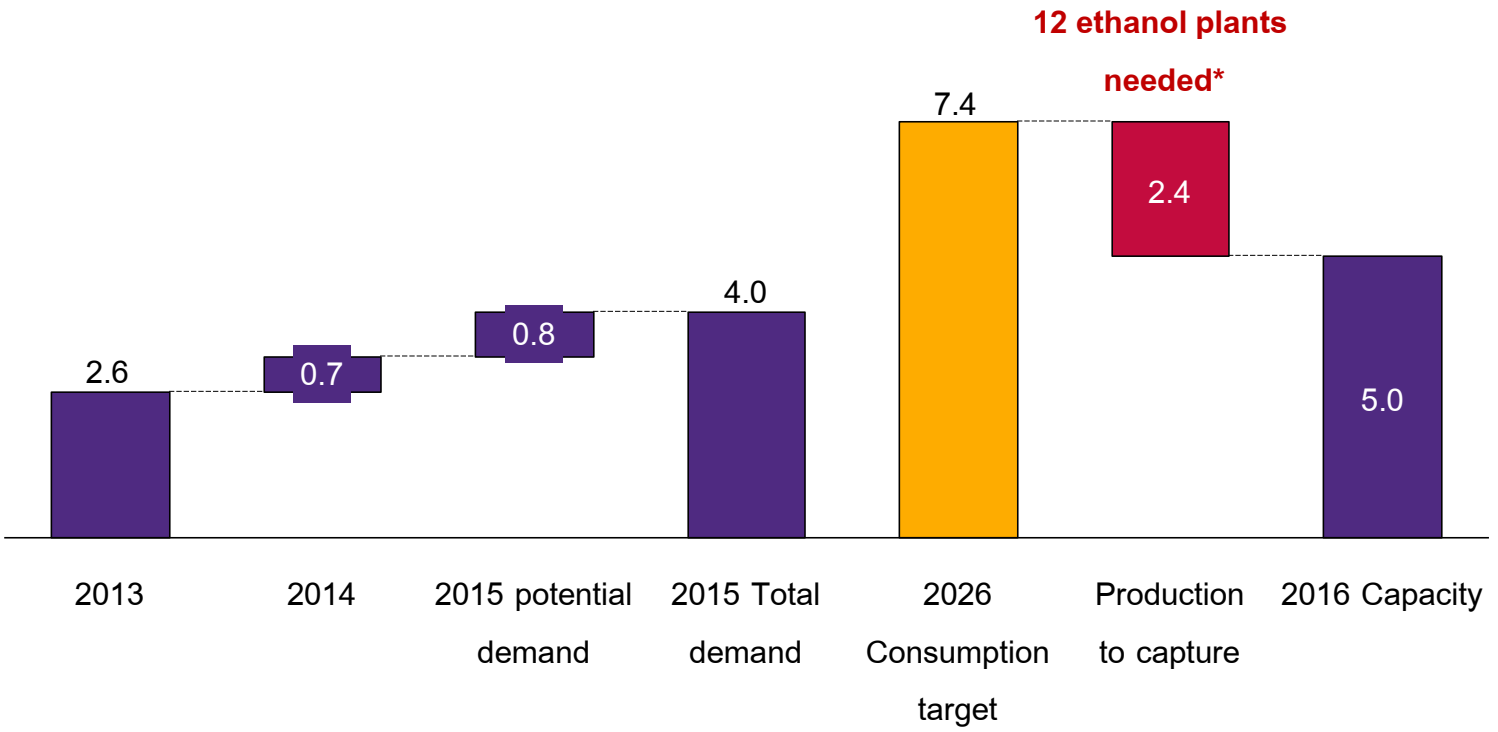
Loser

- Out of market players generally have low capacity with no economy of scale advantage
- Not able to manage cost reduction in the production process no value chain partner or integration, and no feedstock security

With ethanol consumption goal of 7.4 mil litres/day, 12 ethanol plants are needed to capture targeted demand

Estimated ethanol demand, supply and production opportunity

Unit: million litres per day



Note: * assume plant capacity 200,000 litres/day and CAPU = 100%

Source: EIC analysis based on data from DEDE, Bloomberg

Ethanol key takeaway and Implication

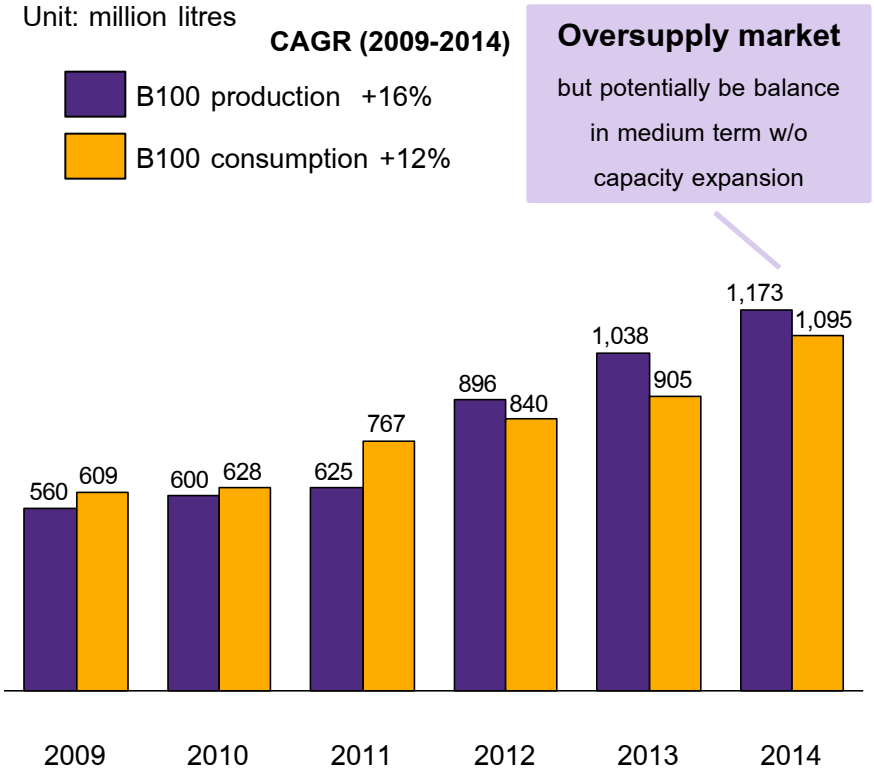
Key takeaway	- Expected balance of demand and supply in ethanol market. In the past, the market is oversupply. However, in 2013-2014 demand surged from shift in gasohol consumption due to ULG 91 cancellation - Government policy to drive strong growth of ethanol demand and supply in medium term e.g. increase price gap between ULG-gasohol, expand E85 gas station, give tax incentive to FFV - Top ten ethanol plants account for 63% of total capacity, majority use molasses as feedstock, which provide higher profit margin than producing from cassava
Key success factors for Ethanol players and market	- Integration or partner cooperation from upstream (Cassava, Molasses supply) to downstream (refinery and marketing) to reduce cost, protect feedstock shortage, gain strong customer base - Feedstock diversification, expertise and technology development e.g. Technology that can apply multiple raw materials in the production process - Large scale of operation to exploit the economy of scale - Government policy and FFV development to determine the likelihood of gaining ethanol market success
Bank opportunities	- Loan and Project finance, for only high CAPU players to construct plant, buy machinery etc. - Trade, ethanol export in case of excess supply in domestic market - Potential M&A fee in the future

Source: EIC analysis

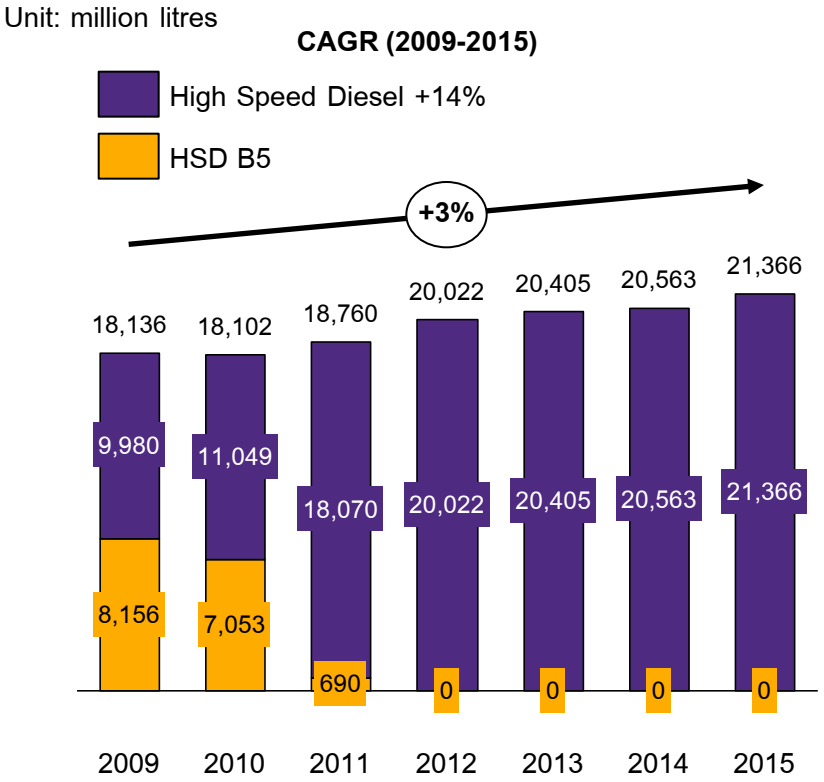
Biodiesel

B100 demand and supply are continually growing, reflecting increased demand from mandatory blended biodiesel use and diesel consumption

B100 production and consumption



Diesel domestic sales



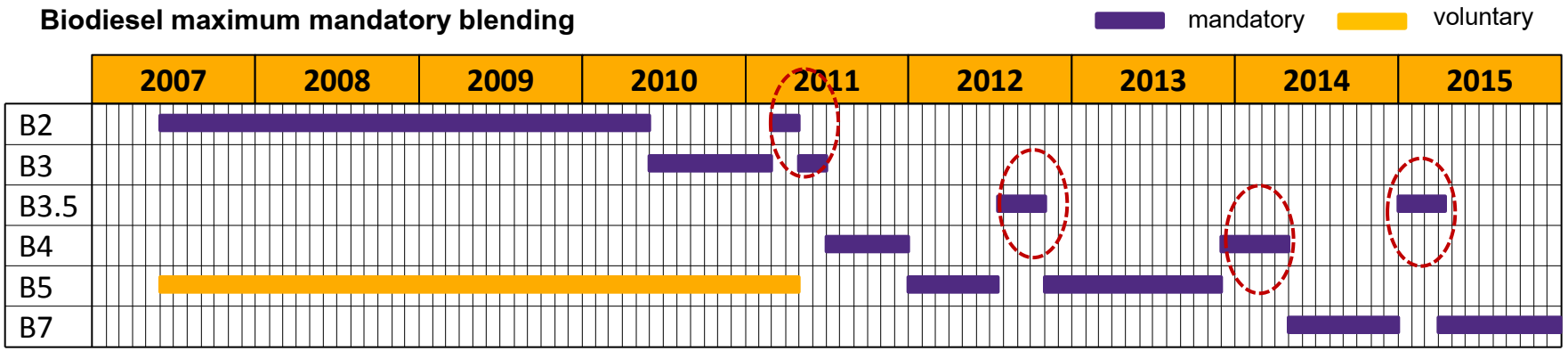
Note: Since May 2011, high speed diesel has been sold in one product type, which mix B100 ranging from 1.5% to 7% depending on the government policy and the supply of palm oil

Source: EIC analysis based on data from DEDE, DOEB

B10 mandate is still uncertain, mandatory B100 blended with diesel depends on supply of palm oil

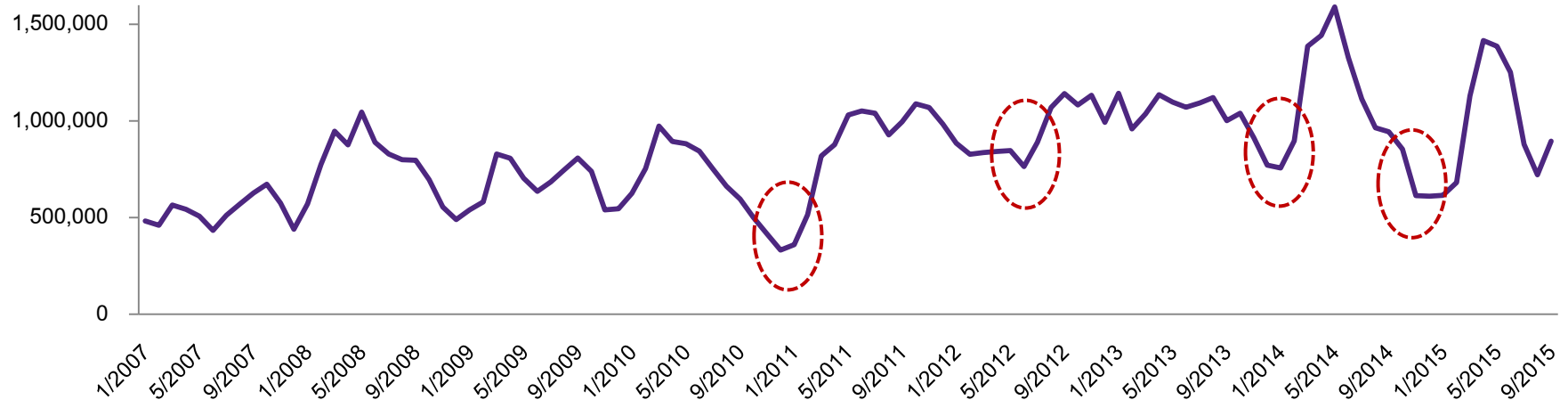
Government may decrease B100 mandatory blending at the time when palm oil supply fall

Biodiesel maximum mandatory blending



Palm production

Unit: Metric ton

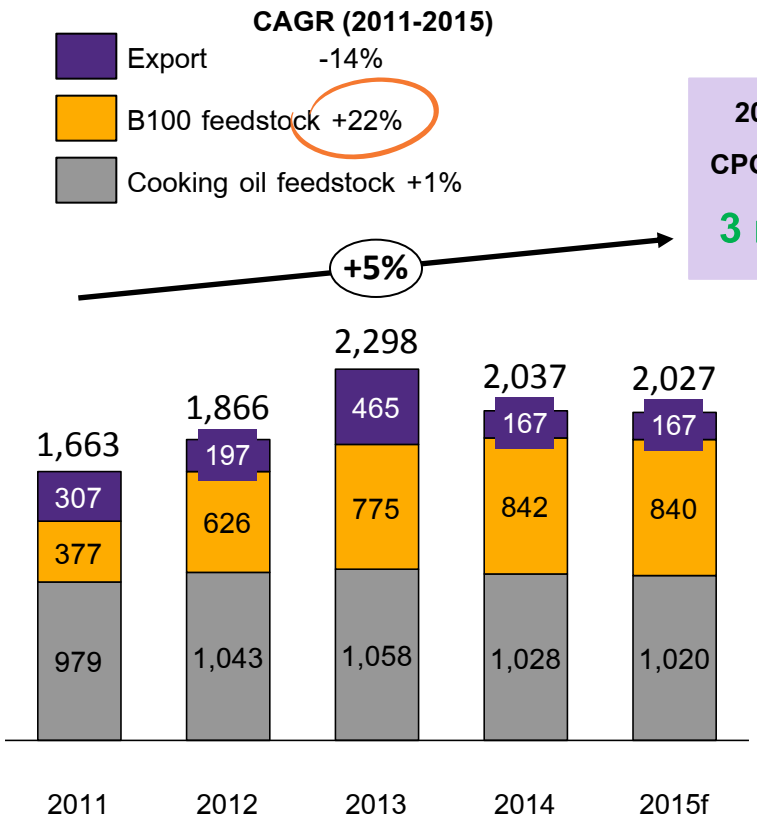


Source: EIC analysis based on data from EPPO and OAE

For feedstock, CPO proportion as B100 feedstock expected to rise nearly cooking oil feedstock

CPO supply and application

Unit: thousand tons



2021 Target
CPO production
3 mil tons

Source: EIC analysis based on data from MOC

CPO Application

Sector

Food

50% of CPO to produce cooking palm oil in food industry e.g. snack, instant noodle, margarine etc. (highest share approx 65% of cooking oil market due to cheaper price)

Energy

41% of CPO to produce B100 in order to increase energy security, proportion of CPO as feedstock has substantially increased

Other

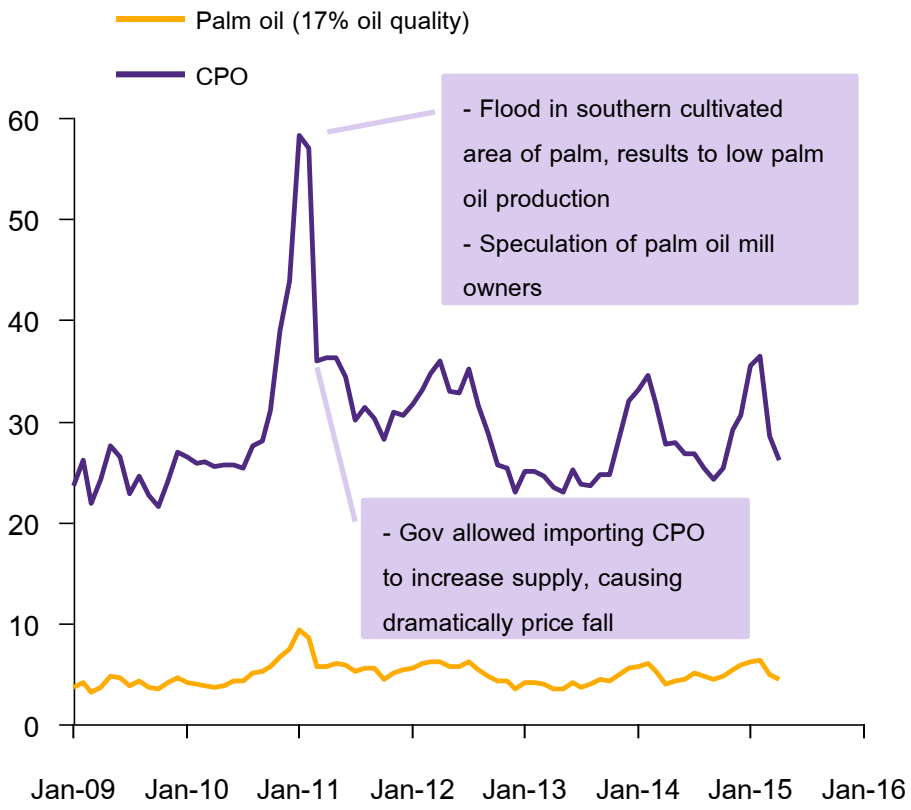
5% of CPO to be feedstock for other sectors e,g. cosmetic and skincare to produce soap etc.

Feedstock price fluctuation and shortage are major risks of B100 players

Price volatility leads to players' stock loss

Palm oil and CPO prices

Unit: THB/kg



Source: EIC analysis based on data from EA

Feedstock risks

Price fluctuation

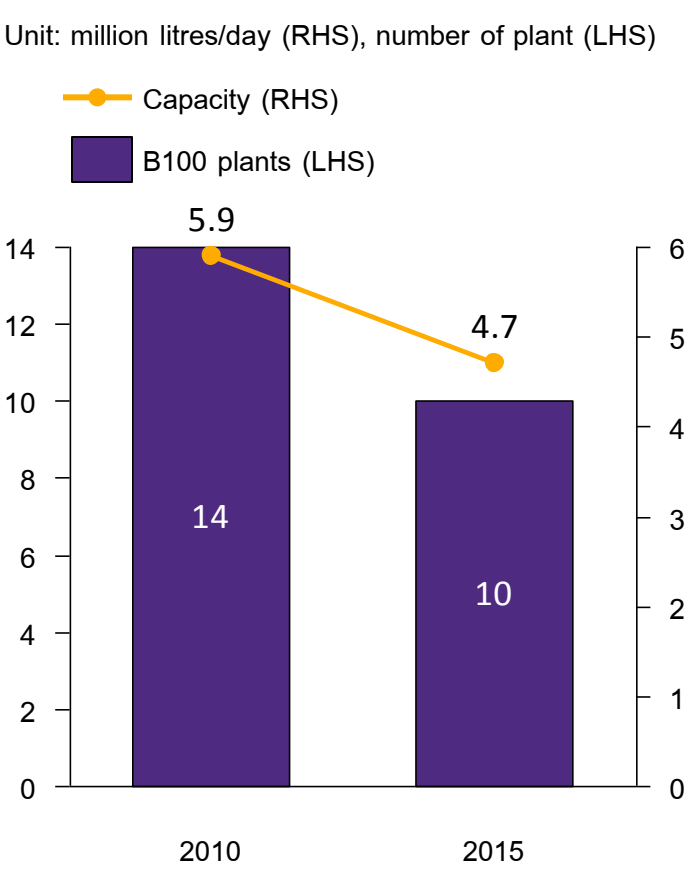
- The cost of CPO in the global market depends on market of CPO in Malaysia (world largest CPO exporter)
- factors affecting CPO price e.g. economic conditions, demand and supply, weather, and price of other alternative oil such as soy oil and rice bran oil etc.

Feedstock shortage

- Risk to a shortage of feedstock if supplier cannot supply CPO, seasonal palm scarcity is around Q1.
- Usually, the purchasing of CPO is in the short-term contract stating purchasing price certainly. Shortage risk mitigation are to increase potential suppliers, maintain good relationship with suppliers continuously and diversify feedstock

Uneconomical players were out of the market due to B100 oversupply, causing potential equilibrium market in medium term

B100 capacity (as of April 2015)



Source: EIC analysis based on data from DOEB

Winner or Loser?

Winner

- Majority are big players with economy of scale and has downstream market support

- BCP and TOL are PTT subsidiaries having advantage in feedstock supply from partner and downstream market

- Patum has the biggest capacity with economy of scale and produce both edible oil and B100

- EA has strong customer base and expand investment to produce higher margin product e.g. refined glycerin

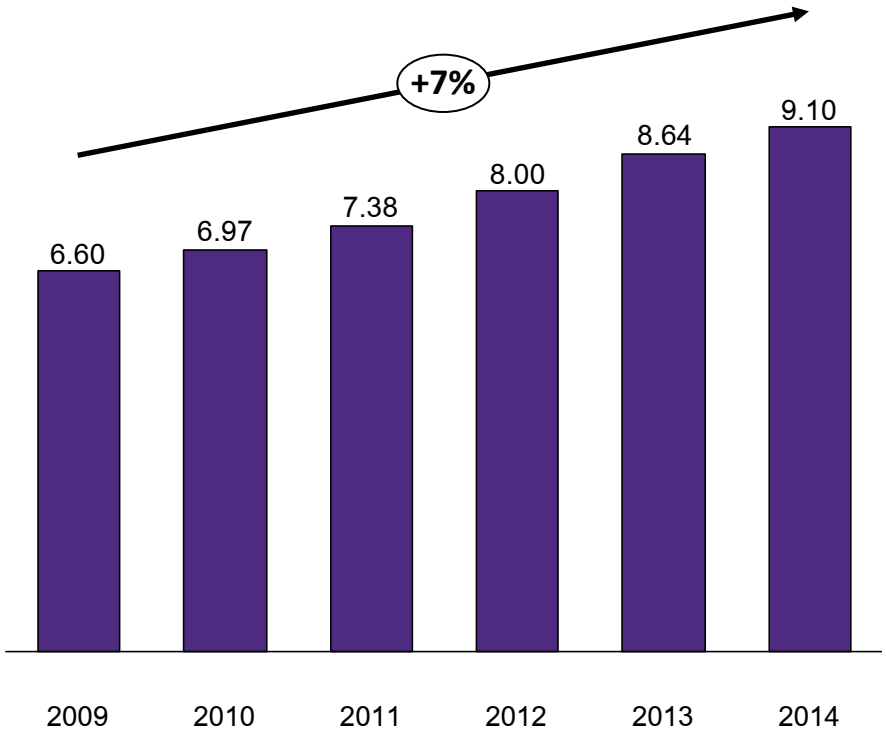
Loser

- Out of market players generally have low capacity with no economy of scale advantage
- No diversification of feedstock to be refined to B100, usually has 1 feedstock
- Not able to manage cost reduction in the production process and no value chain integration

Diesel vehicles growth is strong plus the trend of diesel eco-car, B10 acceptance is in necessity to push more B100 demand

Cumulative registered diesel vehicles

Unit: number of vehicles



Source: EIC analysis based on data from MOT

Diesel car: major threat and opportunity

Threat

Major car producers in Thailand accept B7 biodiesel at maximum as vehicle fuel

Opportunity

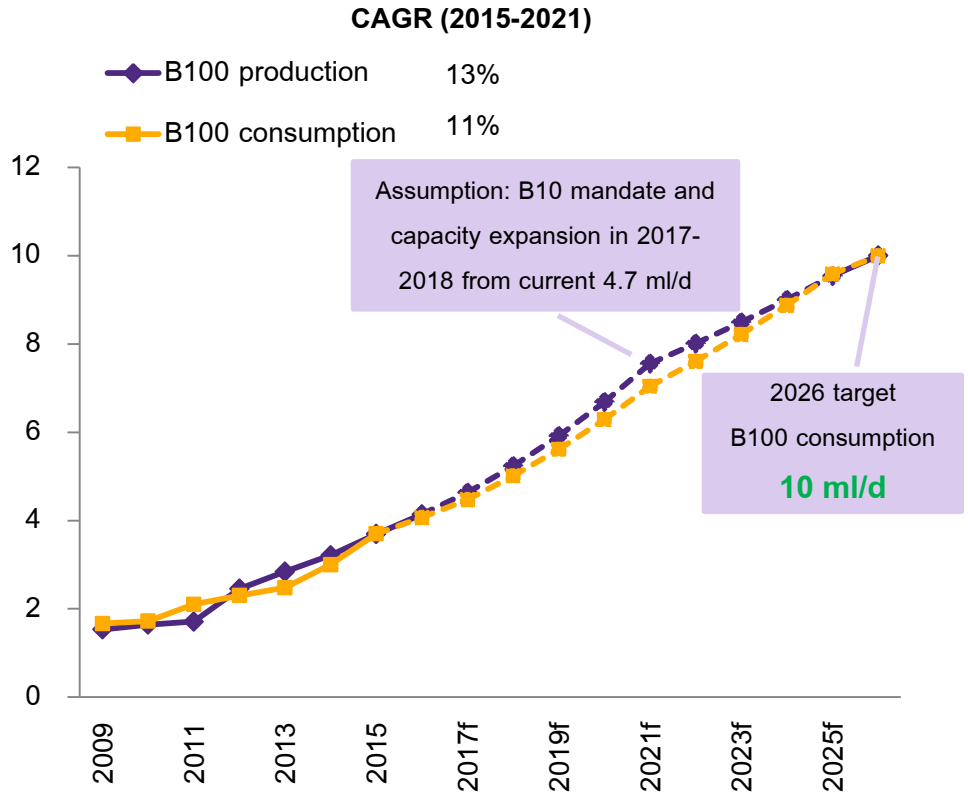
Trend of Diesel Eco-car

- Eco-car model with diesel engine e.g. Mazda2, Nissan March, Honda Idtec, Suzuki Swift, Suzuki Ciaz DDiS will be introduced in Thai market with the advantage of fuel efficiency (23-25km/l)

Expected strong growth of B100 industry and capacity expansion needed

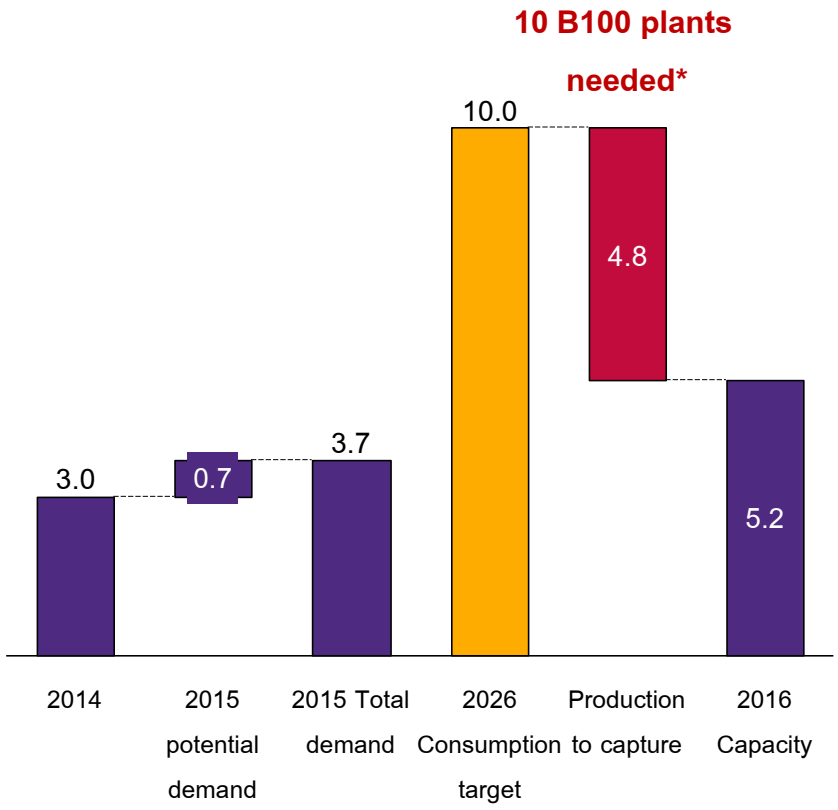
B100 production and consumption forecast

Unit: million litres/day



Estimated plants needed to reach consumption target

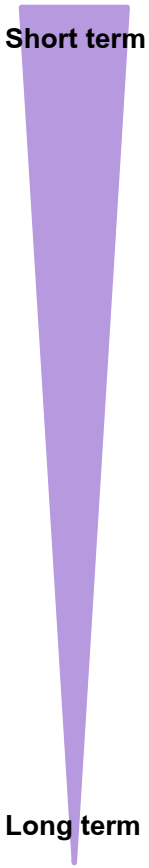
Unit: million litres/day



Note: * Assume capacity 500,000 litres/day/plant and CAPU = 100%

Source: EIC analysis based on data from DEDE, DOEB

Game changer: fierce competition from Indonesia and Malaysia after AEC trade barrier remove



Game changer	Detail	Impact
AEC	- With AEC trade liberalization, after 31 Dec 15 ASEAN members need to get rid of all trade barriers. Possible influx of palm oil from Malaysia and Indonesia with lower price will negatively affect palm growers and palm oil industry	− Palm growers and palm oil industry: need to cut their price + − B100 producers: cheaper feedstock but compete with lower B100 price from abroad
Shale oil/gas	- Rising shale oil/gas production has increased global and energy supply and pressured oil price, causing lower competitiveness in biofuel compared to fossil fuel	− B100 producers: Less competitiveness, need to reduce production cost
2nd, 3rd generation feedstock	- Feedstock from a variety of non food sources. 2nd generation biofuels use biomass to liquid (BTL) technology, by thermochemical conversion mainly to produce B100 - 3rd generation is algae, offering the highest oil yields, but issues around capital cost have created challenges for commercial use	+ B100 producers: Reduce risk of feedstock shortage and price volatility, increase oil yield

Note: for AEC, palm oil is considered a highly sensitive product, its import tariff has continually decreased to 5% in 20007 and 0% in 2010

Source: EIC analysis

B100 key takeaway and Implication

Key takeaway	- Oversupply of biodiesel market approximately 200,000 litres/day (no export of B100 right now) - B100 production is still far less than capacity (3.2 vs 4.7 mil litres/day) - Government policy to drive strong growth of B100 demand and supply in medium term e.g. B10 mandate, however, the mandatory heavily depends on supply of palm oil - B100 winners are generally integrated players taking cost advantage for the whole value chain and big players having economy of scale and capital
Key success factors for B100 players and market	- Integration or partner cooperation from upstream (palm oil and CPO supply) to downstream (refinery and marketing) to reduce cost, protect feedstock shortage, gain strong customer base - Feedstock diversification, expertise and technology development e.g. cellulosic feedstock to reduce feedstock price volatility - By product with high value added in focus e.g. refined glycerin for application in pharmaceutical, cosmetics and healthcare sectors - Government policy and vehicle's biodiesel specification acceptance to determine the likelihood of gaining B100 market success
Bank opportunities	- Loan and Project finance, for only high CAPU players to construct plant, buy machinery etc. - Trade, import CPO from Indonesia, Malaysia in case of feedstock shortage - Potential M&A fee in the future

Source: EIC analysis

End of document

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