Chapter 2

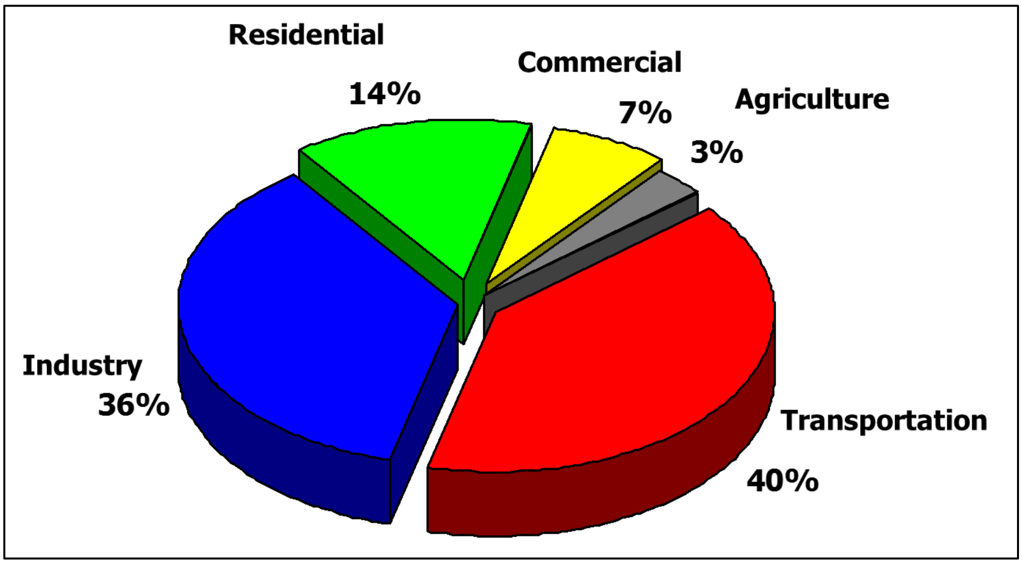
Potential Study of Diversified Transportation Energy Mix

1. Current Status of Transportation Energy Supply Demand and National Policy in ASEAN Member States

1.1. Thailand

In 2017, Thailand's gross domestic product (GDP) grew approximately 3.9% from investment and export to a recovering world economy. Total primary energy consumption in 2017 was 2.754 million barrels of oil equivalent per day (BOE/day), an increase of 2.4% from the previous year. A detailed look reveals that gasoline, diesel, and jet fuel increased by 3.8%, 2.6%, and 4.4%, respectively, whereas fuel oil, liquefied petroleum gas (LPG), and compressed natural gas (CNG) decreased by 7.2%, 1.8%, and 0.1%, respectively. Electricity consumption increased by 1.4% (EPPO, 2017a). This final energy consumption is mainly for transportation (40%) and industry (36%), as shown in Figure 2.1.1-1 (EPPO, 2017b).

Figure 2.1.1-1 Share of Final Energy Consumption in Thailand by Sector, 2017



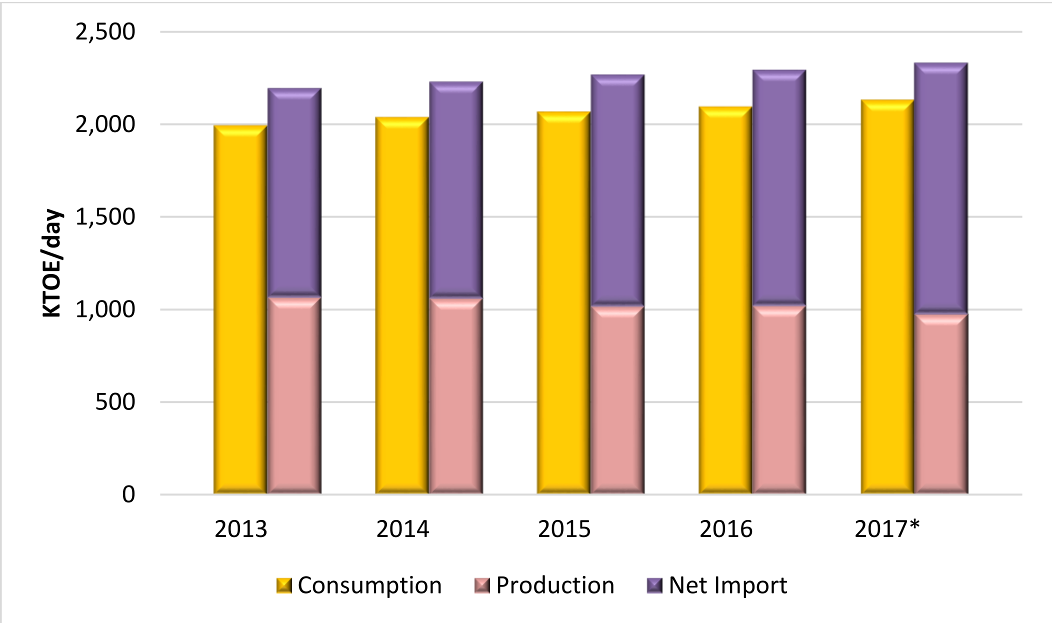
Source: EPPO (2017b).

1.1.1. Current Status of Energy Supply

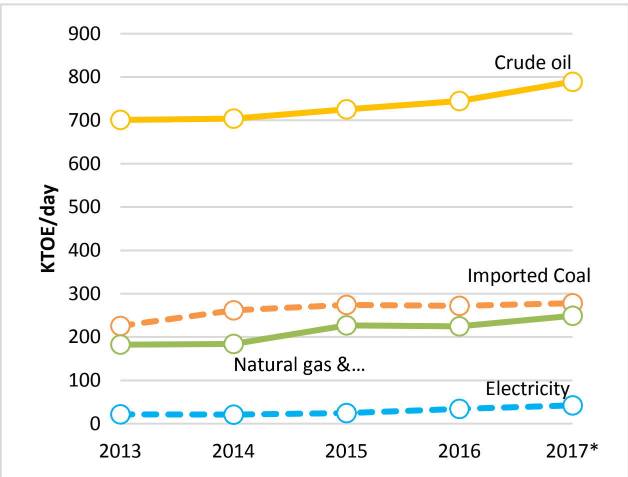
Thailand's energy supply has relied on energy import more than domestic production (Figure 2.1.1-2(a)), to cover energy demand by approximately 110% (EPPO, 2017b). The share of energy import in energy consumption steadily increased from 57% in 2013 to 64% in 2017, implying that Thailand has becoming more dependent on energy import. As shown in Fig. 2.1.1-2(b), Thailand's greatest energy import (over 50%) is crude oil for the transportation and industry sectors, followed by coal, natural gas and/or LNG, and some electricity with an increasing trend over the past 5 years. On the other hand, Thailand's domestic energy production (Fig. 2.1.1-2(c)) has been mainly based on natural gas (over 60% of total primary energy production), but this has recently started to decline due to depleting natural gas wells, leading to import of LNG.

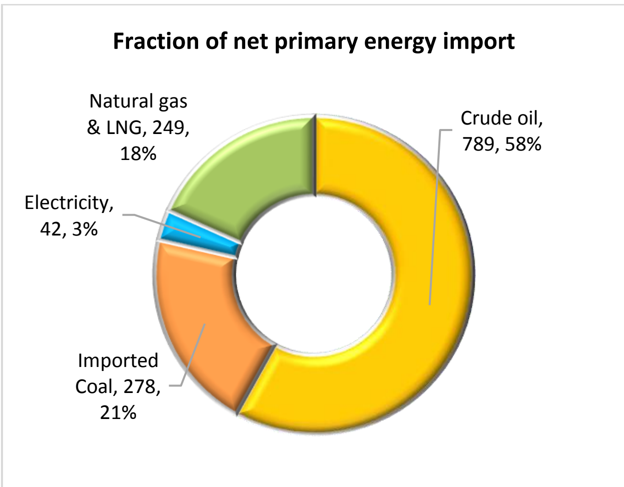
Figure 2.1.1-2 Energy Balance of Thailand, 2013–2017

(a) Consumption, Production, and Import

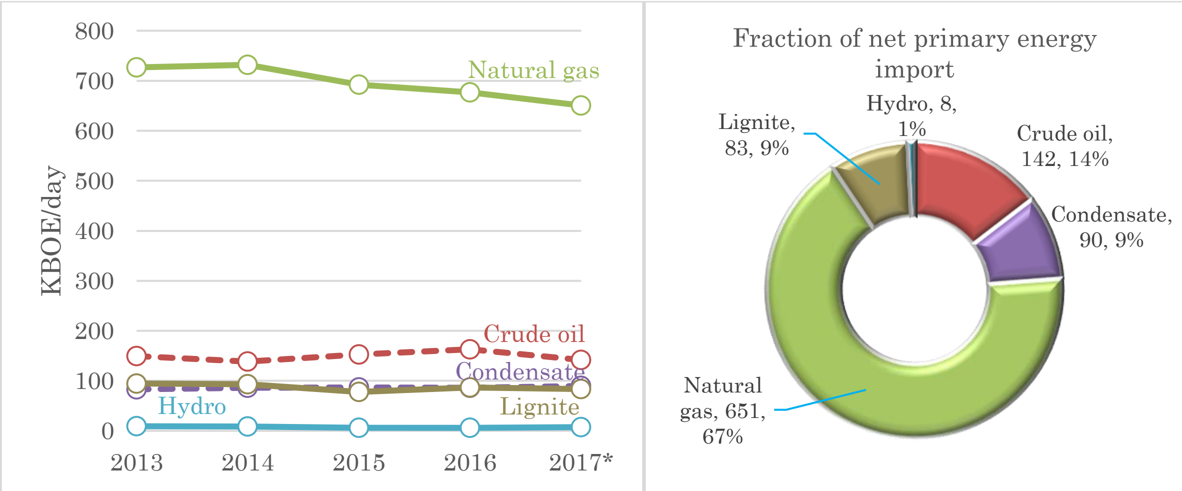


(b) Energy Import





(c) Energy Production

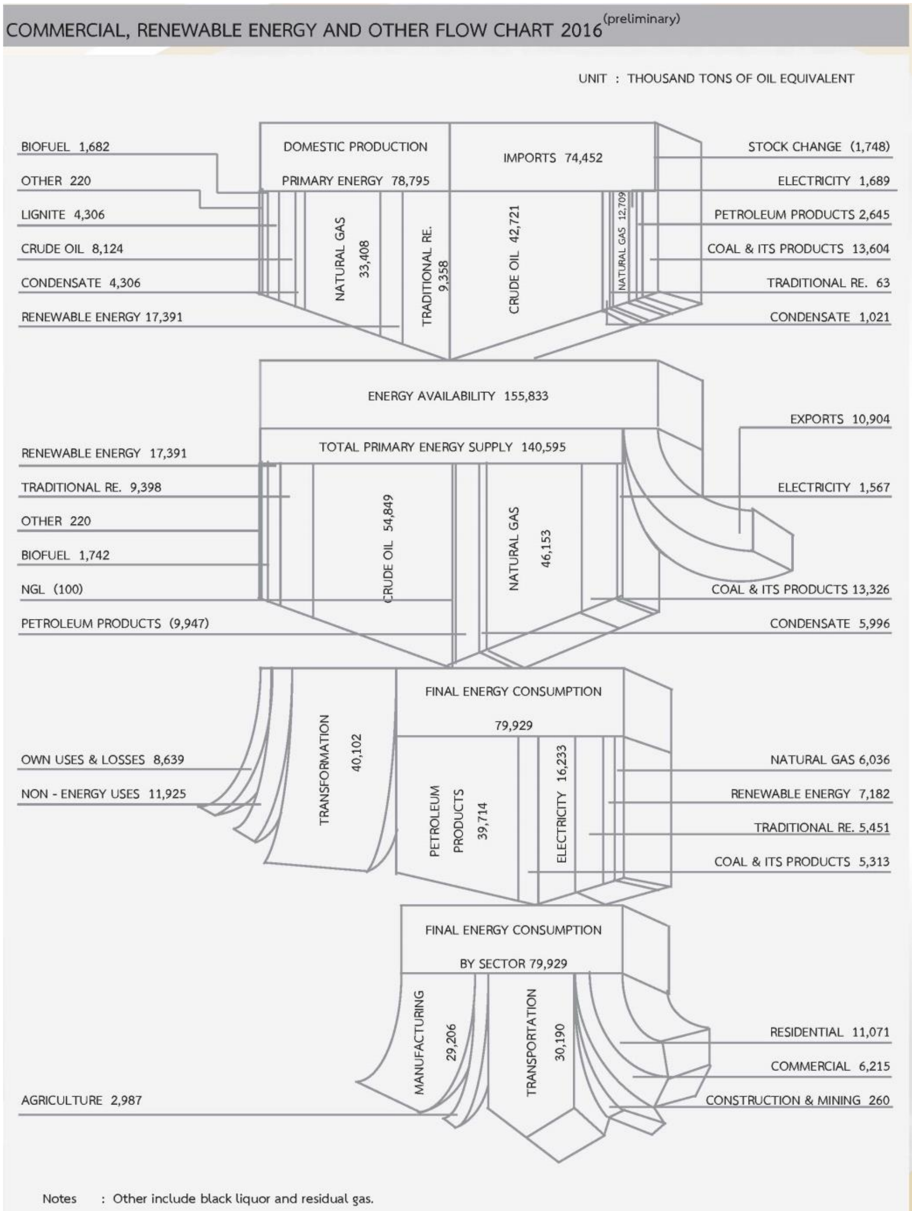


KBOE = thousand barrels of oil equivalent, LNG = liquefied natural gas.
Source: EPPO (2017b).

As the final details of Thailand's energy balance have not yet been released, a summary of the energy balance for 2016 is shown in Fig. 2.1.1.-3, where domestic production of energy is slightly higher than energy import due to inclusion of renewable energy, unlike in Figure 2.1.1-2(a). As in Figures 2.1.1-2(b) and (c), energy import is dominated by crude oil, whereas energy domestic production is mainly natural gas.

In terms of energy availability, crude oil and natural gas accounted for 65%. However, most natural gas has undergone transformation as electricity, leaving petroleum products accounting for 50% of final energy consumption, which is used mainly in transportation (about 38%) and manufacturing and/or industry (about 37%).

Figure 2.1.1-3 Energy Balance of Thailand, 2016



Source: DEDE (2016).

1.1.2. Current Status of Transportation Fuel Supply

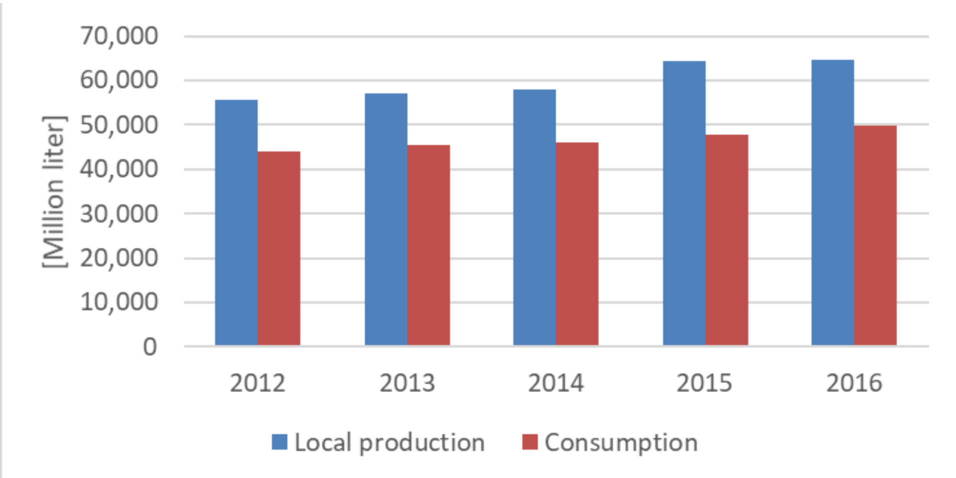
As shown in Table 2.1.1-1 and Figure 2.1.1-4, Thailand has six large refineries with a capacity of over 100,000 barrels/day for a total production capacity in 2016 of approximately 1.2 million barrels per day (BBL/day), where about 75% of the production amount is consumed.

Table 2.1.1-1 Official Refinery Capacity in Thailand with Actual Production and Consumption

Refinery plant (BBL/day)	2012	2013	2014	2015	2016
PTTGC	280,000	280,000	280,000	280,000	280,000
Thai oil	275,000	275,000	275,000	275,000	275,000
IRPC	215,000	215,000	215,000	215,000	215,000
Esso	170,000	177,000	177,000	177,000	177,000
Star Petroleum	150,000	150,000	165,000	165,000	165,000
Bangchak	120,000	120,000	120,000	120,000	120,000
Fang	2,500	2,500	2,500	2,500	2,500
RPCG	17,000	17,000	17,000	0	0
Total	**1,229,500**	**1,236,500**	**1,251,500**	**1,234,500**	**1,234,500**

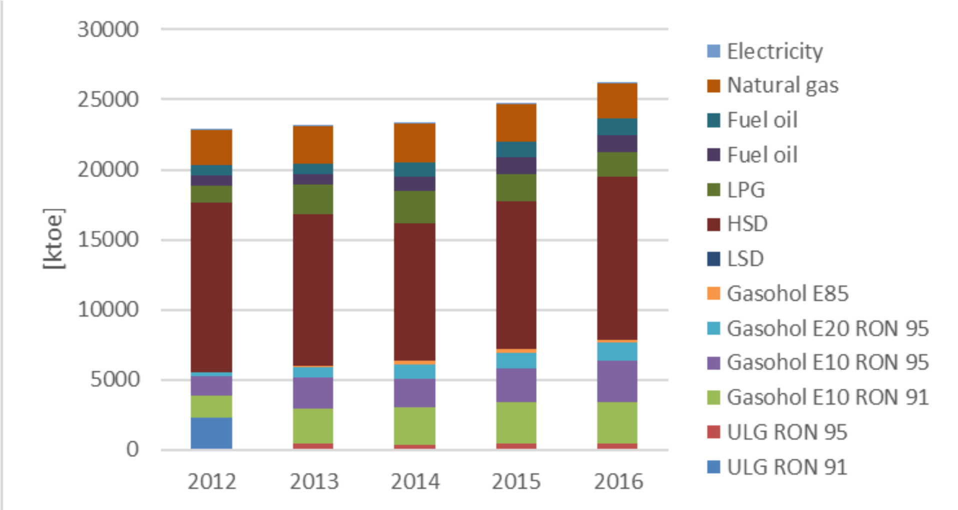
BBL = barrel, PTTGC = PTT Global Chemical Public Company Limited.
Source: DEDE (2016).

Figure 2.1.1-4 Comparison of Yearly Local Production and Consumption of Petroleum Products in Thailand, 2012–2016



Source: DEDE (2016).

Figure 2.1.1-5 Energy Consumption of Various Fuels in the Transportation Sector in Thailand, 2012–2016



HSD = high speed diesel, ktoe = kilotonne of oil equivalent, LPG = liquefied petroleum gas, LSD = low sulphur diesel, ULG = unleaded gasoline.
Source: DEDE (2016).

Amongst the transportation fuel types in Thailand, diesel fuel has accounted for approximately 42%, more than double the amount of gasoline, as shown in Fig. 2.1.1.-5. Consistent with government policy, biofuel has been commercially used in transportation fuel. Bioethanol has been blended with gasoline at 10%, 20%, and 85%, known as gasohol E10, gasohol E20, and gasohol E85, respectively. On the other hand, biodiesel has been mandated to be blended up to 7% in all diesel.

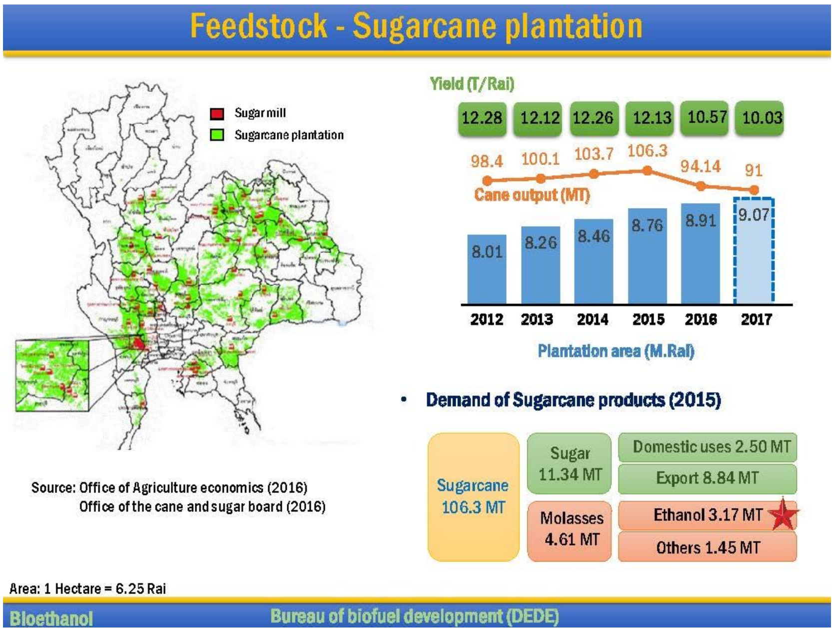
1.1.3. Current Status of Biofuel Supply in the Transportation Sector

Focusing on the biofuel supply in the transportation sector, bioethanol (blended in gasoline) is made from molasses, by-products of sugar, and cassava, whereas biodiesel is made from palm oil. Thailand's policy on feedstock clearly states that its use is always as food first, before the surplus is used for biofuel. As shown in Figure 2.1.1-6(a), sugarcane plantations are mostly located in the central and north-eastern parts of Thailand with bioethanol production from molasses and sugarcane by-product. On the other hand, Figure 2.1.1-6(b) shows a larger area for cassava plantations, where cassava product is mainly for export (Thammanomai, 2017). As ethanol demand increases from bioethanol blending in gasoline, those cassava exports can be used domestically to produce ethanol since sugarcane plantation is more limited.

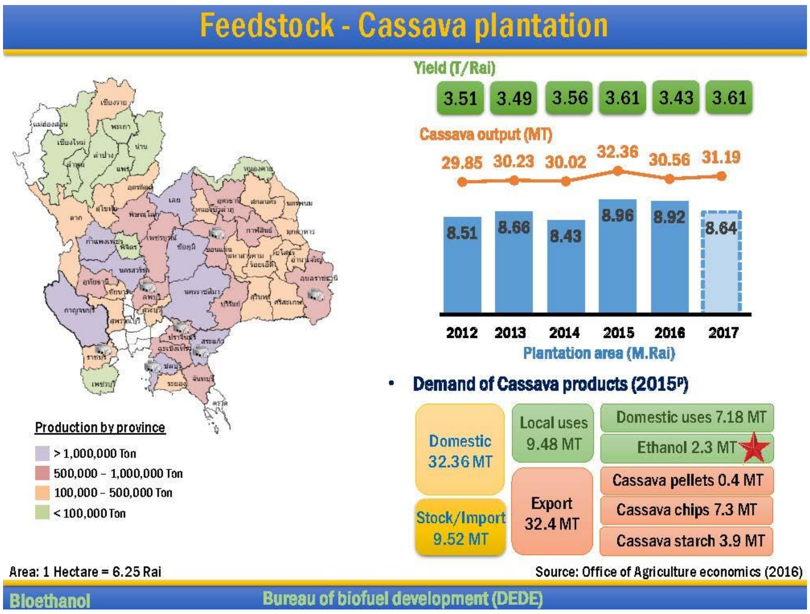
As a result of the Thailand gasohol programme, ethanol production has been increasing over time (twofold from 2011 to 2014), as shown in Fig. 2.1.1-7(a). Even though molasses still dominate bioethanol feedstock, the share of cassava has increased with newer ethanol production plants using cassava as feedstock. It is worth noting that the large increase of ethanol demand from 2012 (656 megalitres, or ML) to 2013 (1,014 ML) was due to the ban of ULG91 (unleaded gasoline with octane 91 without ethanol blending), but continued use of ULG95 with an added high tax for luxury cars, as shown in Fig. 2.1.1-7(b). Since 2013, the fraction of gasohol E10 (octane 91 and 95) has dominated the market share, with increased sale of E20.

Figure 2.1.1-6 Bioethanol Feedstock in Thailand

(a) From Molasses



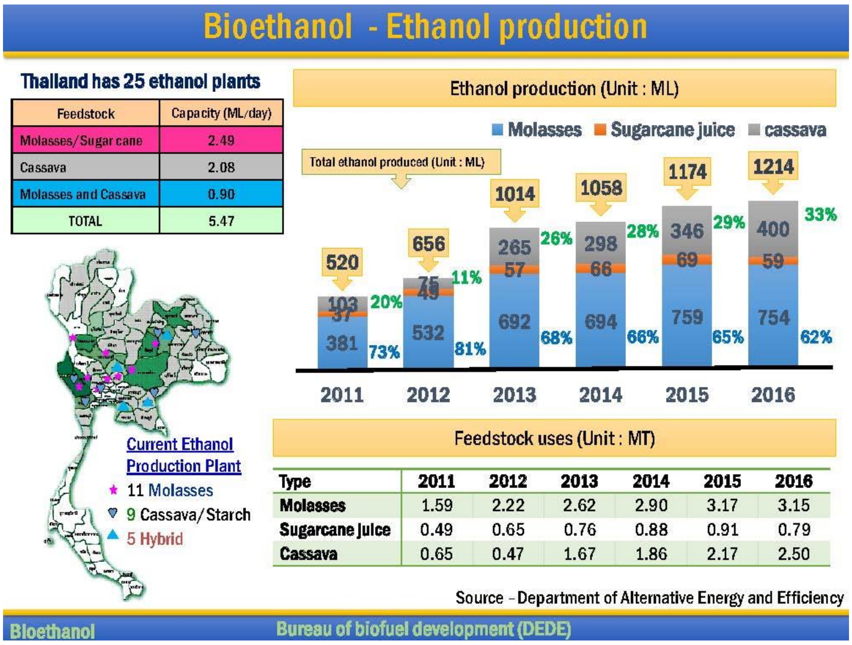
(b) From Cassava



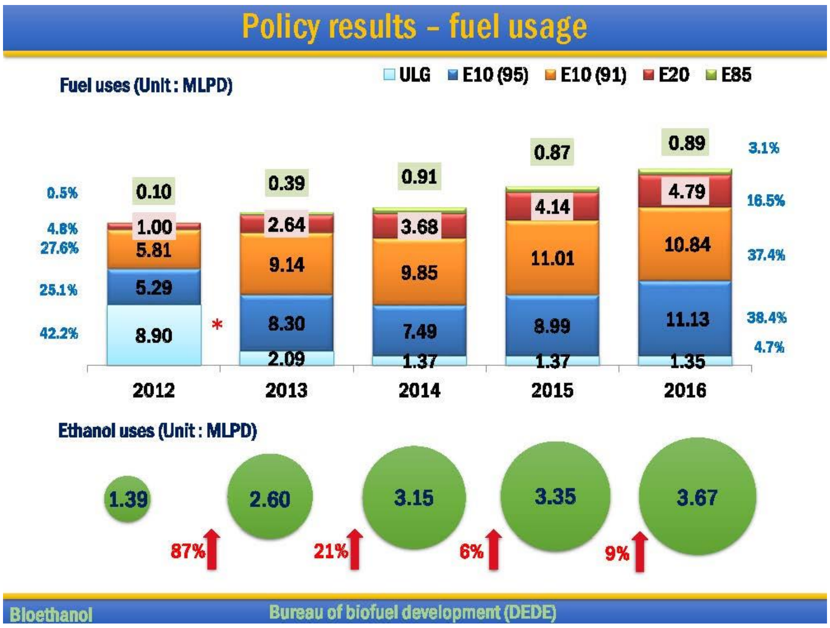
Source: Thammanomai (2017).

Figure 2.1.1-7 Bioethanol Production with Blending in Thailand

(a) Bioethanol Production



(b) Blending in Gasoline at Various Fraction



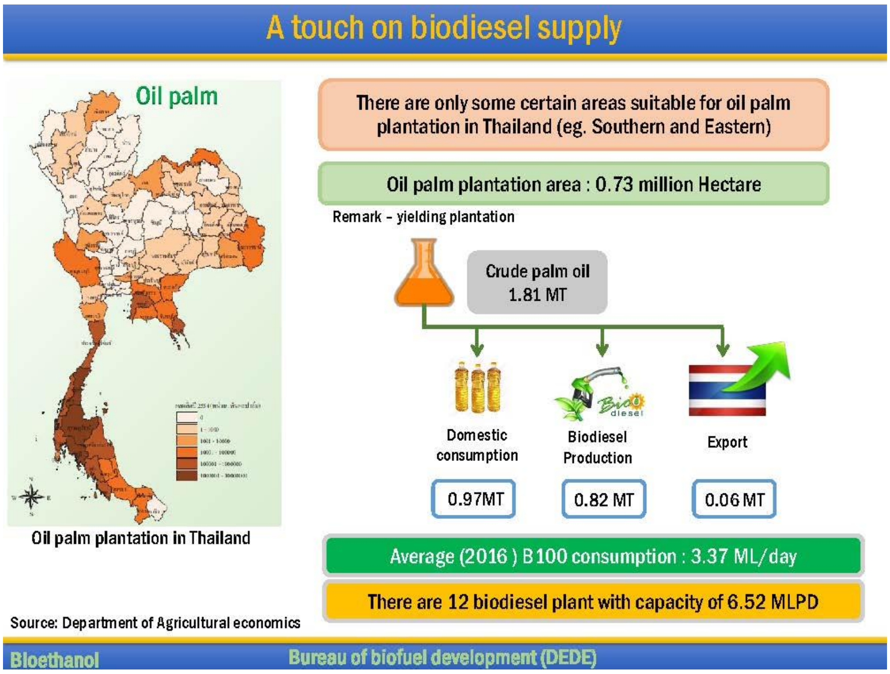
Source: Thammanomai (2017).

As for diesel, only palm oil is commercially used as feedstock for biodiesel with plantations mostly in the southern part of Thailand, as shown in Figure 2.1.1-8(a). Again, Thailand's policy on biodiesel is to use surplus palm oil from edible cooking oil. In fact, the country's biodiesel programme has been a tool to absorb surplus palm oil in the market, as clearly shown in Figure

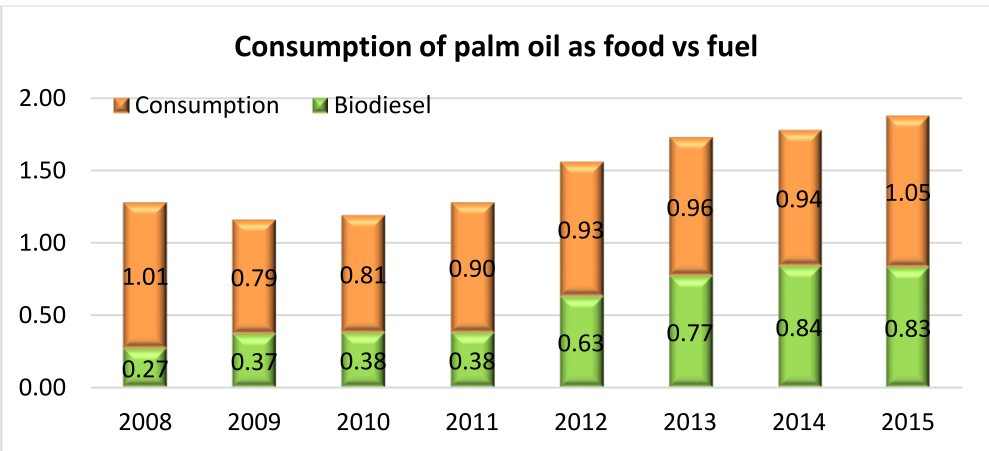
2.1.1-8(b), where the share of biodiesel greatly increased from 17% in 2008 to 40% in 2015. It is worth noting that the big increase of biodiesel demand from 2011 (1.71 ML/day) to 2012 (2.42 ML/day) was due to the mandate to blend 5% biodiesel in diesel, or B5. From 2013 to 2014, biodiesel demand should have gone up again due to a mandate of B7, but a palm oil shortage made it difficult to blend economically so the percentage blend of biodiesel was adjusted with consideration of the palm oil price.

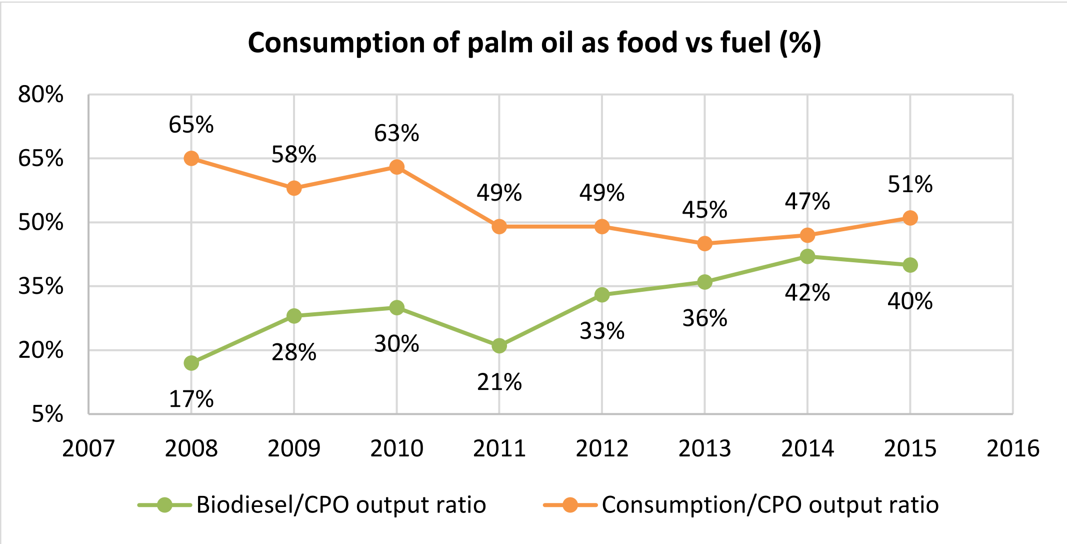
Figure 2.1.1-8 Biodiesel Feedstock in Thailand

(a) A touch on Biodiesel Supply

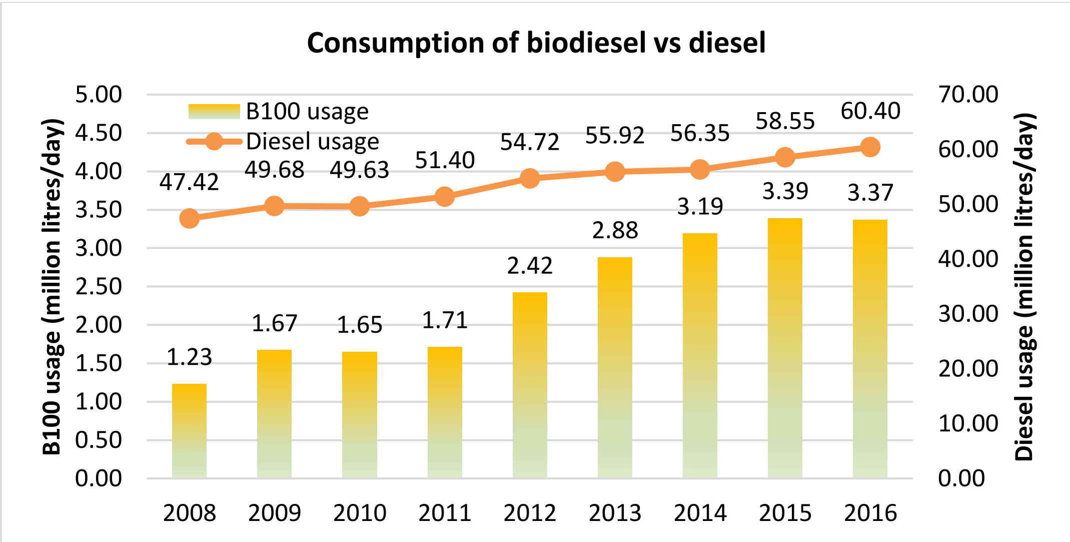


(b) As a Tool to Manage Palm Surplus





(c) With Increasing Use of Biodiesel Blended in Diesel

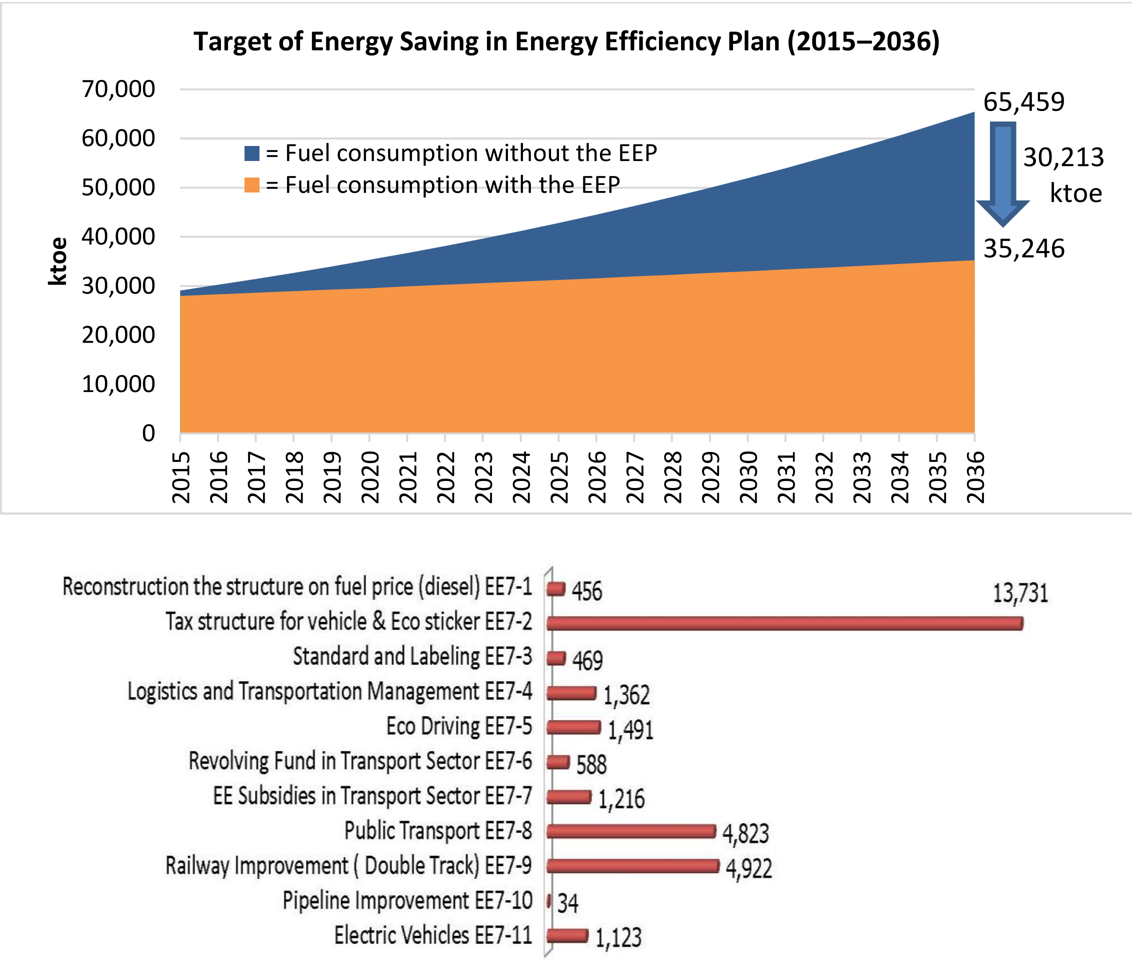


CPO = crude palm oil, MLPD = million litres per day.
Source: Thammanomai (2017).

1.1.4. Fuel Demand and Biofuel Supply Outlook Based on the National Plan

With Thailand's Integrated Energy Blueprint (2015–2036) being launched in 2015 (EPPO, 2016), fuel demand has been forecasted under the Energy Efficiency Plan 2015–2036 (EEP), with a targeted reduction of 30,213 kilotonnes of oil equivalent (ktoe) by 2036 through 11 initiatives, as shown in Figure 2.1.1-9 (Sunipasa, 2017). On the other hand, the biofuel outlook is forecasted under the Alternative Energy Development Plan 2015–2036 (AEDP) with a 2036 target of 11.30 ML/day of bioethanol consumption and 14 ML/day of biodiesel. However, there is no official biofuel supply outlook or target from now until 2036. Hence, bioethanol and biodiesel supplies have to be estimated for section 2.3.3.

Figure 2.1.1-9 Forecast of Transportation Fuel Demand in Energy Efficiency Plan (2015–2036)



EEP = Energy Efficiency Plan, ktoe = kilotonne of oil equivalent.
Source: Sunipasa (2018).

1.1.5. Current National Plans for Energy Consumption Reduction

As previously discussed, the relevant national plan to reduce energy consumption is the EEP with a target to reduce energy intensity by 30%. With a focus on transportation, the 11 initiatives shown in Fig. 2.1.1-9 and Table 2.1.1-2 are elaborated as follows.

1. The fuel price structure should be adjusted to reflect the true costs of fuel production, since the price of diesel fuel, which is deemed a key transportation fuel, has been closely monitored and often subsidised in order to keep it at an affordable level. This price manipulation has led to an imbalance of diesel fuel usage – which nowadays is also reflected in the high share of diesel-fuelled pickup trucks.

2. The vehicle excise tax structure has been changed from a system based on engine size to one based on CO_2 tailpipe emissions, which directly correlate with vehicle fuel economy (ICCT, 2016), from 2016 onwards.

3. The vehicle tyre labelling scheme shall be introduced to help customers choose suitable tyres for energy-saving purposes.
4. The logistic and transportation management personnel shall be systematically guided and trained by experts in order to help energy saving.
5. An eco-driving programme shall be introduced to help change driver behaviour and to raise awareness for the issue of energy saving.
6. A revolving fund shall be provided to support energy efficiency technology and activities in the transportation sector.
7. Financial mechanisms shall be introduced to spur investment in technology to improve energy efficiency, such as a standard offer programme (SOP) or demand side management (DSM).
8. The transportation infrastructure for both passengers (rail expansion, as well as non-motorised mode) and fuels (pipeline) shall be expanded in order to improve energy efficiency.
9. A double-track train network shall be introduced nationwide to help reduce energy inefficiency from passing trains waiting for clearance.
10. An electric vehicle infrastructure programme shall be prepared for introduction in Thailand, with a target of bringing 1.2 million electric vehicles to the road by 2036.

Table 2.1.1-2. 11 Measures for Energy Efficiency Planning in the Transportation Sector in Thailand

No.	Measure with energy saving target (ktoe)	2015	2021	2036	% share
1	Adjust fuel price structure		67	456	2
2	Adjust vehicle excise tax structure	813	4,242	13,731	45
3	Introduce vehicle tyre labelling		83	469	2
4	Implement logistics and transportation management	9	160	1,360	5
5	Expand ECO driving sill		22	1,491	5
6	Provide revolving fund for transportation sector		104	588	2
7	Provide financial mechanism (transport) SOP+DSM		394	1,216	4
8	Expand transportation infrastructure (passenger, fuel)	894	1,151	4,857	16
9	Introduce double-track train infrastructure		2,040	4,922	16
10	Introduce electric vehicles		75	1,123	4
	Total	1,716	8,338	30,213	100

DSM = demand side management, ktoe = kilotonne of oil equivalent, SOP = standard offer programme.
Source: Sunipasa (2017).

1.1.6. Current National Plans for Alternative Fuel Introduction

As previously discussed, the relevant national plan to introduce alternative fuel is the Alternative Energy Development Plan, with a target of 30% renewable energy by 2036. With a focus on transportation, a target of 8,712 ktoe from biofuel usage in transportation would come from 11.3 ML/day bioethanol, 14 ML/day biodiesel, 0.53 ML/day pyrolysis, and 4,800 tonnes per day of compressed biogas.

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