Chapter 2

Biofuel Policies and Biofuel Implementation in East Asia Summit Countries

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Chapter 2

Biofuel Policies and Biofuel Implementation in East Asia Summit Countries

1 Introduction

1.1 Background

As a follow up to previous ERIA projects, 'Study of Renewable Energy Potential and Its Effective Usage in East Asia Summit Countries' and 'Evaluation of CO_2 Emissions Reduction by Mobility Electrification and Alternative Biofuel Introduction in East Asia Summit Countries', the topic of biofuel policies and implementation, especially from the sustainability aspect, is continuously monitored in the context of mobility transition into electric vehicles across East Asia Summit (EAS) countries. Balancing between existing biofuel implementation and emerging electric mobility trends towards sustainable future mobility scenario can be harnessed through careful policy directions, which is a focus of this chapter.

1.2 Objective and Scope

The objective of this chapter is to update existing biofuel policies and implementation plans from selected EAS countries as a foundation to accommodate emerging electric vehicle trends during mobility energy transition. Biofuel policies mechanism that already create demand for agriculture surplus to food production must be carefully analysed if part of this demand is replaced by electricity for future mobility. Review of past and existing biofuel polices and regulations in the context of potential EV scenario (to be discussed in Chapter 4) is the scope of this chapter.

1.3 Methodology

In selected EAS countries, the following information on biofuel policies and implementation mechanism, as well as potential CO_2 reduction, are collected.

・Past and current national plan for biofuels (ethanol and biodiesel) promotion

・National biofuels (ethanol and biodiesel) standard and their blends with fossil fuel

・Government support and/or incentives for biofuels (ethanol and biodiesel), e.g. subsidies, mandates, targets

・Biofuels (ethanol and biodiesel) blending acceptance by vehicle manufacturer

・Statistics of biofuels (ethanol and biodiesel) and their fossil counterpart landscape

· CO_2-related information (well-to-tank) for biofuels (ethanol and biodiesel) and their fossil counterpart

2. Biofuel Policies and Biofuel Implementation

A. India

Given continuing uncertainties with regard to supplies, energy security has emerged as a matter of priority concern for India over the last few years. With the sharp escalation in crude oil prices in the past few years, it has been inexorably driven centre-stage, and appears likely to stay that way – at least in the foreseeable future. India's energy security emanates from a continuous supply of energy to cater for sustainable economic and commercial growth. Traditionally India is an oil and gas importer. The growing concern of climate change has forced India to look for alternative green fuel strategies.

The adoption of blending ethanol and the promotion of biofuel are the important strategies that India is following with the objectives of not only reducing the oil import bill but also addressing the climate change concern. It was the first oil crisis of 1973 that compelled India to look for alternative strategies. The genesis of India's biofuel programme went back to 1975 when India began examining the feasibility of blending ethanol with petrol and set up six technical committees and four study groups. After passing through various phases finally India adopted the National Plan of Biofuel in 2018.

National Policy on Biofuel 2018

Salient Features

i. The policy categorises biofuels as 'Basic Biofuels, i.e. first generation (1G) bioethanol & biodiesel and 'Advanced Biofuels' - Second Generation (2G) ethanol, Municipal Solid Waste to drop-in fuels, Third Generation (3G) biofuels, bio-compressed natural gas, etc. to enable extension of appropriate financial and fiscal incentives under each category.

ii. The policy expands the scope of raw material for ethanol production by allowing the use of sugarcane juice, sugar containing materials like sugar beet, sweet sorghum, starch containing materials like corn, cassava, damaged food grains like wheat, broken rice, rotten potatoes, that are unfit for human consumption for ethanol production.

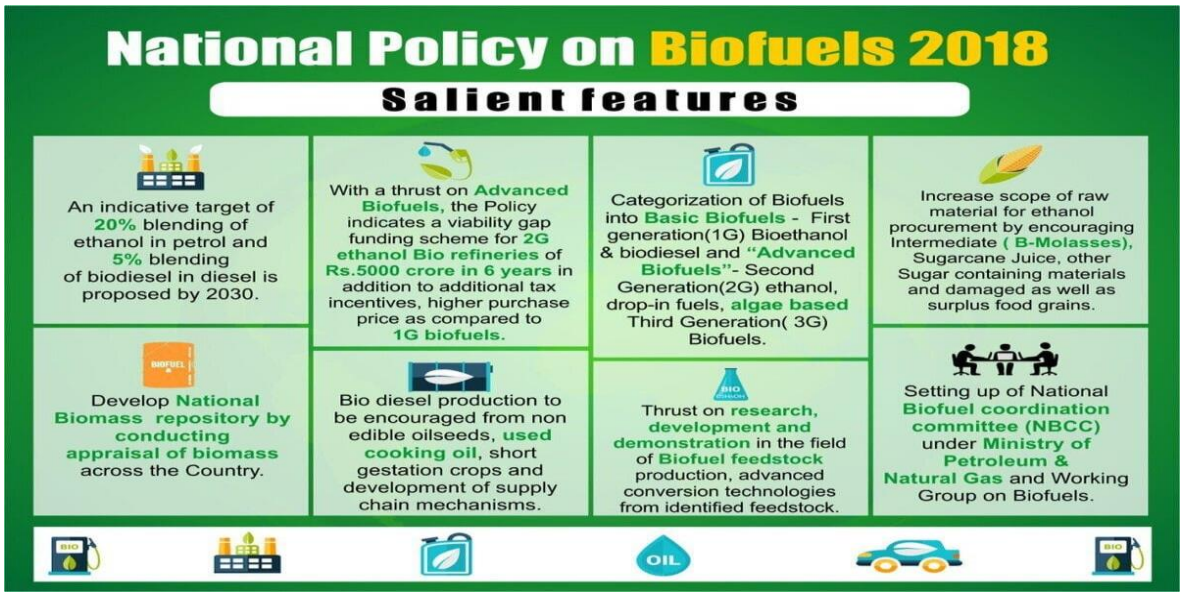
iii. Farmers are at risk of not getting appropriate prices for their produce during the surplus production phase. Taking this into account, the policy allows the use of surplus food grains for the production of ethanol for blending with petrol with the approval of the National Biofuel Coordination Committee.

iv. With a thrust on advanced biofuels, the policy indicates a viability gap funding scheme for 2G ethanol biofuel refineries of Rs5,000 crore in 6 years in addition to additional tax incentives, higher purchase price as compared to 1G biofuels.

v. The policy encourages the setting up of supply chain mechanisms for biodiesel production from non-edible oilseeds, used cooking oil, and short gestation crops.[1]

One of the most important salient features of this programme is achieving an indicative target of 20% blending of ethanol in petrol and 5% blending in diesel by 2030. Other important features are shown in Figure 2.1.

Figure 2.1: National Policy on Biofuels 2018



Source: Civilsdaily, 21 Nov 2018. https://www.civilsdaily.com/burning-issue-national-policy-on-biofuels-2018/

National Biofuel (ethanol and biodiesel) Standard and their Blends with Fossil Fuel

Currently petrol with 10% ethanol blend (E10) is being retailed by various oil marketing companies (OMCs) in India. However, due to the scarcity of sufficient ethanol, only around 50% of petrol sold is E10 blended, while the rest is unblended (E0). The current level of average ethanol blending in the country is 5% (ethanol supply year [ESY] 2019–20). Due to several interventions in the supply side of ethanol, the Ministry of Petroleum aims to achieve 10% ethanol blending levels in the ESY 2021–22, i.e. April 2022. The Ministry of Road Transport and Highways has notified BS-VI emissions norms in Central Motor Vehicle Rules 1989, which are applicable to all vehicles after 1 April 2020. Newer vehicles on E20 will have to meet BS-VI norms. The ministry has notified GSR 156(E) on 8 March 2021 for the adoption of E20 fuel as automotive fuel and issued mass emissions standards for it (PPAC 2021).

Currently gasoline vehicles (two-wheelers and four-wheelers) in the country are designed for running on pure gasoline and can be tuned to suit ethanol-blended fuels ranging from E0 to E5 depending on the vehicle type. The government aims to advance the adoption of 20% blending

in gasoline in the country by 2025. Surprisingly ethanol blending in India hit over 7.2% in the first 4 months of 2021 (Biofuels-news.com, 2021).

The supply of ethanol under the EBP Programme has increased from 38 crore litres during ESY 2013–14 to 173 crore litres during ESY 2019–20 resulting in an increase in blend percentage from 1.53% to 5.00%, respectively. Further, the allocation for the ongoing ESY (2020–21) has surged to 332 crore litres, which is 91% more in comparison to the ethanol supplies received during preceding ESY (2019–20). The quantity supplied and blending trends are shown in Table 2.1.

Table 2.1: Quantity Supplied (Ethanol) and % Blending Trends

Ethanol Supply Year	Quantity Supplied (crore litre)	Blending % PSU OMCs
2013–14	38.0	1.53%
2014–15	67.4	2.33%
2015–16	111.4	3.51%
2016–17	66.5	2.07%
2017–18	150.5	4.22%
2018–19	188.6	5.00%
2019–20	173.0	5.00%
2020–21	332	8.50%

OMC = oil marketing companies, PSU = public sector undertakings.
Source: Ministry of Petroleum & Natural Gas (2021).

Government Support and Incentives for Biofuel

As per the Union budget 2021–22 of the Government of India, financial assistance will be provided to set up distilleries to produce 1G ethanol from feedstock such as cereals (rice, wheat, barley, corn, and sorghum), sugarcane, and sugar beet.

Assistance will also be provided for the conversion of molasses-based distilleries to dual feedstock. Under the programme, the government would bear interest subvention for 5 years, including a 1-year moratorium against the loan availed by project proponents from banks at 6% per annum or 50% of interest, whichever is lower. The new programme is expected to bring about Rs400 billion (about $5.47 billion) in investments. The programme would facilitate the diversion of excess sugar to ethanol and encourage farmers to diversify their crops from sugarcane and rice to maize and corn, which need less water. About 50 million sugarcane farmers and 500,000 workers associated with sugar mills and other ancillary activities would benefit from the programme.

Loans amounting to about Rs3,600 crore have been sanctioned by banks to 70 sugar mills so far; 31 projects have been completed creating a capacity of 102 crore litres as a result. The capacity of molasses-based distilleries has reached 426 crore litres. Thirty-nine more projects with a capacity of 93 crore litres are likely to be completed by March 2022, which will bring the cumulative capacity to about 519 crore litres.

The Cabinet Committee on Economic Affairs in its meeting dated 30 December 2020 approved a note of the Department of Food & Public Distribution for extending financial assistance for producing 1G ethanol from feedstock such as cereals (rice, wheat, barley, corn & sorghum), sugarcane, sugar beet, etc. The DPFD notified a modified scheme to enhance ethanol distillation capacity in the country for producing 1G ethanol from feedstock such as cereals (rice, wheat, barley, corn & sorghum), sugarcane, sugar beet etc (PIB, 2021). Thereafter, with the approval of the Cabinet Committee on Economic Affairs, the DFPD has notified modified interest subvention scheme on 14.01.2021 for setting up new grain-based distilleries and/or the expansion of existing grain-based distilleries to produce ethanol from other 1G feedstock. About 418 applications received for capacity addition of 1,670 crore litres have been recommended for in-principle approval. It is expected that at least ethanol capacity of about 500 crore litres (molasses and grain-based) would be added from these upcoming projects. Further applications would be invited by the DFPD as and when required.

Thus, it is expected that the capacity of molasses-based distilleries would increase from current levels of 426 crore litres to 730 and 760 crore litres by 2024–25 and 2025–26, respectively. Seventy-five crore litres capacity is being added by existing grain-based distilleries; further oil marketing companies (OMCs) are planning to set up about 10 to 15 new grain-based distilleries thereby adding capacity by 100 to 150 crore litres. Hence, the capacity of grain-based distilleries is expected to reach 350, 450, 700, and 740 crore litres during 2022–23, 2023–24, 2024–25, and 2025–26, respectively from current levels of 258 crore litres.

Under the Pradhan Mantri Jaiv Indhan–Vatavaran Anukool Fasal Awashesh Nivaran (PM–JIVAN) scheme, 12 commercial plants and 10 demonstration plants of 2G biorefineries (using ligno-cellulosic biomass as feedstock) are planned to be set up in areas having sufficient availability of biomass so that ethanol is available for blending throughout the country. Already Rs1,969.50 crore have been earmarked for this scheme. These plants can use feedstock such as rice straw, wheat straw, corn cobs, corn stover, bagasse, bamboo and woody biomass.

Ethanol production projection

Table 2.2 shows the projection of ethanol production. As per the table the current (2020–21) blending rate is 5% which is projected to increase 20% by 2025–26. Commodity wise, sugar molasses would be dominating.

Table 2.2: Year-wise and Sector-wise Ethanol Production Projections

Ethanol Production Projections (crore litres)										
Ethanol Supply Year	For Blending			Blending (in %)	For other uses			Total		
	Grain	Sugar	Total		Grain	Sugar	Total	Grain	Sugar	Total
2019–20	16	157	173	5	150	100	250	166	257	423
2020–21	42	290	332	8.5	150	110	260	192	400	592
2021–22	107	330	437	10	160	110	270	267	440	707
2022–23	123	425	542	12	170	110	280	293	535	828
2023–24	208	490	698	15	180	110	290	388	600	988
2024–25	438	550	988	20	190	110	300	628	660	1,288
2025–26	466	550	1016	20	200	134	334	666	684	1,350

Source: USDA (2021).

Vehicular ethanol demand projection and manufacturers view

The vehicle population in the country is around 22 crore of two- and three-wheelers and around 3.6 crore of four-wheelers (Society of Indian Automobile Manufacturers, 2021). The two-wheelers account for 74% and passenger cars around 12% of the total vehicle population on the road. The two- and three-wheelers consume two-thirds of the gasoline by volume, while four-wheelers consume the balance of one-third by volume. The growth rate of vehicles in this segment is pegged at around 8%–10% per annum. Based on expected vehicle population, the demand projections of gasoline in India is given in Table 2.3.

Table 2.3: Gasoline Demand Projections

Product/Year	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Motor Gasoline (MMTPA)*	27.7	31	32	33	35	36	37	39	40	41
Motor Gasoline (crore litre)	3,908	4374	4,515	4,656	4,939	5,080	5,221	5,503	5,644	5,785

FY = fiscal year, MMTPA = million metric ton per annum.
Note: Projections as per the 'Report of the Working Group on Enhancing Refining Capacity by FY2040'.
Source: http://www.niti.gov.in/sites/default/files/2021-07/Ethanol-blending-in-India-compressed.pdf

The projected requirement of ethanol based on petrol (gasoline) consumption and estimated average ethanol blending targets for the period ESY 2020–21 to ESY 2025–26 are shown in Table 2.4.

Table 2.4: Ethanol Demand Projections

Ethanol Supply Year	Projected Petrol Sale (MMT)	Projected Petrol Sale (crore litres)	Blending (in %)	Requirement of ethanol for blending in Petrol (crore litres)
A	B	B1 = B * 141.1	C	D = B1* C %
2019–20	24.1 (Actual)	3,413 (Actual)	5	173
2020–21	27.7	3,908	8.5	332
2021–22	31	4,374	10	437
2022–23	32	4,515	12	542
2023–24	33	4,656	15	698
2024–25	35	4,939	20	988
2025–26	36	5,080	20	1,016

MMT = million metric ton.
Source: NITI Aayog (2021).

However, Indian vehicle manufacturers think that some changes in the production line will be necessary to produce compatible vehicles. Engines and components will need to be tested and calibrated with E20 as fuel. Vendors need to be developed for the procurement of additional components compatible with E20. All the components required can be made available in the country. A shift to E20 fuel is a logical, direct progression from E10 rather than going through intermediate steps of E12 and E15. However, two important concerns need to be taken care of.

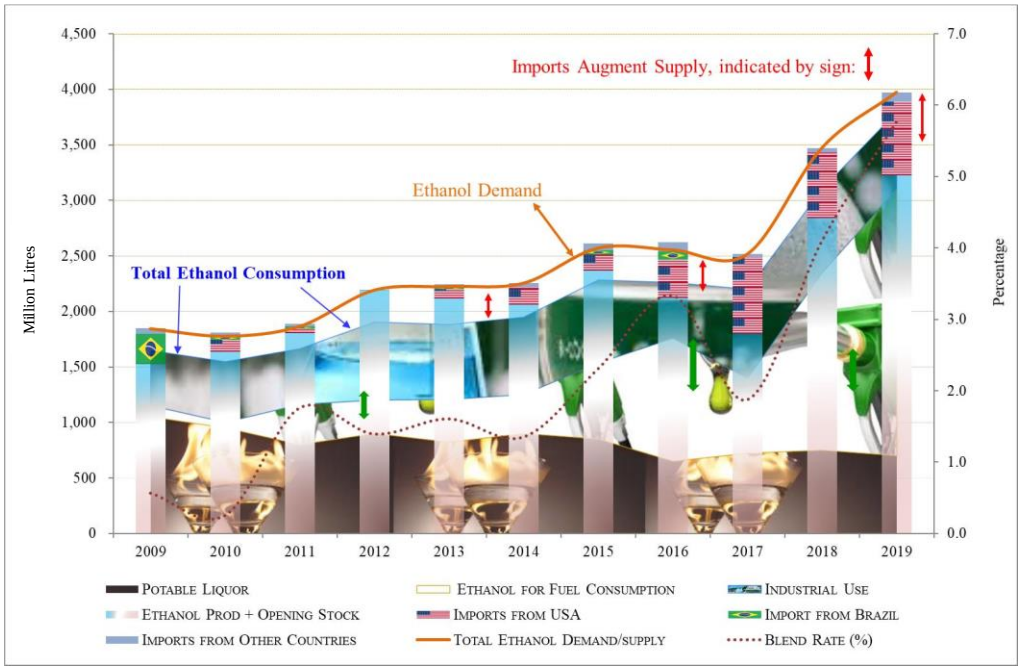
First, E20 should be made available on a pan-India basis. Second, E10 should be made available on a pan-India basis as protection grade fuel for existing pool of vehicles.

The cost of E100 and/or flex fuel vehicles will be higher in comparison to E0/E10 vehicles, which may result in an increase in total cost of ownership for the customer. It has been suggested that only when E100 can be sold at 30% lower cost compared to gasoline and if E100 fuel is available across the country, can flex fuel vehicles be a possible solution.

In the past, OMCs and original equipment manufacturers moved together for implementation of Bharat Stage 6 (BS6) emissions regulations and specification of a single fuel across the country. This needs to continue in future also to ensure portability of vehicles by the customer, especially for vehicles designed for higher blends of ethanol keeping in mind the customer's acceptance and requirements.

Adopting engines with a higher ethanol blend means changes in engine hardware and also engine calibration (tuning). The auto industry is already working on the engine upgradation work for the next level of regulations (BS6.2). Being a huge, unmodifiable task, it is important that fuel changes are also aligned with these regulations to derive complete benefit from all the perspectives, as shown in Figure 2.2.

Figure 2.2: Industry View of Ethanol Production and Consumption



Source: USDA (2019a).

Consumption and Pricing of Biofuel, Gasoline, and Diesel

As Table 2.5 shows there has been an increase of biofuel consumption in India since 2011. In 2011 the total consumption of biofuel in India was 8.24 thousand barrels per day which increased to 44.55 thousand barrel per day in 2019. The changeover is 45.22%. In March 2021, the biofuel price of India was around Rs70 per litre.

Table 2.5: Biofuel Consumption in India Since 2011

Year	Value (thousand barrels per day)
2019	44.55
2018	30.67
2017	14.48
2016	21.18
2015	13.84
2014	7.79
2013	8.79
2012	7.41
2011	8.24

Source: Knoema, 2019. https://knoema.com/atlas/India/topics/Energy/Renewables/Biofuels-consumption about India Total Biofuel Consumption (Access date 25th June 2021)

As far as gasoline is concerned there is a high jump in consumption. Despite conservation measures, the adoption of biofuel and enhancing of energy efficiency of engines, there is an escalating trend of gasoline consumption. In 2011, gasoline consumption in India was 344,000 barrels per day which increased to 646,600 barrels in 2019 as shown in Table 2.6. As far as pricing is concerned there was a steady increase of pricing up to 2019, but afterwards there was a high jump of price and currently (June 2021) the price of gasoline is around Rs96/litre, as shown in Table 2.6.

Table 2.6: Gasoline Consumption and Pricing, India

Year	Consumption (thousand barrels per day)	Price (Rs/litre)
2018–19	646.6	78.43
2017	593.0	65.63
2016	552.0	63.02
2015	492.0	66.29
2014	429.0	71.51
2013	394.0	63.09
2012	363.0	73.18
2011	344.0	63.37

Source: India Gasoline Consumption, https://www.theglobaleconomy.com/download-data.php India Gasoline Consumption about thousand barrels per day) (Access date 25th June 2021)

Table 2.7 shows the consumption and pricing pattern of diesel in India from 2011 to 2019

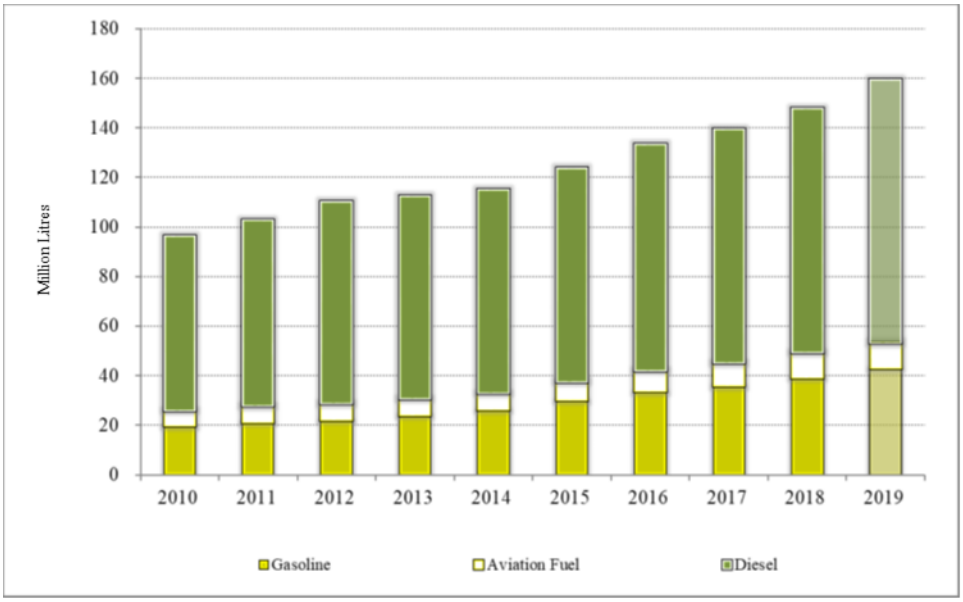
Table 2.7: Diesel Consumption and Pricing, India

Year	Consumption ('000 million tonnes)	Price (Rs/litre)
2019	82602	66.00
2018	83528	67.80
2017	81073	53.33
2016	76027	54.28
2015	74647	49.71
2014	69416	55.48
2013	68364	48.63
2012	69080	40.91
2011	64750	37.75

Source: Petroleum Planning and Analysis Cell, Ministry of Petroleum and Natural Gas, Government of India.

A comparative view of consumption of gasoline and diesel in India has been depicted in Figure 2.3. Table 2.8 shows the biodiesel production and consumption pattern.

Figure 2.3: Comparative View of India's Gasoline and Diesel Consumption



Source: Petroleum Planning and Analysis Cell (PPAC), Government of India.

Table 2.8. India: Biodiesel Production from Multiple Feedstock

Biodiesel (million litres)										
Calendar Year	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Beginning Stocks	45	15	13	14	15	11	13	13	18	25
Production	100	111	126	132	138	152	158	170	185	190
Imports	0	0	0	0.3	1.7	0.8	2.7	7.1	25.2	11.5
Exports	0	0	0	3.9	41.5	33.1	41.7	7.6	23.1	19.7
Consumption	131	113	125	128	102	118	119	165	180	185
Ending Stocks	15	13	14	15	11	13	13	18	25	22
Production Capacity (million litres)										
Number of Biorefineries	5	5	5	6	6	6	6	6	6	6
Nameplate Capacity	450	450	460	465	480	500	550	600	650	660

Biodiesel (million litres)										
Calendar Year	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Capacity Use (%)	22.2	24.7	27.4	28.4	28.8	30.4	28.7	28.3	28.5	28.8
Feedstock Use for Fuel (1,000 metric tons)										
Non-edible Industrial	50	58	65	70	75	85	90	100	110	105
Used Cooking Oil	38	42	48	49	50	55	55	55	60	65
Animal Fats & Tallows	6	6	7	7	6	5	6	6	8	10
	94	106	120	126	131	145	151	161	178	180
Market Penetration (million litres)										
Biodiesel, on-road use	36	31	42	49	32	41	48	72	83	85
Diesel, on-road use	42,625	45,520	49,343	49,354	49,605	52,239	55,179	57,025	61,247	62,284
Blending Rate (%)	0.09	0.07	0.08	0.1	0.06	0.08	0.09	0.13	0.14	0.14
Diesel, total use	71,041	75,866	82,238	82,256	822,674	87,064	91,965	95,041	102,079	103,807

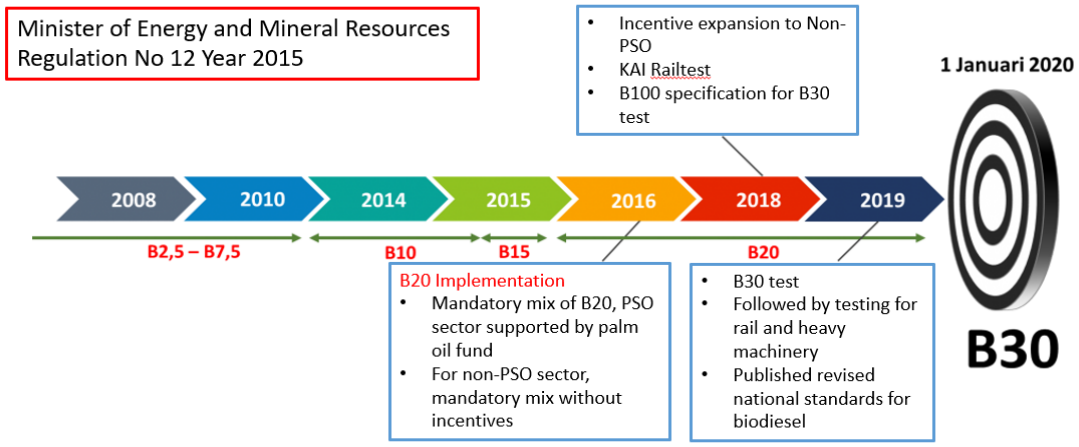
Source: USDA (2019b).

B. Indonesia

Indonesia's mandatory biofuel content within commercial diesel and gasoline fuels was last determined by the Minister of Energy and Mineral Resources Regulation No 12 Year 2015. This regulation defined the targets to be met for both bioethanol and biodiesel-based biofuels for industry, power generation and transportation.

In regard to transportation, the development of bioethanol content has been lagging, however, for biodiesel, the programme has been relatively successful. As according to the regulation, by January 2020, the target biodiesel content is B30, as shown in Figure 2.4 (ESDM, 2019).

Figure 2.4: Road Map Towards Mandatory B30 in 2020

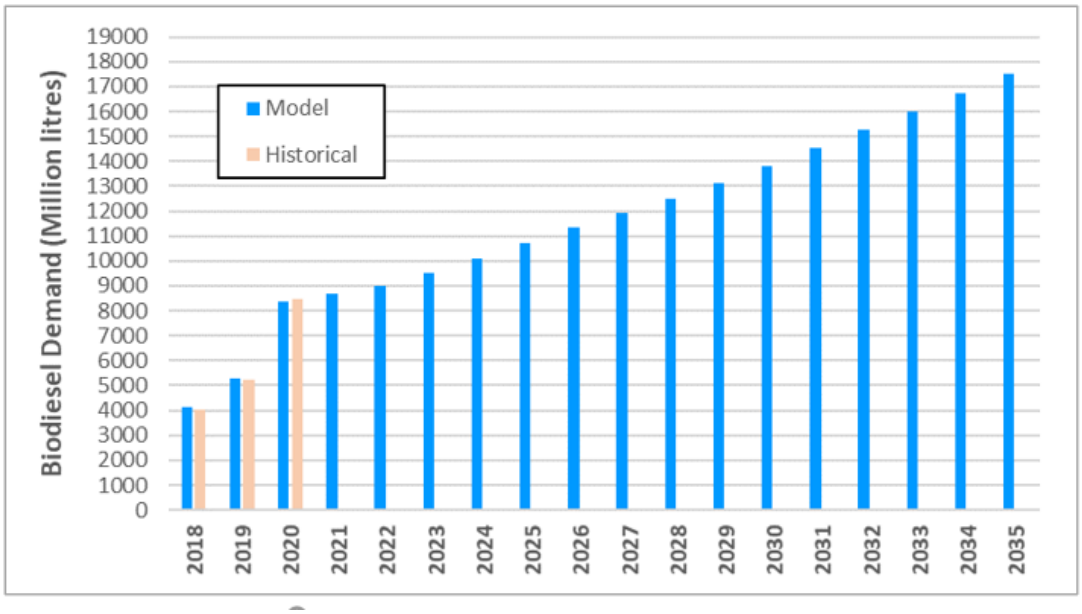


Source: ESDM (2019).

A simulation we have developed to calculate biofuel supply requirements shows that with the current biofuel target, the biodiesel demand will exceed 15 million kilolitres by 2032, as shown in Figure 2.5 (ESDM, 2020; APROBI, 2021). As the sustainability and expansion of the biodiesel programme will further require increased supply, possibilities in regard to unconventional biodiesel sources should be explored.

The success in the development of crude palm oil (CPO) based biodiesel is largely due to the regulatory framework constructed. This framework includes provisions to expand and subsidise CPO based biodiesel. Government Decree 24/2015 concerning Plantation Fund Collection stipulates that funds are collected from entrepreneur fees and levies on exports of strategic plantation commodities which include oil palm, coconut, rubber, coffee, cocoa, sugar cane, and tobacco, as well as other commodities stipulated by the minister. Funds are then allocated amongst others to improve the optimisation of the use of strategic plantations for biofuel. In the case of palm oil, a specific Palm Oil Plantation Fund is defined in Presidential Decree 61/2015 concerning Collection and Use of Palm Oil Plantation Funds. The specific funds are used to subsidise biodiesel as such to cover the shortfall between the market index price for diesel fuel and the market index price for biodiesel fuel.

Figure 2.5: Historical and Simulated Indonesian Biodiesel Demand



Sources: ESDM (2020); APROBI (2021).

One potential source of unconventional biofuels is waste frying oil. Indonesia's palm oil production increased rapidly in 2016 to above 30 million tons and reached 40 million tons in 2019 (BPS, 2018; USDA, 2019b). While the majority goes towards exports, followed by industrial domestic consumption (through production of biodiesel), the human consumption of palm oil for cooking was estimated at more than 5.9 million tons in 2019 with the total estimated domestic consumption being 13.11 million tons in the same year (USDA, 2019b).

As the laws and regulations become the driving force to establish the development of renewable energy, including the development of biodiesel from unconventional sources, it is crucial that a mapping be conducted of the current legal framework pertaining to the use of renewable energy (RE), conventional, and unconventional biofuels. Based on this mapping, regulatory avenues to accelerate inclusion of non-conventional biodiesel sources can be explored. Here, we will focus on the regulatory mapping for use of waste frying oil as a source of unconventional biofuel.

Laws and Government Regulations pertaining to Renewable Energy

The overarching law in regard to the use of renewable energy is the Government Regulation No. 79 of 2014 on The National Energy Policy (PP No 79 Tahun 2014 tentang Kebijakan Energi Nasional) and Law No. 30 of 2007 on Energy (UU No 30 Tahun 2007 tentang Energi).

Government Regulation No. 79 of 2014 on The National Energy Policy

・Specifies the new and renewable energy (NRE) target of 23% NRE in 2025 and 31% NRE in 2050 as long as the economic feasibility is met

・The central and regional governments provide subsidies if the price of NRE is higher than the price of unsubsidised fuel

・The use of NRE from biofuels is carried out while maintaining food security

・Earmarking of fossil energy depletion premiums for NRE development

Law No. 30 of 2007 on Energy

・The provision of RE is prioritised in underdeveloped areas, remote areas, and rural areas

・The central and regional governments provide facilities and/or incentives to business entities, permanent establishments, and individuals who develop RE for a certain period of time until economic feasibility is achieved.

Laws and Government Regulations pertaining to Biofuels for Transportation

In regard to the use of biofuels for transportation, the relevant laws and articles are as follows :

Presidential Decree No. 61 of 2011 concerning the National Action Plan for Reducing Greenhouse Gas Emissions (RAN-GRK)

・The energy and transportation sector is targeted to contribute to a reduction in emissions of 0.056 gigatons CO_2e, amongst others through increased NRE, use of cleaner fuels (fuel switching), and utilisation of clean technology for transportation facilities.

Presidential Decree No. 191 of 2014 concerning the Provision, Distribution and Retail Price for Oil Based Fuels

・Business entities that are assigned the supplying and distributing certain (subsidised) fuels are required to blend biofuel.

・The market index price for fuel oil and the market index price for biofuel which are mixed into certain types of fuel and special assigned fuel types are determined by the minister.

・The market index price for fuel oil and the market index price for biofuel which is mixed into the general fuel type shall be determined by the business entity and reported to the minister.

Minister of Energy and Mineral Resources (MEMR) Regulation No 12 Year 2015 on the Third Revision of MEMR Regulation No.32 of 2008 on the Provision, Usage and Commercialization of Biofuels as Alternative Fuels

·Setting the blending target up to 2025 in the form of phasing the minimum obligation to use biodiesel (B100) as a mixture of fuel for public service obligation (PSO) and non-PSO transportation by 30% of total demand

·The phasing of the minimum obligation to use bioethanol (E100) as a fuel mixture for PSO transportation is 5% in January 2020 and 20% in January 2025 of total demand

·The minimum obligation to use bioethanol (E100) as a mixture of fuel for non-PSO transportation is 10% in January 2020 and 20% in January 2025 of total demand

Laws and Government Regulations pertaining to CPO based Biodiesel for Transportation

·To devise a recommendation to promote the development and supply of biodiesel from unconventional sources, it is important to recognise the regulations supporting the existing provision of biodiesel from CPO.

Minister of Energy and Mineral Resources Regulation No. 45 of 2018 on the Amendment of Minister of Energy and Mineral Resources Regulation Number 41 of 2018 Concerning Provision and Utilization of Biofuel of the Biodiesel Type in the Context of Financing by the Oil Palm Plantation Fund Management

·The government provides biodiesel financing funds originating from oil palm plantation funds that are collected, administered, managed, stored, and distributed by the Fund Management Agency to cover the deficiency between the market index price for diesel fuel oil and the market index price for biodiesel fuel.

Government Regulation No. 24 of 2015 concerning Plantation Fund Collection

·Establishment of a Plantation Fund that is collected by the Fund Management Agency which comes from entrepreneur fees and levies on exports of strategic plantation commodities which include oil palm, coconut, rubber, coffee, cocoa, sugar cane, and tobacco, as well as other commodities stipulated by the minister.

·Funds are allocated amongst others to improve the optimisation of the use of strategic plantations for biofuel.

Government Regulation No. 61 of 2015 concerning Palm Plantation Fund Collection and Usage

·Establishment of the Palm Oil Plantation Fund which is collected from fees and export levies from palm oil plantation products or derivatives.

·Funds are allocated for the provision and utilisation of biofuel from the type of biodiesel originating from oil palm plantations.

Government Regulation No. 66 of 2018 on the Second Amendment of Government Regulation No. 61 of 2015 concerning Palm Plantation Fund Collection and Usage

·The utilisation of the funds support the purpose of provision, distribution, and usage of biodiesel fuels of which in this regard is to cover the shortfall between the market index price for diesel fuel and the market index price for biodiesel fuel.

·These funds are paid to business entities supplying biodiesel fuels after verification by the Ministry of Energy and Mineral Resources

Minister of Finance Regulation No. 113/PMK.01 of 2015 on the Organization and Working Procedure of the Plantation Fund Management Agency

·Defines the organisation and functions and tasks of the of divisions of the Plantation Fund Management Agency

·The Division of Biodiesel Development is tasked with the planning of allocation and disbursement of funds, management of funding collaborations, research, and data management regarding biodiesel development.

Laws and Government Regulations pertaining to Biofuel from Waste and Unconventional Sources

There are existing regulations in place that provide an avenue towards the collection of waste and feedstock for the production of biodiesel from unconventional sources. Regulations from the Ministry of Villages, Development of Disadvantaged Areas and Transmigration particularly mention the funding of biodiesel production from cooking oil waste.

Law No. 32 of 2009 on the Environment

·Parties that produce Hazardous and Toxic Waste (LB3) are required to manage the LB3 they produce, either independently or submitted to other parties. Management includes reduction, storage, collection, transportation, utilisation and/or processing, including hoarding.

Minister of Villages, Development of Disadvantaged Areas and Transmigration Regulation No. 11 of 2019 concerning Priority for the Use of Village Funds in 2020

·One of the list of priority activities in the Village Development Sector is the development of renewable energy, which includes:

1) processing livestock waste for biogas energy,

2) making bioethanol from cassava,

3) processing used cooking oil into biodiesel,

4) management of wind power plants,

5) management of solar energy,

6) training in utilising solar energy, and

7) development of other renewable energy in accordance with the authority of the Village and decided in Village deliberations.

Minister of Villages, Development of Disadvantaged Areas and Transmigration Regulation (MVDT) No. 14 of 2020 on the Third Amendment of MVDT Regulation No. 11 of 2019 concerning Priority for the Use of Village Funds in 202018

·The use of Village Funds is prioritised for climate change mitigation and adaptation activities, including construction of RE infrastructure such as cooking oil waste treatment equipment for biodiesel.

·Utilisation of Village Funds for village owned companies that are engaged in the business of managing waste and used cooking oil waste from households into biodiesel

Regional and local governments have initiated regulations that support the development of renewable energy. These include regulations there are also regulations that support the collection and processing of waste cooking oil to biodiesel.

Bogor City Regulation No. 1 of 2014 on Environmental Protection and Management

·Produced waste cooking oil can be handed over by the producer to the regional or city government

·Any agency whose business activities produce used cooking oil as a result of its business activities is obliged to submit used cooking oil to the regional government.

·Used cooking oil is processed into biodiesel, which is used as an environmentally friendly alternative fuel.

DKI Jakarta Governor Regulation No. 167 of 2016 on the Management of Frying Oil Waste

·Promotes the use of frying oil waste as an alternative biodiesel fuel for transportation and local industries

·Producers of frying oil waste must manage the waste and/or collaborate with waste collection parties and/or users

·It is prohibited to reuse frying oil waste for human consumption or for food processing

·Frying oil waste can be utilised directly as a combustible fuel or converted into biodiesel

·The chain of frying oil waste management may include:

- Producers, which include restaurant businesses, hotels, food industries, and other cooking oil user businesses, are required to prepare a cooking oil waste management plan document as part of the environmental document in the application for a business license to the Badan Pelayanan Terpadu Satu Pintu (a one Stop Integrated Service Agency). Producers are required to store waste cooking oil produced in storage places that meet technical safety standards, for further use alone (except for human and animal consumption) and/or in collaboration with collectors.
- Collector: a party that carries out business activities to collect and distribute cooking oil waste based on a cooking oil waste collection permit from the Badan Pelayanan Terpadu Satu Pintu.
- Utiliser: parties who directly utilise cooking oil waste to add fuel diesel oil and/or process it into biodiesel or for other permitted purposes.

·Penalties for parties who violate the provisions on cooking oil waste management in the form of temporary suspension of business activities or revocation of business licenses.

Aceh Qanun 4/2019 concerning the General Plan for Aceh Energy

·Building supply and demand by :

- Formulating and implementing incentive policies for the use of NRE
- Limit the amount of fossil fuels at service posts, and on the other hand, improve the quality and quantity of biofuels
- Providing incentives for entrepreneurs in the form of:

✓Relax the timing for implementing licenses

✓Assisting soft loans in development and production operations

✓Ensuring good quality production results will be purchased by the Government of Aceh

✓Prioritising marketing access

- Giving incentives to mass transportation entrepreneurs who use alternative energy:

  ✓Investment incentives take the form of investment facilitation and tax breaks

  ✓Priority in the business area

  ✓Subsidies and assistance by the Government of Aceh
- Acceleration of biofuel supply for transportation and industry through:

  ✓Mapping of potential areas for raw material production through surveys and feasibility studies

  ✓Determination of production areas for biomass raw materials into Aceh Qanun

✓Development of processing plants in the form of ethanol plants in the eastern and western regions and biodiesel plants in the central and northern regions

North Kalimantan Provincial Regulation 3/2019 concerning General Regional Plan for Energy

· Encourage and strengthen the development of the energy industry in the regions through:

· Facilitation (public–private partnership scheme) of the development of manufacturing industries that support the energy and energy services industries

· Development of industrial equipment for production and utilisation of RE

· Prepare local regulations on RE investment from local sources specifically in remote and border areas

· The use of biofuel in the land transport sector, especially urban and urban public transport, sea transportation including fishing boats, and air transportation until 2025

· Establish a special provincial government enterprise in the energy sector that is tasked with producing and buying biofuel

· Encourage increased use of environmentally friendly energy technology based on the 3Rs (reuse, reduce, and recycle) principle for waste

· Implement a one-stop permit policy and simplifying licensing in order to increase investment in the energy sector

· Develop the biodiesel industry in 2025 as a mixture of fuel for the utilisation of the transportation, industrial and power generation sectors

· Provide facilitation and incentives in fiscal and non-fiscal forms in order to accommodate the development of the bioethanol industry to meet bioethanol needs in North Kalimantan and its surrounding areas

Recommendations for the acceleration of unconventional biofuels from waste:

Table 2.9 (Widyaparaga, 2021) shows the comparison of current conditions and relevant regulations for the sources of biofuels. It is clear that the current regulatory framework, although supportive in some aspects, still requires development if it is intended to support the development of biofuels from unconventional sources.

Table 2.9: Comparison of Current Conditions and Relevant Regulations for the Sources of Biofuels

Biofuel Source	Current Condition	Relevant Government Branches/Body and Regulations
Biofuel from strategic plantation commodities	○ Palm oil is the most sustainable to develop today ○ There is relatively well-established funding support from the Oil Palm Plantation Fund ○ The management scheme and institutions have been established ○ Political support exists and is strong	Ministry of Energy and Mineral Resources, Ministry of Agriculture; Ministry of State Owned Enterprises (SOE); Local Governments ○ Energy sector regulation ○ Agriculture-plantation sector regulation ○ The compensation policy from the Minister of SOE ○ Local/regional regulations
Biofuel from non-strategic plantation commodities	○ Plants such as jatropha, tamanu (nyamplung) and reutalis (kemiri sunan) have the potential to be developed (DEN, 2020), but are not yet sustainable to be developed at this time ○ There is no definite funding support yet ○ Supply–demand has not yet been developed	Ministry of Energy and Mineral Resources; Ministry of Agriculture; Ministry of State Owned Enterprises; Local Government ○ Energy sector regulation ○ Agriculture-plantation sector regulation ○ The compensation policy from the Minister of SOE ○ Local/regional regulations
Unconventional biofuel from waste	○ Potential to be developed at the regional level	Ministry of Energy and Mineral Resources; Ministry of Environment and Forestry; Ministry of Home

Biofuel Source	Current Condition	Relevant Government Branches/Body and Regulations
	○ Requires large community participation ○ There is no definite institutional and financial support; possible funding via Village funds ○ Requires the role of regional government/village owned enterprises (BUMD/BUMDes) as a driving vehicle ○ National and local regulations are needed that are able to build sustainable supply–demand	Affairs; Ministry of Health, Development of Disadvantaged Areas and Transmigration; Local Governments ○ Energy sector regulation ○ Environment sector regulations ○ Health sector regulations ○ Supervisory policy from the Minister of Home Affairs ○ Local/Regional Regulations

Source: Widyaparaga (2021).

To accelerate the inclusion and development of unconventional sources of biofuel, the following is recommended:

Formulation of strict regulations regarding the energy transition in the transportation sector in regard to unconventional biofuels

oBinding and applicable regulations that create supply–demand for unconventional biofuels (e.g. waste oil collection and processing)

o The obstacle in developing unconventional biofuels in general is that the price of unconventional biofuels is higher than fossil fuels. This is a barrier from the national oil company (Pertamina) side as end-user supplier.

o Designated state owned enterprises such as Pertamina will require government support in the form of compensation and/or incentives. There is a legal basis in Article 66 paragraph (4) of the State Owned Enterprises Law which has been amended in the Law No. 11 of 2020 concerning Job Creation, which reads: 'If the assignment is financially impractical, the Central Government must provide compensation for all costs incurred by the SOE, including margins expected as long as it is within the level of reasonableness in accordance with the assignment given'.

o Guarantee demand and feasible prices for producers of unconventional biofuels

oEstablish a funding mechanism for unconventional biofuels. This can adopt the scheme that has been established for CPO based biodiesel.

Include cost of externalities in the cost of fossil fuels thus increasing attractiveness of biofuels, as shown in Figure 2.6

o Currently, Indonesia has not considered the cost of externalities of non-RE fuel usage.

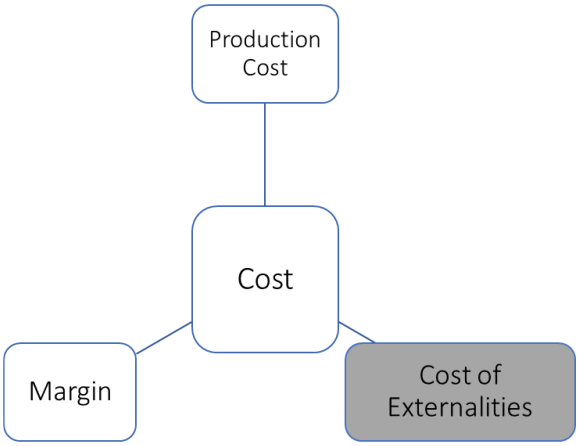
o Including the cost of externalities in non-RE fuel can level the playing field between RE and non-RE fuels by reducing the attractiveness of non-RE fuels (Fig. 2.6)

o Cost of externalities can be compensated via a carbon tax mechanism

o Carbon tax as: (1) disincentive for fossil fuel users (2) regulatory function of tax, where carbon tax is aimed to reduced fossil fuel usage and create demand for biofuels

o Regulatory basis for carbon tax is present in Law No 32 of 2009 article 43 point (3) introducing tax as an economical instrument for environment protection

Figure 2.6: Inclusion of the Cost of Externalities into the Final Cost of Fuels



Source: Widyaparaga (2021).

C. Malaysia

Any legitimate implementation of fuel mandates requires the proper framework in the form of government policies to spearhead it. The Malaysian government had rolled out policies from different ministries that were able to streamline with each other to achieve increased usage of biofuels in the country as follows.

National Biofuel Policy 2006

This policy (MPIC, 2006) was published on 21 March 2006 by the Ministry of Plantation Industries & Commodities (MPIC) together with the Malaysian Palm Oil Board (MPOB) to serve as the framework for biofuel industry development in Malaysia. The policy looks to achieve the following objectives.

·To expand the use of downstream palm oil products and become an initiative to increase the income of oil palm smallholders through palm oil market price control mechanisms

·To help reduce the country's dependence on fossil fuels as one of the energy security initiatives

·To reduce the greenhouse gas (GHG) emissions rate in line with the country's aspiration towards achieving the GHG emissions reduction target of 45% of GDP by 2030

The National Biofuel Policy 2006 contains five thrusts that are geared towards pushing the development of the biodiesel industry. The thrusts are: Thrust 1: Biofuel for Transport; Thrust 2: Biofuel for Industry; Thrust 3: Biofuel Technologies; Thrust 4: Biofuel for Export and Thrust 5: Biofuel for Cleaner Environment.

Malaysian Biofuel Industry Act 2007 (Act 666)

The Biofuel Industry Act of Malaysia (Commissioner of Law Revision, 2007) was followed shortly by the establishment of National Biofuel Policy of Malaysia in 2006. The Biofuel Industry Act was introduced to further regulate and facilitate biofuel sectors development.

With the introduction of this Act, companies that are interested to venture into biofuel only need to apply for one license and therefore the Act reduced administrative barriers by streamlining the licensing process. The activities licensed under the Act include (a) production of biofuel (b) trading of biofuel, and (c) biofuel services.

As for future policy and regulation related to biofuel in Malaysia, related policies are as follows.

National Energy Policy 2021–2040

The National Energy Policy was started in 1979 to become the framework for the direction of energy in Malaysia. The newest iteration of this policy is due to be unveiled in the second half of 2021 by the Malaysian Economic Planning Unit (EPU, 2021). In its efforts to transform Malaysian energy sector into a cleaner and more sustainable industry, initiatives such electrification and renewable fuels utilisation are to be introduced.

In the biofuels front, biogas and biodiesel initiatives are being touted as possible steps to be taken. Biogas can be a clean alternative for power generation whereas B20 (20% palm biodiesel blended with 80% petroleum diesel) implementation in the transportation sector can reduce vehicle emissions.

National Automotive Policy 2020

The National Automotive Policy was first introduced in 2006 under the Third Malaysia Plan to spearhead Malaysia's automotive industry as a prime contributor to the economy. The latest iteration of the policy was published in 2020 by the Ministry of International Trade and Industry (MITI, 2020) which highlights policies to introduce supply chain integration, investment promotion, green and sustainable improvements, and connected mobility.

Under the green and sustainability policy, the implementation of biodiesel blends is seen as one of the programmes that can help achieve this vision. The following are some of the strategies outlined.

· Coordinate R&D between industry and academia.

· Comprehensive validation system by government and industry on biodiesel approved vehicles

· Review biodiesel vehicles ecosystem to inculcate promotion of higher biodiesel grade.

· Empower research activities on application of biodiesel.

Malaysian Standards on Automotive Diesel and Biodiesel

The Department of Standards Malaysia has published multiple standards regarding the use of diesel and biodiesel in automotive engines. The latest biodiesel standard, MS 2008:2014 was further enhanced with new limits for oxidation stability (10 hours minimum @ 110^{o}C) and monoglycerides content (0.7 weight % maximum). The latest diesel standards which are MS 123-4:2020 (Euro 2M) and MS 123-5:2020 (Euro 5) allows for the blending of 7.1% to 20% palm biodiesel in petroleum diesel. These standards have allowed for the implementation of biodiesel blends up to B20 as quality requirements have been met.

Government Instruction on Specifications of Imported Vehicles

MITI is the governing authority on imported vehicles coming into Malaysia. Through cooperation between MPIC and MITI, an instruction was made to all vehicle manufacturers that starting from 1 January 2020 all diesel vehicles in the Malaysian market must be compatible with B20 and above usage.

The implementation of biodiesel usage in Malaysia had started in 2011 with the usage of B5 (5% palm biodiesel blended with 95% petroleum diesel). It then expanded to B7 in 2014, B10 in 2019, and B20 starting 2020 (MPOB, 2021). As shown in Table 2.10, the implementation had covered various sectors that utilise diesel and ensures that there is constantly a mix of renewable fuels and fossil fuels in the country.

Table 2.10: Biodiesel Implementation Timeline in Malaysia

Date of Implementation	Sector	Programme	Region
November 2011	Transport	B5	Central region, Peninsula Malaysia
July 2013		B5	Southern region, Peninsular Malaysia
February 2014		B5	Northern region, Peninsular Malaysia
March 2014		B5	Eastern region, Peninsular Malaysia
November 2014		B7	Whole Peninsular Malaysia
December 2014		B7	East Malaysia
February 2019		B10	Nationwide
July 2019	Industrial	B7	Nationwide
January 2020	Transport	B20	Langkawi and Labuan Islands
September 2020			Sarawak

Source: MPOB (2021).

Biodiesel usage in Malaysia has been steadily increasing from 2011 until 2020 with every implementation of the biodiesel blending programmes, as shown in Table 2.11 (MPOB, 2021). Currently the B20 implementation is being done in phases to accommodate for blending facilities upgrading at petroleum terminal. Once the upgrades have been completed, the blending facilities can cater up to B30 blending. It is projected that the B30 programme for the transport sector with B10 programme for industrial sector to be in place until 2030.

Table 2.11: Projected Demand of Biodiesel in Malaysia

Mandate	Implementation Period	Biodiesel Demand (tons/year)
B5 Transport	2011–2014	267,000
B7 Transport	2014–2018	374,000
B10 Transport B7 Industry	2019–2020	761,000
B20 Transport B7 Industry	2020–2024	1,294,000
B30 Transport B10 Industry	2025–2030	1,926,000

Source: MPOB (2021).

In 2020, there were a total of 19 licensed biodiesel plants that were operating with a total production capacity of 2.32 million tons per year, as shown in Table 2.12 (MPOB, 2021). The palm biodiesel produced in 2020 only accounts for about 39.2% of the total production capacity of the operating biodiesel plants. This indicates that there is room for the biodiesel industry to grow with initiatives and policies to increase domestic consumption and new markets to export are introduced.

Table 2.12: Palm Biodiesel Production (2011–2020)

Duration	Palm Biodiesel Production (million tons)
2011	0.17
2012	0.24
2013	0.47
2014	0.60
2015	0.67
2016	0.50
2017	0.72
2018	1.09
2019	1.42
2020	0.91

Source: MPOB (2021).

Initial implementation of the B5 programme for the transport sector was met with anxiety by most diesel vehicle manufacturers as most OEM are wary of new fuels coming into the market. MPOB together with MPIC had conducted trials on engines and vehicles prior to the implementation to provide proof that biodiesel blends can be used in diesel engines.

With the development of Malaysian standards for diesel and biodiesel, OEM and users of diesel vehicles concerns on fuel quality were allayed. The current implementation of B20 has been accepted by most vehicle manufacturers especially brands from Japan that constitute a majority of diesel vehicles in the market.

D. Philippines

National Plan for Biofuel (ethanol and biodiesel) Promotion

Republic Act (R.A.) No. 9367 otherwise known as the Biofuels Act of 2006, signed into law on 12 January 2007, is a landmark law which directed the use of biofuels as well as establishing the National Biofuels Program (NBP). The Biofuels Act was aimed to increase the contribution of biofuels in the country's energy mix by developing and utilising indigenous renewable and sustainably sourced clean energy sources, thereby reducing the country's dependence on imported fossil-based fuels, enhance the quality of the environment, and create opportunities for countryside socio-economic development.

The Act also created the National Biofuel Board (NBB), an inter-agency policy recommendatory body, whose main functions are to monitor the implementation of the NBP including the supply and utilisation of biofuel and biofuel-blends, review and recommend to the Department of Energy the adjustment in the mandated biofuel blends subject to the availability of locally sourced biofuels, amongst others.

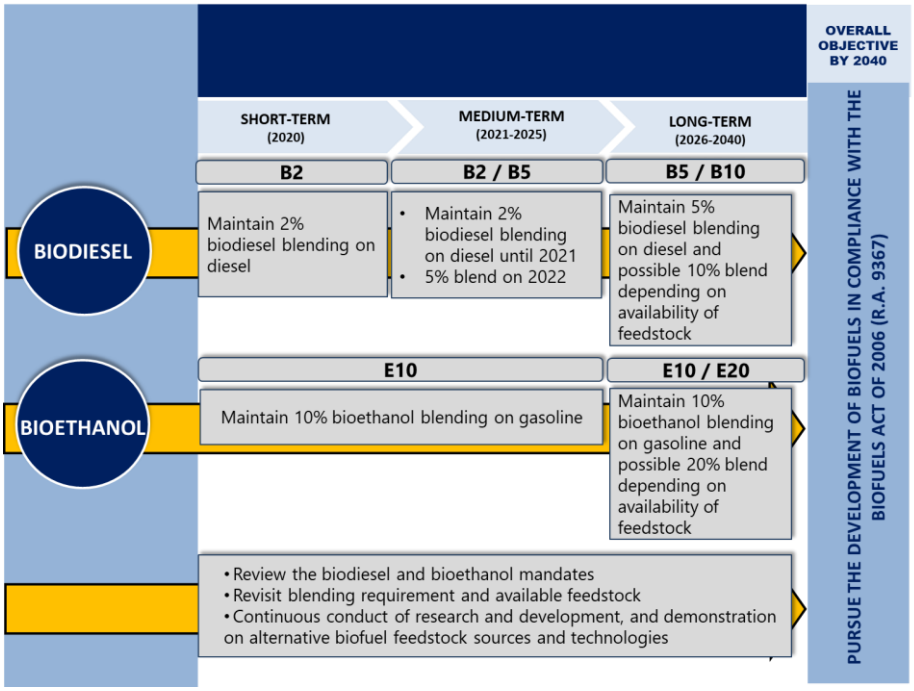
To address the growing concern on 'food versus fuel' being raised in the development and utilisation of biofuels in the country, the NBB has initiated the formulation of the Joint Administrative Order (JAO) No. 2008-1, Series of 2008, which provides the guidelines governing the biofuel feedstocks production, biofuels and biofuel blends production, distribution, and sale under the RA 9367. The guidelines were adopted by the NBB for the information, guidance, and compliance of all concerned stakeholders.

The Philippine Department of Energy (PDOE) is continuously embarking on research, development, and demonstration and deployment activities geared towards identifying viable and alternative feedstock for biofuel production in partnership with academic and research institutions and other industry stakeholders. There are other alternative biofuel feedstock sources that can be tapped and harnessed to address the issue on supply sustainability. Implementation of higher blend may also be hastened through the development of indigenous biofuel feedstock. In the case of biodiesel, feedstock sources include (a) jatropha, (b) waste cooking oil, (c) microalgae, and (d) rubber seed oil. While for bioethanol sources include (a) sweet sorghum, (b) cassava, (c) microalgae, (d) nipa sap, and (e) cellulosic materials, amongst others.

Several developmental issues encountered by the industry have contributed to the delays in the biofuel sector's road map, as shown in Figure 2.7 and Figure 2.8 (PDOE, 2021). It has always been a continuing challenge for the industry to sustain the level of production and supply to meet the growing demand, particularly in increasing the mandated biofuels' blend rates. The rise in demand of biofuels is always paralleled with the rise in demand for feedstock. The sustainability of feedstock, such as sugarcane and coconut oil for bioethanol and biodiesel production, respectively, poses a challenge for the industry specifically on the issue of food security and pricing. While pricing is also considered as a major factor that challenges the stability of the domestic biofuel industry with relatively higher per litre price of local biodiesel and bioethanol than gasoline and diesel. Thus, this affects the pump price of the transport fuel, which further

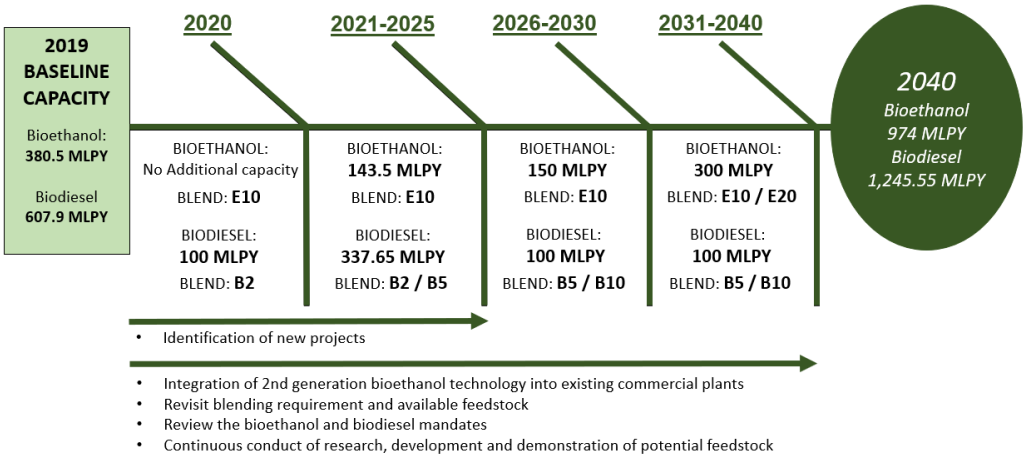
makes higher blends more expensive. The PDOE and NBB deemed it necessary to address these issues through a holistic analysis as the basis in finalising a decision to increase biofuel blend mandates.

Figure 2.7: Biofuel Road Map (2020–2040)



Source: PDOE (2021).

Figure 2.8: Biofuel Targets in Biofuel Road Map (2020–2040)



MLPY = million litres per year.
Source: PDOE (2021).

National Biofuel (ethanol and biodiesel) Standard and their Blends with Fossil Fuel

The 2% biodiesel (B2) and 10% bioethanol (E10) blend mandates were implemented starting 6 February 2011 and 5 February 2009, respectively, through the issuance of the Department Circular No. 2011-02-0001 also known as the Mandatory Use of Biofuel Blend pursuant to the Biofuels Act. Pursuant to Section 9.C of RA 9367 to wit:

The National Biofuel Board shall review and recommend to DOE the adjustment in the minimum mandated biofuels-blends subject to the availability of locally-sourced biofuel: Provided, That the minimum blend may be decreased only within the first four years from the effectivity of this Act. Thereafter, the minimum blends of 5% and 2% for bioethanol and biodiesel, respectively, shall not be decreased.

The Philippine National Standards (PNS) for Anhydrous Bioethanol and Bioethanol Fuel (PNS/DOE QS 007:2014) – E100 were formulated to address the technical requirements for biofuel grade ethanol in pure form and denatured use as blending component of automotive gasoline suitable for various types of automotive spark ignition engine and other similar types of engines. While the PNS for Coconut Methyl Ester (CME) – B100 was formulated to address the technical requirements for CME (B100) suitable for blending with diesel fuel for use in various types of compression ignition engines and other similar types of engines. The PDOE issued DC Nos. DC2015-07-0012 and DC2016-05-0006 to effectively implement the PNS for E100 and B100, respectively.

Further, in preparation for the increase in the biodiesel blend mandate from B2 to B5, the PNS was promulgated to address technical requirements for high FAME-blended diesel oils (B5) suitable for various types of diesel engines and other similar types of engines. The standard specification is not yet implemented since there is no mandate for B5 and shall support future energy policies towards the integration of higher biofuels blends in the petroleum sector.

Meanwhile, the PDOE, through its Oil Industry Management Bureau, is soliciting comments and inputs on the draft PNS for CME-blended automotive and industrial diesel Oils covering the biodiesel blends of 3% (B3) and 4% (B4) on or before 30 June 2021. The draft PNS was formulated in anticipation of a proposed gradual or calibrated increase in the biodiesel blend mandate, as initially recommended by the biodiesel industry stakeholders.

The PNS for higher bioethanol blends such as E15 and E20 are still to be developed . The PDOE through its Technical Committee on Petroleum Products and Additives shall formulate said specification to be used as standard for ethanol-blended gasoline fuel suitable for various types of gasoline engines.

Government Support and Incentives for Biofuel (ethanol and biodiesel)

Consistent with the objectives of the Biofuels Act, the PDOE encourages investments and provides fiscal incentives to entities engaged in the production of biofuels and biofuels feedstock. Under R.A. 9513 or the Renewable Energy Act of 2008, the Biofuels Act and its corresponding implementing rules and regulations, registered and/or accredited biofuel producers shall be

entitled to the privilege of availing various fiscal incentives as provided for in both Acts and the implementing rules and regulations, including but not limited to income tax holiday, zero-rated value added tax transactions, tax and duty-free importation of components, parts and materials, amongst others, subject to the biofuel producers' compliance to its obligations under the registration/accreditation with the PDOE and concerned national government agencies (NGAs).

In accordance with Section 17 of the Biofuels Act, the Social Amelioration Welfare Program has been institutionalised to provide the following services to qualified biofuel workers: (a) training and education, (b) livelihood assistance, (c) emergency assistance, and (d) social protection and welfare benefits. The Social Amelioration Welfare Program fund is sourced from the lien or the levy collected from PDOE-accredited biodiesel and bioethanol producers, and planters who are supplying sugarcane for bioethanol production. Lien from the biodiesel sector is equivalent to Php0.05 for every litre of coco methyl ester (biodiesel) produced and sold. While for the bioethanol sector which utilises sugarcane as feedstock, lien is equivalent to Php13.43 for every ton of sugarcane used as feedstock for bioethanol production, while Php0.07 per litre of molasses-based bioethanol produced and sold is the equivalent lien for bioethanol sector which utilises molasses as feedstock.

Biofuel Targets

Based on the PDOE's Biofuels Road Map, the biodiesel mandate shall be maintained at B2 until 2021 amidst developmental challenges and targeted to increase to B5 by 2022, with possible implementation until 2025 to cover the medium term. From 2026 to 2040, the target biodiesel blend rate will be at B10. With continued research and development, and resource assessment, an additional 200 million litres is targeted for the long-term period depending on the availability of feedstock.

On the other hand, the bioethanol mandate shall be maintained at E10 until 2025–2030 and possibly increased to higher blends such as E15 or E20 for the period of 2031–2040, depending on feedstock supply availability. Additional capacities are foreseen until 2025 as existing bioethanol producers are undertaking progressive optimisation of production and additional feedstock supply. For the period 2030–2040, possible capacity increase may reach 450 million litres per year, derived from non-food based and second generation feedstock and technologies. While maintaining the current blend mandates at B2 and E10 as well as utilising coconut and sugarcane and/or molasses as feedstock, respectively, the PDOE along with the NBB and other stakeholders shall revisit the biofuel blend requirements and available feedstock.

Biofuel (ethanol and biodiesel) Blending Acceptance by Vehicle Manufacturer

One of the identified developmental issues encountered in the biodiesel sector is the potential impact of higher biofuels blend to current vehicle fleets (both in-use and new) in terms of suitability to existing specifications. However, based on the PDOE-implemented actual on-road

testing using B5, initial results of the covered 17,000-kilometres distance showed a kilometre increase of about 10% for B5 as compared to B2.

Statistics of Biofuel (ethanol and biodiesel) Landscape

For bioethanol, the PDOE has 13 accredited local producers with a total rated production capacity of 425.5-MLPY as of June 2021, which is equivalent to about 52% of the volume requirement for the E10 mandate. While for biodiesel, PDOE has 13 accredited local producers as of June 2021, with a total rated production capacity amounting to 707.9-MLPY, about three-fold of the volume requirement for the B2 mandate. Thus, the biofuel industry situation in the Philippines shows a big gap in local ethanol supply where the deficit is filled in by importation sourced from the US, Brazil, Thailand, amongst others, while for biodiesel, there is excess capacity that are not fully utilised.

Further, total sales of local bioethanol for 2020 reached 276.74-ML or an increase of 63.87% as compared to the 2015 level. For biodiesel during the same period, local sales amounted to 160.42ML or a decrease of 20.02% in comparison to the 2015 level, as shown in Table 2.13 (PDOE, 2021). As a result of the pandemic which caused the drop in demand for gasoline and diesel, local sales for both bioethanol and biodiesel have registered a decrease of 22.17% and 26.25% from the 2019 levels, respectively.

Table 2.13: Bioethanol and Biodiesel Sales

Year	Bioethanol Sales (in million litres)	Biodiesel Sales (in million litres)
2015	168.88	200.57
2016	226.88	217.70
2017	234.61	203.53
2018	303.73	205.24
2019	355.55	217.52
2020	276.74	160.42

Source: PDOE (2021).

In terms of pricing, bioethanol producers refer to the Bioethanol Reference Price Index as circulated by the NBB, while biodiesel producers use current market price as basis in supply contract negotiations. Bioethanol price in 2015 ranging from PhP41.00–61.14/litre has slightly increased to about PhP48.00–66.00/litre as of end 2020. While biodiesel price in 2015 of around PhP43.00–72.00/litre has significantly fluctuated to about PhP 35.00–75.01/litre in 2020, as

shown in Table 2.14 (PDOE, 2021), with fossil fuel price counterpart shown in Table 2.15 (PDOE, 2021).

Table 2.14: Bioethanol and Biodiesel Sales

Year	Biodiesel Price Range (PhP)	Bioethanol Price Range (PhP)
2015	43.00 – 72.00	41.00 – 61.14
2016	42.50 – 85.00	49.00 – 63.10
2017	45.00 – 95.00	40.00 – 63.00
2018	40.00 – 90.75	38.00 – 58.15
2019	35.00 – 70.00	47.98 – 65.00
2020	35.00 – 75.01	48.00 – 66.00

Source: PDOE (2021).

Table 2.15: Gasoline and Diesel Sales

Year	**Sales /Actual Consumption/Demand (in million litres)**		**Average Price (PhP)**	
	Gasoline	Diesel	Gasoline	Diesel
2015	5,221	9,336	42.23	27.54
2016	5,741	10,321	39.80	25.36
2017	6,253	10,860	45.89	32.14
2018	6,441	11,207	54.41	43.02
2019	6,973	11,534	53.11	42.44
2020	5,936	9,786	48.25	35.12

Source: PDOE (2021).

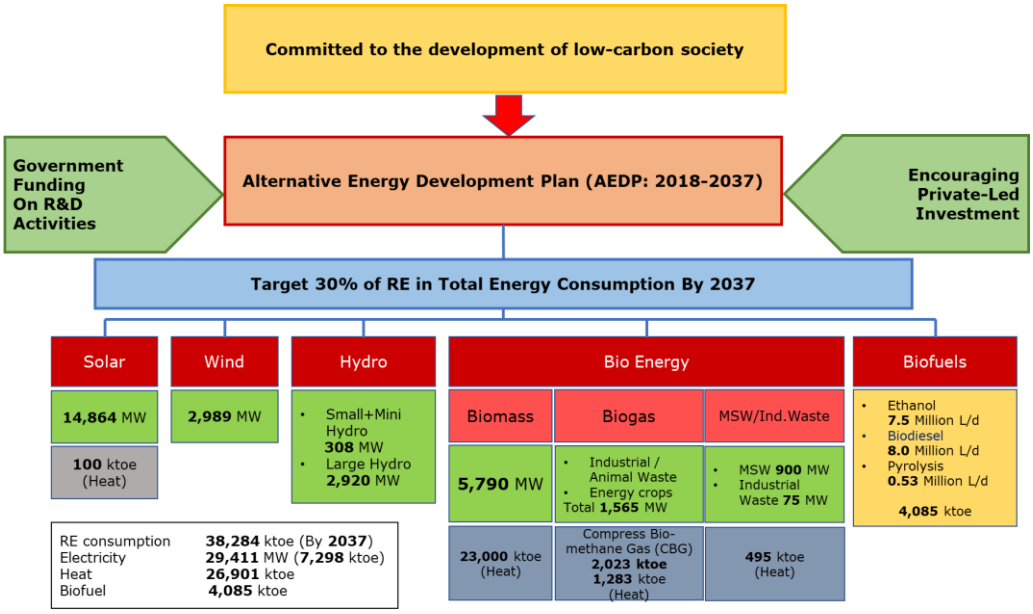
As of end 2020, the PDOE has 17 accredited oil industry participants, all of which are mandated to blend at B2 and E10 as per the Biofuels Act. Actual consumption of gasoline for 2020 reached 5,936 million litres or an increase of 13.69% as compared to the 2015 level. While for diesel during the same period, actual consumption amounted to 9,786 million litres or an increase of 4.82% as compared to the 2015 level. Due to the pandemic which heavily affected the transportation sector, demand for gasoline and diesel both registered a decrease of 14.87% and 15.16% from the 2019 levels, respectively.

As regard to average prices, gasoline was sold at around PhP42.23/litre in 2015 and has increased to PhP48.25/litre as of end 2020. While for diesel, the 2015 average price of PhP27.54/litre and has increased to about PhP35.12/litre in 2020.

E. Thailand

The first policy on renewable energy, with targets on biofuel for transportation, has dated back since 2008 under the Renewable Energy Development Plan (2008–2022), which was then revised with a name change to the Alternative Energy Development Plan (AEDP: 2012–2021). AEDP2012 was again revised as AEDP: 2015–2036 to align under the same 2015–2036 periods with other national energy plans, such as the Power Development Plan (PDP), the Energy Efficient Plan, the Gas Plan, and the Oil Plan. With recent trends in energy transition to digitalisation, where the consumer becomes the prosumer and electric vehicles have penetrated conventional vehicles, the current AEDP: 2018–2037 was launched with the same overall 30% renewable energy target in 2037 but decreasing biofuel target and increasing renewable electricity and heat targets, as shown in Figure 2.9 (DEDE, 2019).

Figure 2.9: Breakdown of Thailand Alternative Energy Development Plan



ktoe = kilotons of oil equivalent, L/d = litres per day, MW = megawatt, R&D = research and development, RE = renewable energy,

Source: AEDP (2018–2037).

The 2037 targets for bioethanol and biodiesel consumptions are 7.5 and 8.0 million litres/day, respectively, where 2019 average consumptions of bioethanol and biodiesel are 4.45 and 4.90 million litres/day, respectively (DEDE, 2019). Commercially available blends for bioethanol into gasoline are 0% (ULG), 10% (E10), 20% (E20), and 85% (E85); whereas biodiesel blends into diesel are 7% (B7), 10% (B10 or main diesel grade), and 20% (B20). Tables 2.16 and Table 2.17 show specifications for ethanol (DOEB, 2005) and their blends (DOEB, 2019a; DOEB, 2019b) with

gasoline; whereas Table 2.18 and Table 2.19 show those for biodiesel (DOEB, 2019c) and their blends (DOEB, 2020) with diesel, respectively.

Table 2.16: Specifications for Ethanol Standard

No.	Items	Unit	Value		Test method
1	Ethanol plus higher saturated alcohols,	% vol.	≥	99	EN 2870 Appendix 2 Method B
2	Higher saturated (C_3-C_5) mono alcohols,	% vol.	≤	2	EN 2870 Method lll
3	Methanol,	% vol.	≤	0.5	EN 2870 Method lll
4	Solvent Washed Gum,	mg/100mL	≤	5	ASTM D 381
5	Water,	% vol.	≤	0.3	ASTM E 203
6	Inorganic chloride,	mg/L	≤	20	ASTM D 512
7	Copper	mg/kg	≤	0.07	ASTM D 1688
8	Acidity as acetic acid,	mg/L	≤	30	ASTM D 1613
9	pHe		≥	6.5	ASTM D 6423
			and		
			≤	9	
11	Electrical conductivity,	µS/m	≤	500	ASTM D 1125
11	Appearance		Clear, No separation/colloid		Visual inspection
12	Additive		Approval by Director General		

Source: DOEB (2005).

Table 2.17: Specifications for Ethanol Blends with Gasoline Standard

No.	Items for E0 (ULG)	Unit	Value		Test method
1	Octane number				
	1.1 Research octane number; RON				ASTM D 2699
	(1) Producer		≥	95	
	(2) Dealer		≥	94.6	
	1.2 Motor octane number; MON				ASTM D 2700
	(1) Producer		≥	94	
	(2) Dealer		≥	83.6	
2	Lead	g/L	≤	0.005	ASTM D 5059
3	Sulphur	% wt.	≤	0.005	ASTM D 2622
4	Phosphorus	g/L	≤	0.0013	ASTM D 3231
5	Silver strip corrosion		≤	Number 1	ASTM D 7671
6	Oxidation stability	minutes	≥	360	ASTM D 525
7	Solvent washed gum	mg/100 mL	≤	4	ASTM D 381
8	Distillation	°C			ASTM D 86
	8.1 Temperature				
	(1) 10% Evaporated		≤	70	
	(2) 50% Evaporated		≥	70	
			and		
			≤	110	
	(3) 90% Evaporated		≤	170	
	(4) End point		≤	200	
	8.2 Residue	% vol.	≤	2	
9	Vapour pressure at 37.8°C	kPa	≤	62	ASTM D 5191
10	Benzene	% vol.	≤	1	ASTM D 5580

No.	Items for E0 (ULG)	Unit	Value		Test method
11	Aromatics	% vol.	≤	35	ASTM D 5580
12	Olefins	% vol.	≤	18	ASTM D 6839
13	Colour				
	13.1 Hue			Yellow	
	13.2 Intensity		≥	0.5	ASTM D 1500
			and		
			≤	1.5	
14	Water	% wt.	≤	0.7	ASTM E 204
15	Oxygenate	% vol.	≥ and ≤	5.5	ASTM D 4815
	MTBE (Methyl tertiary butyl ether) or other oxygenates that are approved by the Department of Energy Business				
				11	
16	Appearance		Clear, No separation/colloid		Visual inspection
17	Detergent additive				
	17.1 Port fuel injector		Approval by Director General		
	17.2 Intake valve		Approval by Director General		
18	Other additives, if any		Approval by Director General		

No.	Items for E10-E20	Unit		Gasohol E10		Gasohol E20	Test method
				Octane 91	Octane 95		
1	Octane number						
	1.1 Research octane number; RON						ASTM D 2699
	(1) Producer		≥	91	95	95	
	(2) Dealer		≥	90.6	94.6	94.6	
	1.2 Motor octane number; MON						ASTM D 2700
	(1) Producer		≥	80	84	84	
	(2) Dealer		≥	79.6	83.6	83.6	
2	Lead	g/L	≤	0.005	0.005	0.005	ASTM D 5059
3	Sulphur	% wt.	≤	0.005	0.005	0.005	ASTM D 2622
4	Phosphorus	g/L	≤	0.0013	0.0013	0.0013	ASTM D 3231
5	Silver strip corrosion		≤	Number 1	Number 2	Number 3	ASTM D 7671
6	Oxidation stability	minutes	≥	360	360	360	ASTM D 525
7	Solvent washed gum	mg/100 mL	≤	4	4	4	ASTM D 381
8	Distillation	°C					ASTM D 86
	8.1 Temperature						
	(1) 10% Evaporated		≤	70	70	65	
	2) 50% Evaporated		≥	70	70	65	
			and				
			≤	110	110	110	

No.	Items for E10-E20	Unit		Gasohol E10		Gasohol E20	Test method
				Octane 91	Octane 95		
	(3) 90% Evaporated		≤	170	170	170	
	(4) End point		≤	200	200	200	
	8.2 Residue	% vol.	≤	2	2	2	
9	Vapour pressure at 37.8°C	kPa	≤	62	62	64	ASTM D 5191
10	Benzene	% vol.	≤	1	1	1	ASTM D 5580
11	Aromatics	% vol.	≤	35	35	35	ASTM D 5580
12	Olefins	% vol.	≤	18	18	18	ASTM D 6839
13	Colour						ASTM D 1500 or
	13.1 Hue			Green	Orange	Brown	ASTM D 2392
	13.2 Dye	mg/L	≥	4	10.0	20.0	
14	Water	% wt.	≤	0.7	0.7	0.7	ASTM E 203
15	Denatured ethanol	% vol.	≥	9	9	19	ASTM D 4815
			and				
			≤	10	10	20	
16	Oxygenates		Approval by Director General				ASTM D 4815
17	Appearance		Clear, No separation/colloid				Visual inspection
18	Detergent additive						
	18.1 Port fuel injector		Approval by Director General				
	18.2 Intake valve		Approval by Director General				
19	Other additives, if any		Approval by Director General				

No.	Items for E85	Unit		Gasohol E85	Test method
1	Octane number				
	1.1 Research octane number; RON				ASTM D 2699
	(1) Producer		≥	95	
	(2) Dealer		≥	94.6	
	1.2 Motor octane number; MON				ASTM D 2700
	(1) Producer		≥	95	
	(2) Dealer		≥	84.6	
2	Lead	g/L	≤	0.005	ASTM D 5059
3	Sulphur	% wt.	≤	0.005	ASTM D 2622
4	Phosphorus	g/L	≤	0.0013	ASTM D 3231
5	Silver strip corrosion		≤	Number 1	ASTM D 7671
6	Oxidation stability	minutes	≥	360	ASTM D 525
7	Solvent washed gum	mg/100 mL	≤	5	ASTM D 381
8	Distillation	°C			ASTM D 86
	8.1 End point		≤	200	
	8.2 Residue	% vol.	≤	2	
9	Vapour pressure at 37.8°C	kPa	≥	35	ASTM D 5191
			and		
			≤	70	
10	Benzene	% vol.	≤	1	ASTM D 5580
11	Aromatics	% vol.	≤	35	ASTM D 5580
12	Olefins	% vol.	≤	18	ASTM D 6839
13	Colour				ASTM D 1500
	13.1 Hue			Purple	or
	13.2 Dye		≥	20	ASTM D 2392
14	Water	% wt.	≤	0.7	ASTM E 203

No.	Items for E85	Unit		Gasohol E85	Test method
15	Denatured ethanol	% vol.	≥	75	ASTM D 5501
16	Hydrocarbon/aliphatic ether	% vol.	≥	14	[(100-(water + alcohol)]
			and		
			≤	25	
17	Methanol	% vol.	≤	0.5	ASTM D 5501
18	Higher	% vol.	≤	2	ASTM D 4815
19	Acidity calculated as acetic acid	mg/L	≤	30	ASTM D 1613
20	Inorganic chloride	mg/L	≤	1	ISO 6227
21	pHe		≥	6.5	ASTM D 6423
			and		
			≤	9	
22	Copper	mg/kg	≤	0.07	ASTM D 1688
23	Appearance		Clear, No separation/colloid		Inspection by eyes
24	Detergent additive				
	24.1 Port fuel injector		Approval by Director General		
	24.2 Intake valve		Approval by Director General		
25	Other additives, if any		Approval by Director General		

Source: DOEB (2019a, 2019b).

Table 2.18: Specifications for Biodiesel Standard

No.	Items for B100	Unit	Value		Method
1	Methyl esters	% wt	≥	96.5	EN 14103
2	Density at 15°C	kg/m³	≥	860	ASTM D 1298
			and		
			≤	900	
3	Viscosity at 40°C	cSt	≥	3.5	ASTM D 445
			and		
			≤	5	
4	Flash point	°C	≥	120	ASTM D 93
5	Sulphur	% wt.	≤	0.001	ASTM D 2622
6	Carbon residue on 10% distillation residue	% wt.	≤	0.3	ASTM D 4530
7	Cetane number		≥	51	ASTM D 613
8	Sulphated ash	% wt.	≤	0.02	ASTM D 874
9	Sulphated ash	% wt.	≤	500	EN ISO 12937
10	Total contamination	mg/kg	≤	25	EN 12662
11	Copper strip corrosion		≤	No.1	ASTM D 130
12	Oxidation stability at 110°C	hours	≥	10	EN 15751
13	Acid value	mg KOH/g	≤	0.5	ASTM D 664
14	Iodine value	g Iodine/100g	≤	120	EN 14111
15	Linolenic acid methyl ester	% wt.	≤	12	EN 14103
16	Methanol	% wt.	≤	0.2	EN 14110
17	Monoglyceride	% wt.	≤	0.4	EN 14105
18	Diglyceride	% wt.	≤	0.2	EN 14105
19	Triglyceride	% wt.	≤	0.2	EN 14105
20	Free glycerine	% wt.	≤	0.02	EN 14105

No.	Items for B100	Unit	Value		Method
21	Total glycerine	% wt.	≤	0.25	EN 14105
22	Group I metals; Na + K	mg/kg	≤	5	EN 14538
	Group II metals; Ca + Mg	mg/kg		5	EN 14538
23	Phosphorus	% wt.	≤	0.001	EN 14107
24	Cloud point	°C	report		
25	Cloud flow plugging point	°C	report		
26	Additives, if any		Approval by Director General		

Source: DOEB (2019c).

Table 2.19: Specifications for Biodiesel-blended Diesel Standard

No.	Items	Unit		Diesel				Method
				High speed			Low	
				Normal	B7	B20	speed	
1	Specific gravity at 15.6/15.6	°C	≥	0.81	0.81	0.81	-	ASTM D1298
			and					
			≤	0.87	0.87	0.87	0.92	
2	Cetane number		≥	50	50	50	0.92	ASTM D613
	or Calculated cetane index							ASTM D976
3	Viscosity	cSt						
	3.1 at 40°C		≥	1.8	1.8	1.8	-	
			and					
			≤	4.1	4.1	4.1	8	
	3.2 at 50°C		≤	-	-	-	7	
4	Pour point	°C	≤	10	10	10	16	ASTM D97
5	Sulphur							ASTM D2622

No.	Items	Unit		Diesel				Method
				High speed			Low	
				Normal	B7	B20	speed	
	Before 1 Jan 2024	mg/kg	≤	50	50	50	-	
		% wt	≤	-	-	-	1.5	
	From 1 Jan 2024 onwards	mg/kg	≤	10	10	10	-	
		% wt	≤	-	-	-	1.5	
6	Copper strip corrosion		≤	No.1	No.1	No.1	-	ASTM D 130
7	Oxidation stability	g/m^3	≤	25	25	25	-	ASTM D2274
		hours	≤	35	35	35	-	EN 15751
8	Carbon residue on 10% distillation	% wt	≤	0.3	0.3	0.3	-	ASTM D4530
9	Water and sediment	% vol.	≤	-	-	-	0.3	ASTM D2709
10	Water	% vol.	≤	200	300	300	-	EN ISO 12937

No.	Items	Unit		Diesel				Method
				High speed			Low	
				Normal	B7	B20	speed	
11	Total contamination	mg/kg	≤	24	24	24	-	EN 12662
12	Ash	% wt.	≤	0.01	0.01	0.01	0.02	ASTM D 482
13	Flash point	°C	≤	52	52	52	52	ASTM D 93
14	Distillation	°C						ASTM D 86
	90% Recovered	°C	≤	35.7	35.7	35.7	-	
15	Polycyclic aromatic hydrocarbon	% wt.						
	Before 1 Jan 2021		≤	11	11	11	-	
	From 1 Jan 2021 onwards		≤	8	8	8	-	

No.	Items	Unit		Diesel				Method
				High speed			Low	
				Normal	B7	B20	speed	
16	Colour							
	16.1 Hue			Purple	Yellow	Red	Brown	ASTM D1500
								ASTM D2392
	16.2 Intensity		≥	equivalent standard color	-	equivalent standard color	4.5	
			and					
			≤		4		7.5	
17	Methyl ester of fatty acids	% vol.	≥	9	6.6	19	-	EN 14078
			and					
			≤	10	7	20	-	
18	Lubricity wear scar	micrometer	≤	460	460	460	-	CEC F-06-96
19	Additive, if any			Approval by Director General				

Source: DOEB (2020).

As biofuels (both bioethanol and biodiesel) are often more expensive than fossil fuel, the Thai Ministry of Energy has a cross-subsidy mechanism though the Oil Fund, which is levied from non and/or low-biofuel blend to subsidise high-biofuel blend, without interfering with the national budget. Another fund, the Energy Conservation Fund, collects all commercial fuel grades for usage in research and development to promote renewable energy. The levies and subsidies are periodically adjusted by the Committee on Energy Policy Administration chaired by the Minister of Energy to ensure that the Oil Fund is stable enough for future subsidy of biofuel. As shown in Table 2.20 (EPPO, 2021), the price structure of various fuels is composed of ex-refinery price (Ex-Refin) as a starting point with excise tax and municipal tax levied on the fossil portion only prior to Oil Fund and Energy Conservation Fund levied before the wholesale price can be determined. A marketing margin is allowable ceiling for fuel retailers.

Table 2.20: Price Structure of Petroleum Products in Bangkok (28 June 2021)

Unit: baht/litre	Ex-Refinery (Average)	Tax baht/Litre	Municipal Tax baht/litre	Oil Fund	Energy Conservation Fund	Wholesale Price	VAT	WS & VAT	Marketing Margin	VAT	Retail
ULG	17.1621	6.5000	0.6500	6.5800	0.1000	30.9921	2.1694	33.1615	3.0827	0.2158	36.46
GASOHOL95 E10	17.8204	5.8500	0.5850	0.6200	0.1000	24.9754	1.7483	26.7236	2.1742	0.1522	29.05
GASOHOL91	17.4255	5.8500	0.5850	0.6200	0.1000	24.5805	1.7206	26.3011	2.3167	0.1622	28.78
GASOHOL95 E20	18.3502	5.2000	0.5200	-2.2800	0.1000	21.8902	1.5323	23.4225	3.8481	0.2694	27.54
GASOHOL95 E85	23.5283	0.9750	0.0975	-7.1300	0.1000	17.5708	1.2300	18.8008	3.5413	0.2479	22.59
H-DIESEL B7	17.3927	5.9900	0.5990	1.0000	0.1000	25.0817	1.7557	26.8374	2.0118	0.1408	28.99
H-DIESEL	17.8315	5.8000	0.5800	-2.5000	0.1000	21.8115	1.5268	23.3383	2.4783	0.1735	25.99
H-DIESEL B20	19.6599	5.1530	0.5153	-4.1600	0.1000	21.2682	1.4888	22.7570	2.7879	0.1952	25.74

Exchange Rate	=	31.9591	Baht/$
Ethanol Reference Price	=	25.84	Baht/Litre
Biodiesel (B100) Reference Price	=	34.47	Baht/Litre

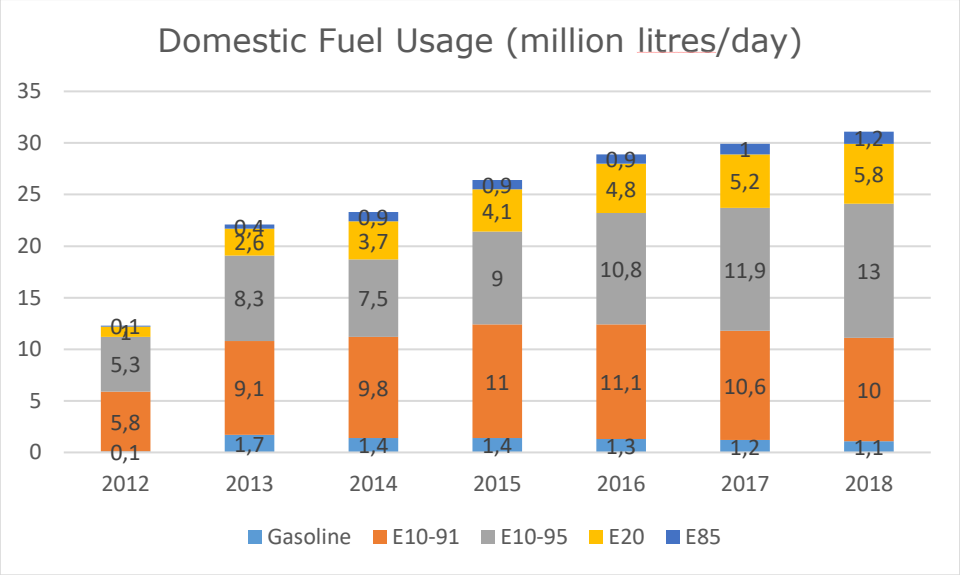
ULG = unleaded gasoline, VAT = value added tax, WS = wholesale.
Source: EPPO (2021).

As shown in Figure 2.9, 2037 targets for bioethanol and biodiesel consumption are 7.5 and 8.0 million litres/day, respectively, where approximately 60% of targets were achieved in 2019 from the average consumption of bioethanol and biodiesel of 4.45 and 4.90 million litres/day, respectively (DEDE, 2019). There are no official periodic targets along the way to 2037.

As for biofuel blending acceptance by vehicle manufacturers, most gasoline vehicles accept E10 with those models after 2008 compatible with E20 due to government incentives to reduce 5% excise tax for E20-compatible vehicles; whereas pure gasoline (ULG or E0) is commercially available for old vehicles that cannot accept ethanol blending. As for biodiesel blending, mandatory blending was enforced since May 2011, so vehicles have been compatible with blending of biodiesel. The blending level was increased to 7% in January 2014 and optional B20 launched in July 2018, followed by optional B10 in May 2019. Since October 2020, the main diesel grade is B10 with optional B7 and B20 available. Official diesel vehicle acceptance for B10 and B20 is shown with biodiesel-blended diesel standard (DOEB, 2020).

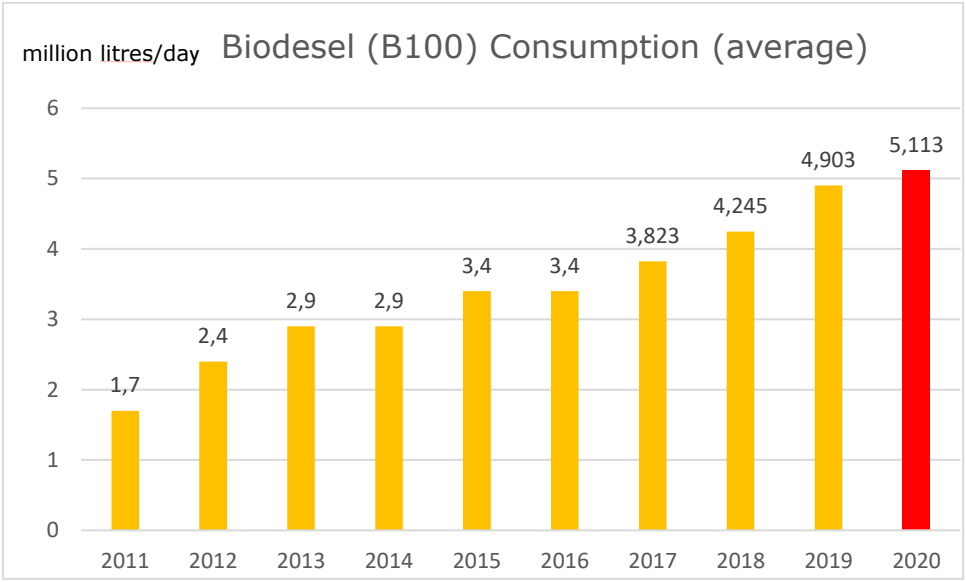
As for biofuel statistics, Figure 2.10 shows consumption of ethanol and various grades of ethanol-blended gasoline (DOEB, 2021); whereas Figure 2.11 shows consumption of diesel and various grades of biodiesel-blended diesel (DOEB, 2021).

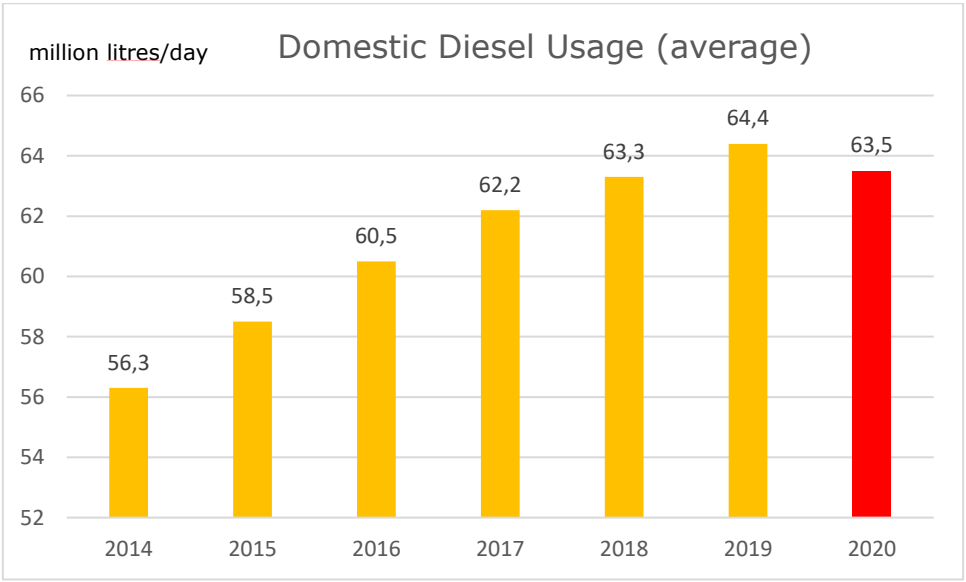
Figure 2.10: Consumption of Ethanol and Various Grades of Ethanol-blended Gasoline



Source: DOEB (2021).

Figure 2.11: Consumption of Biodiesel and Various Grades of Biodiesel-blended Diesel





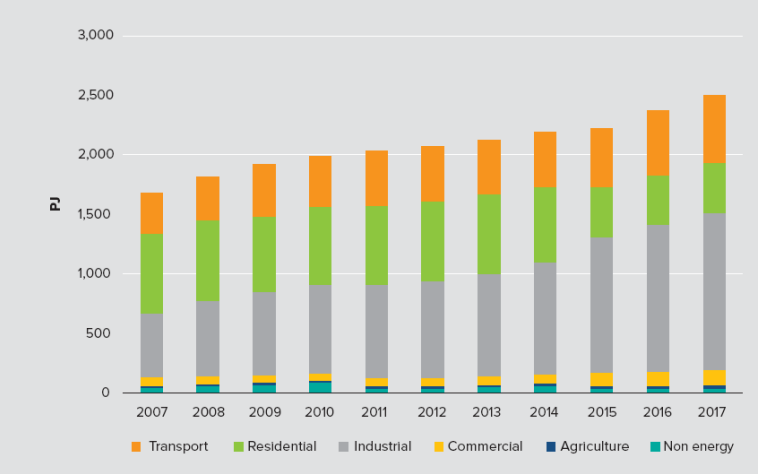
Source: DOEB (2021).

F.Viet Nam

Viet Nam is a country with a population of 96.48 million in 2019 and an area of 331,236 square kilometres (General Statistics Office of Vietnam, 2019). For decades Viet Nam has been one of the fastest growing economies in the region and in the world. From 2011 to 2019, the average gross domestic product (GDP) growth was 6.3% per annum, reaching 7.0% in 2019 (World Bank, 2021). In 2020, despite COVID-19, Viet Nam's economy has remained resilient, expanding by 2.9% in 2020—one of the highest growth rates in the world (IMF, 2021). The economic growth resulted in an increase in energy consumption. During 2007–2017, the total final energy

consumption increased from 1,691 petajoules in 2007 to 2,500 petajoules in 2017, with a growth rate of 4.0% per annum (EREA and DEA, 2019). As shown in Figure 2.12, the industrial sector shows the largest average annual growth during the period (9.3%), followed by the commercial and transport sectors with 6.4% and 5.2% per annum, respectively.

Figure 2.12: Trends for Total Final Energy Consumption, 2007–2017



PJ = petajoule.
Source: EREA and DEA (2019).

Economic development has been the key to improvements in the quality of life and has resulted in a dramatic drop in the poverty rate. While economic growth is high priority for the government, government strategies emphasise that the fast development needs to uphold sustainability at the same time.

The Government of Viet Nam has several key policies for sustainable energy development with four main pillars: energy efficiency, renewable energy, energy market, and climate change. The current main policy targets for renewable energy, energy efficiency, and greenhouse gas emissions are listed in Table 2.21 (EREA and DEA, 2019).

Table 2.21: Specific Targets in Current Energy and Climate Policy, Viet Nam

Target	2020	2025	2030	2050
Renewable energy				
RE share in primary energy supply	31%		32%	44%
RE share in total electricity generation	38%* 4% excl. hydro		32%* 15% excl. hydro	43%* 33% excl. hydro
Energy efficiency as compared to business-as-usual				
Final energy demand saving		5-7%	8-10%	
GHG emissions reduction as compared to business-as-usual				
Green growth strategy	10–20%		20-30%	
Intended Nationally Determined Contributions			8% (unconditional) 25% (conditional)	
Energy sector	5%		25%	45%

* Including small and large hydro power, wind power, solar power, biomass, biogas, and geothermal energy.
GHG = greenhouse gas, RE = renewable energy.
Source: EREA and DEA (2019).

Viet Nam, assisted by the World Bank, published its renewable energy action plan in 2002, which aimed to develop renewable energy that included renewable energy policy and institutional development and other technical and business support from government and international assistance (World Bank, 2002).

With the domestic potential of biomass feedstock and renewable energy sources, in 2007 the government approved the Decision 1855/QD-TTg on National Energy Development Strategy to 2020, with a vision to 2050. This strategy plans to develop new and renewable energies and set the target for new and renewable energy shares to 5% of primary commercial energy in 2020, and 11% by 2050, respectively.

For biofuel development and utilisation, in 2007 the government issued Decision 177/2007/QD-TTg approving the scheme on development of biofuels up to 2015, with a vision to 2025 that aims to promote biofuel for use as an alternative to partially replace conventional fossil fuels,

contributing to assuring energy security and environmental protection. The main tasks of the scheme comprise:

·Conducting scientific research and technological development, deploying trial production of products to serve biofuel development.

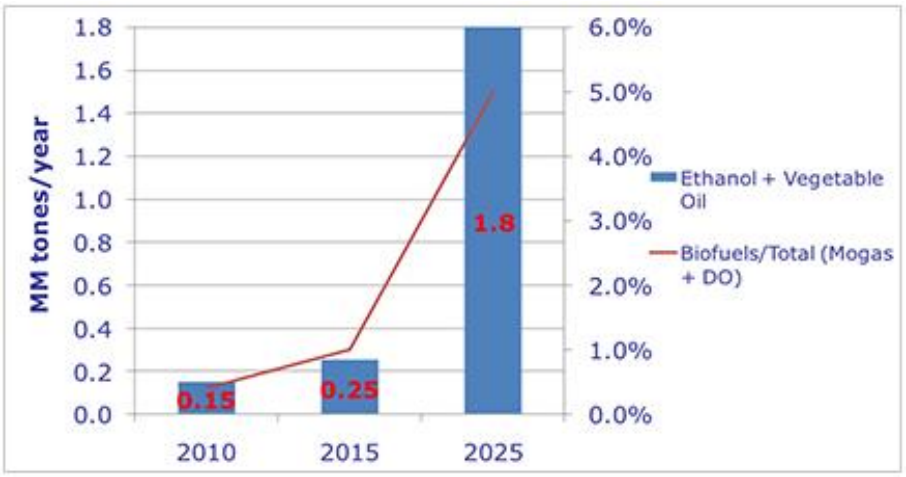
·Founding and developing the biofuel production industry

·Building biofuel development potential

·International cooperation in research and development, technology transfer, and application for biofuel production and utilisation

The scheme states that the output of ethanol and vegetable oil will reach 250,000 tons (enough for blending 5 million tons of E5 and B5), satisfying 1% of the whole country's fuel demand by 2015, and reach 1.8 million tons, satisfying about 5% of the whole country's fuel demand by 2025, as shown in Figure 2.13. The Ministry of Industry and Trade, in coordination with concerned ministries, is responsible for the development and implementation of the government's policy for biofuels, while the Ministry of Planning and Investment and the Ministry of Finance are responsible for policies on tax and investment incentives.

Figure 2.13: Expected Ethanol and Vegetable Oil Production According to Decision 177/2007/QD-TTg



MM = metric million.
Source: The Prime Minister of Vietnam (2007).

To boost the consumption of biofuel, especially bioethanol, Decision 53/2012/QD-TTg on the road map for application of ratios for blending biofuels with traditional fuels was issued in 2012. This decision laid out a road map to commercialise E5 in seven big cities (Hanoi, Ho Chi Minh City, Hai Phong, Danang, Can Tho, Quang Ngai, and Ba Ria-Vung Tau) beginning in December 2014 and nationwide from December 2015. This decision also set a target for E10 commercialisation in the above seven cities beginning in December 2016, and nationwide from December 2017.

In 2015, the government issued Directive No. 23/CT-TTg on enhancement of the use, blending, and distribution of ethanol-gasoline blends in order to implement Decision 53/2012/QD-TTg. It is noted that biodiesel has not been mentioned in the decision due to it still not being commercially available on the market. In order to encourage the use of E5 (and E10 in the future), according to Law No. 70/2014/QH13 issued in 2014 amending and supplementing the Law on Special Consumption Tax (SCT), the SCT for E5 is 8% and E10 is 7%, while the SCT for gasoline is 10%. Also, the Environment Protection Tax on E5 is 5% lower than that for gasoline. Moreover, to protect domestic ethanol production, the tax imposed on imported ethanol was high at 20% in 2014, but has been reduced to 15% since October 2020 based on Decree 57/2020/ND-CP. Table 2.22 shows various taxes on ethanol and gasoline.

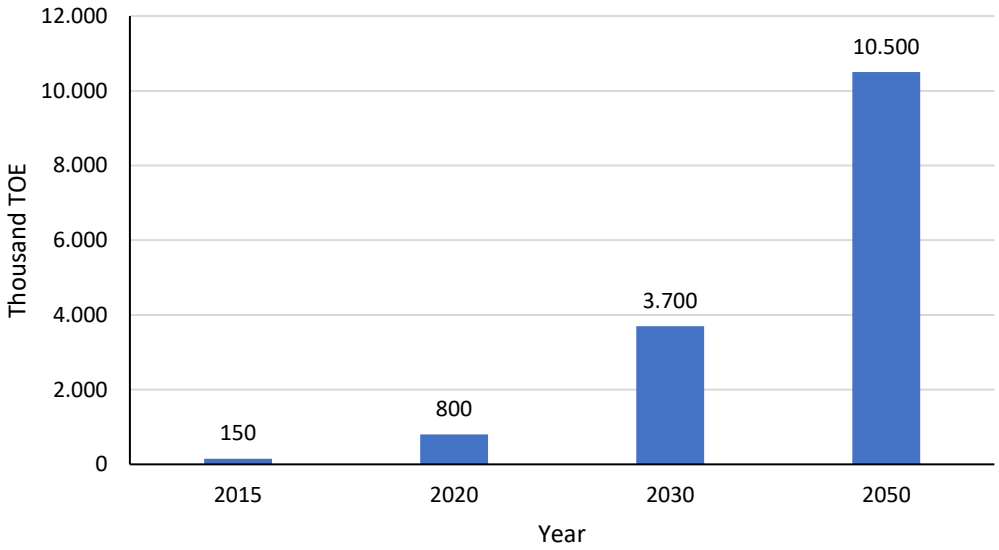
Table 2.22: Current Taxes on Ethanol and Gasoline

Tax	**E5 RON92**			**Gasoline RON95**
		Ethanol	**Gasoline RON92**	
Import tax	Most Favoured Nation (MFN)	15%	20%	20%
	Vietnam–Korea Free Trade Agreement (VKFTA)	0%	10%	10%
	ASEAN Trade in Goods Agreement (ATIGA)	0%	20%	20%
Value Added Tax (VAT)	10%			10%
Special Consumption Tax (SCT)	8%			10%
Environmental Protection Tax (EPT)	D3,800/litre			D4,000/litre

Source: USDA (2020).

In 2015 the government also issued Decision No. 2068/QĐ-TTg, a further plan – the Viet Nam's Renewable Energy Development Strategy up to 2030 with an outlook to 2050. As part of this strategy biofuels are expected to be produced from approximately 150,000 tons of oil equivalent (TOE) in 2015 to about 800,000 TOE, i.e. 5% of the transport sector's fuel demand in 2020; 3.7 million TOE, i.e. 13% of transport sector's fuel demand in 2030; and 10.5 million TOE, i.e. 25% of the transport sector's fuel demand in 2050, as shown in Figure 2.14.

Figure 2.14: Expected Biofuel Production According to Decision No. 2068/QĐ-TTg



TOE = tons of oil equivalent.
Source: Decision of The Prime Minister of Vietnam (2015). About Development Strategy of Renewable Energy of Vietnam by 2030 with a Vision to 2050. https://policy.asiapacificenergy.org/node/3447

In order to control and monitor biofuel quality, the government has issued and implemented several national standards and national regulation technical regulations on ethanol, biodiesel, and their blends with fossil fuel:

·TCVN 7716:2011 – Denatured fuel ethanol for blending with gasolines for use as automotive spark-ignition engine fuel – specification and test methods

·TCVN 7717:2007 – Biodiesel fuel blend stock (B100) – specification

·TCVN 10625:2014 – Undenatured fuel ethanol for blending with gasolines for use as automotive spark-ignition engine fuel – specification and test methods

·TCVN 8063:2015 – 5% ethanol unleaded gasoline blends – specification and test methods

·TCVN 8064:2015 – 5% fatty acid methyl esters blended diesel fuel oils –specification and test method

·TCVN 8401:2015 – 10% ethanol unleaded gasoline blends – specification and test methods

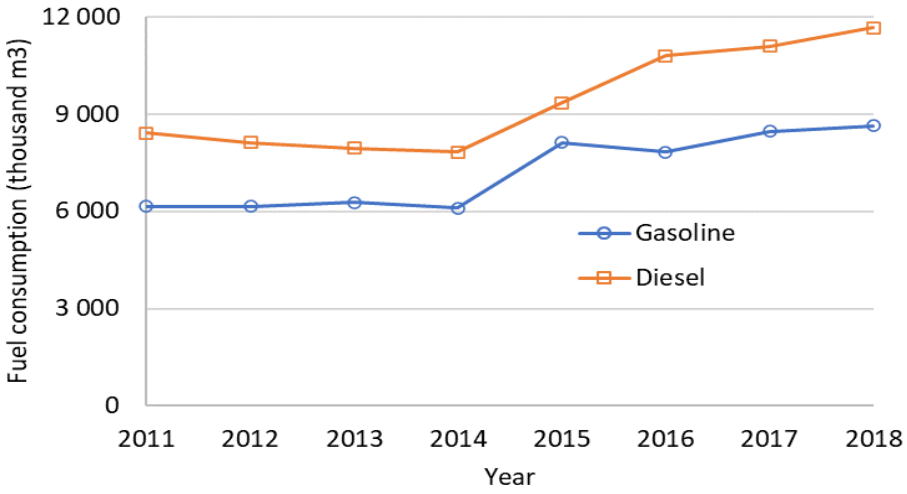
·QCVN 01:2015/BKHCN and amending 1:2017 QCVN 01:2015/BKHCN – National technical regulation on gasolines, diesel fuel oils, and biofuels

·QCVN 02: 2014/BCT – National technical regulation on equipment, auxiliaries for storing and dispensing ethanol blended gasoline – gasohol E10 at filling station

The government also issued Decision No.49/2011/QD-TTg providing a road map for the application of exhaust emissions standards to manufactured, assembled, and imported new cars and motorbikes. According to this road map, newly manufactured, assembled, and imported cars shall meet Euro 4 norms from 1 January 2017, then Euro 5 norms from 1 January 2022 onwards. Newly manufactured, assembled, and imported motorbikes shall meet Euro 3 norms from 1 January 2017 onwards to be eligible for registration in Viet Nam. To meet the requirement of the road map for vehicle emissions standards, the national fuel standards and regulations have been updated and supplemented.

The economic growth leads to the growth in fuel consumption. In recent years, Viet Nam has consumed about 20 million cubic metres (m^3) of gasoline and diesel fuels annually in which gasoline contributes to about 42% of the total, as shown in Figure 2.15 (EIA, 2021).

Figure 2.15: Fuel Consumption in Viet Nam, 2011–2018



m^3 = cubic metre.
Source: EIA (2021).

Concerning biofuel, in Viet Nam the main feedstock for ethanol production is cassava. The cassava growing area nationwide is about 550,000 hectares (ha), the average yield in 2016 is about 20 tons/ha, with many regions having achieved high yields of over 50 tons/ha.

Cassava production reached 10.7 million tons in 2015, 10.1 million tons in 2019 and the target is 16.5 million tons in 2030 for starch processing, export, and biofuel production serving food needs (domestic and export) as well as feedstock for ethanol production (General Statistics Office of Vietnam, 2019; Vietnam Economic News, 2017).

In order to provide sufficient ethanol for E5 and E10 blending that should follow the road map, Viet Nam has built seven ethanol plants as listed in Table 2.23 (General Statistics Office of Vietnam, 2019), with a total design capacity of about 600,000 m^3 per year. However, five plants have halted production due to inefficiencies and financial losses.

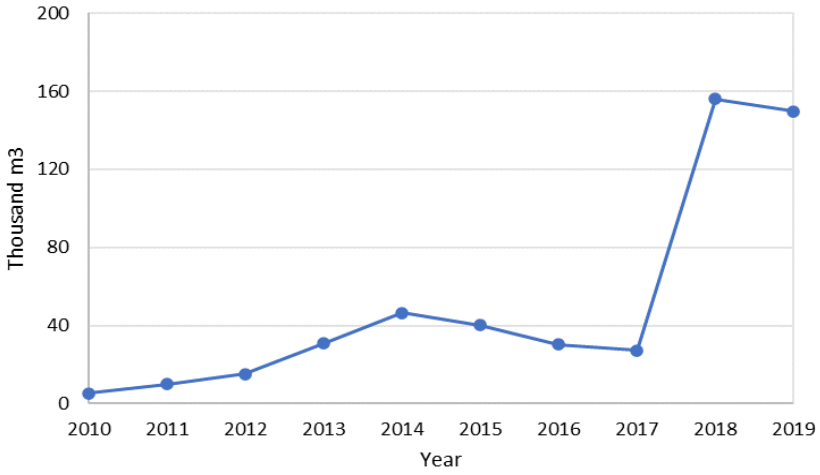
Table 2.23: Ethanol Plants in Viet Nam

No.	**Name of Plant**	**Province**	**Capacity (1,000m^3/y)**	**Status**
1	Tam Nong Bioethanol plant	Phu Tho	100	In construction
2	Dai Tan Bioethanol plant	Quang Nam	120	In operation
3	Dung Quat Bioethanol plant	Quang Ngai	100	Not in operation
4	Binh Phuoc Bioethanol plant	Binh Phuoc	100	Not in operation
5	Dak To Bioethanol	Kon Tum	65	Not in operation
6	Dai Viet Bioethanol plant	Dak Nong	60	Not in operation
7	Tung Lam Co.	Dong Nai	75	In operation

m^3 = cubic metre.
Source: General Statistics Office of Vietnam (2019).

Even though the road map for application of ethanol-gasoline blends was issued and there are several policies to promote the utilisation of the blends, in some localities, customers still ignored E5 fuel, due to weak dissemination on the new energy, the lack of retail stations, and difficult production and distribution. Actually, it was not until January 2018 that gasoline research octane number (RON)92 was banned, and only E5 RON92 and gasoline RON95 have been produced and available for purchase so far, following Notification No. 255/TB-VPCP issued by the government in 2017. Ethanol production, therefore, increased significantly in 2018, as shown in Figure 2.16 (Adapted from World Data Atlas, 2019).

Figure 2.16: Ethanol Production in Viet Nam

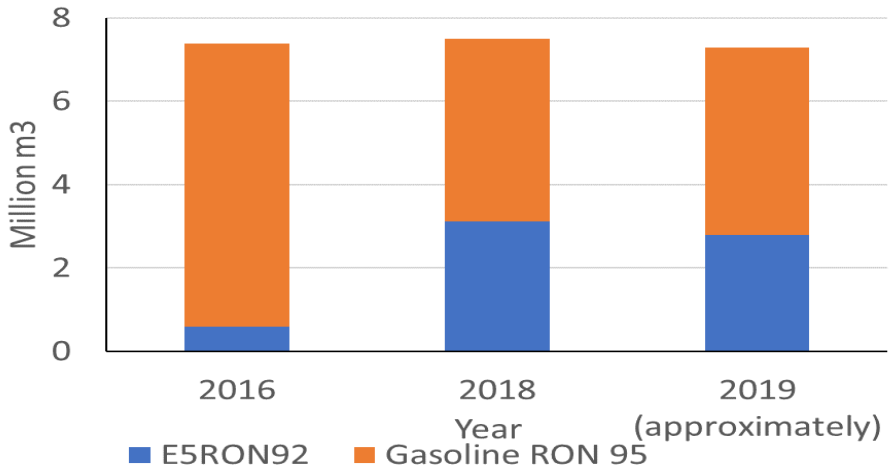


Source: Adapted from World Data Atlas (2019).

In 2016, total gasoline consumption in Viet Nam reached about 7.4 million m^3, of which, E5 RON92 was about 0.590 million m^3, accounting for 8% of the total amount of gasoline consumed in the market; and gasoline was about 6.81 million m^3, accounting for about 92%. In the composition of gasoline, gasoline RON95 accounted for about 2.043 million m^3, equivalent to 30% of the total amount of gasoline, and gasoline RON92 accounted for about 4.767 million m^3, equivalent to 70% of the total amount of gasoline. Total ethanol fuel consumed in 2016 was about 29 500 m^3 (MOIT, 2017).

When gasoline RON92 was banned in 2018, E5 RON92 consumption increased up to 3.12 million m^3, accounting for 42% of total gasoline consumption. In 2019, however, E5 consumption tended to decrease slightly, accounting for approximately 38% of total gasoline consumption, and in 2020 it still decreased, leading to a low demand for bioethanol, as shown in Figure 2.17 (Vietnamnet, 2019).

Figure 2.17: Share of E5 Fuel in Total Gasoline Consumption



M^3 = cubic metre, RON = research octane number.
Source: Vietnamnet (2019).

The decline in sales of E5 RON92 was attributed to a narrow gap between conventional gasoline and E5 prices, making E5 less attractive to price sensitive consumers. Currently, the E5 RON 92 and RON95-III price gap is D1,110 ($0.049) per litre as shown in Table 2.24, which is not sufficient to shift consumers' buying patterns (Petrolimex, 2021).

Table 2.24: Fuel Prices

Fuel	Price in D/litre	Price in US$/litre*
Gasoline RON95-IV	19,630	0.859
Gasoline RON95-III	19,530	0.855
E5 RON92	18,420	0.806
Diesel 0.001S	15,790	0.691
Diesel 0.05S	15,444	0.676

Note: *exchange rate Vietcombank at 8 am, 15 June 2021: US$1 = D 22,850.
D = Vietnamese dong; US$ = United States dollar; RON = research octane number.
Source: Petrolimex (2021).

Another reason is that consumers still have concerns about the quality of E5. Regardless of the government efforts to educate consumers on the environmental benefits and that E5 is not harmful to vehicle engines, changing consumer consumption habits remains a challenge.

Not aligned with bioethanol, the implementation for biodiesel still faces difficulties, that mainly come from the shortage of feedstock. Biodiesel is produced from vegetable oil and animal fat, while their production is still low they are often prioritised for food rather than for biodiesel production. There was a scheme on the research, development, and utilisation of Jatropha curcas (a species of flowering plant) in Viet Nam in 2008 to 2015, with a vision to 2025. However, this scheme had an unexpected result and just stayed in the research phase. As a consequence, so far in Viet Nam, biodiesel has been produced on a pilot scale, not on a commercial scale.

3.Evaluation of Well-to-Wheel CO_2 Reduction

This section focuses on the primary potential benefit for biofuel in term of CO_2 reduction for further discussion on sustainability in Chapter 3.

A. India

Environmental Impacts of Usage of Ethanol

The use of ethanol-blended gasoline decreases GHG emissions. A summary of emissions benefits with E10 and E20 fuels compared to neat gasoline are presented in Table 2.25.

Table 2.25: Emissions Reduction Potential of Ethanol-gasoline Blends

Emissions	**Gasoline**	**Two-wheelers**		**Four-wheelers**	
		E10*	**E20***	**E10***	**E20**
Carbon Monoxide	Baseline	20% lower	50% lower	20% lower	30% lower
Hydrocarbons	Baseline	20% lower	20% lower	20% lower	20% lower
Oxides of nitrogen	Baseline	No significant trend	10% higher	No significant trend	same

Note: *The E10 project was carried out in 2009–2010, the E20 project in 2014–2015. Hence, the test vehicles were not the same. However, the emissions trend is similar.
Source: NITI Aayog (2021).

Higher reductions in CO_2 emissions were observed with E20 fuel – 50% lower in two-wheelers and 30% lower in four-wheelers. Hydrocarbon emissions reduced by 20% with ethanol blends compared to normal gasoline. Nitrous oxide emissions did not show a significant trend as they depended on the vehicle and/or engine type and engine operating conditions. The unregulated carbonyl emissions, such as acetaldehyde emissions were, however, higher with E10 and E20 compared to normal gasoline, due to the presence of hydroxyl groups in ethanol. However, these emissions were relatively minor (in a few micrograms) compared to regulated emissions (which

were in grams). Evaporative emissions test results with E20 fuel were similar to E0. Overall, ethanol blending can help decrease emissions from both two-wheelers and four-wheelers (NITI Aayog, 2021).

B. Malaysia

Palm biodiesel is a green and sustainable alternative fuel for petroleum diesel. Although the Malaysian fuel mix in the automotive sector is dominated by gasoline, the use of diesel has an image of trucks spewing out black smoke from their exhausts. Further advances in diesel exhaust aftertreatment systems have reduced the polluting emissions in most diesel vehicles. The addition of biodiesel into diesel can also reduce the polluting factor from older models of diesel vehicles that do not have up to date exhaust aftertreatment systems.

The GHG emissions computation in Table 2.26 (Choo et al., 2011; Mortimer, 2010) is based on refined vegetable oils. Generally, the GHG emissions for the production of biodiesel from vegetable oils (palm, rapeseed, and soybean) using the transesterification process are similar as it uses the same amount of energy and chemicals.

Table 2.26: GHG Emissions

GHG Emissions	Refined Palm Oil	Refined Rapeseed Oil	Refined Soybean Oil
Ton CO_2eq/ton oil	1.11 (without biogas capture) 0.63 (with biogas capture)	1.35	1.70

GHG = greenhouse gas.
Sources: Choo et al. (2011); Mortimer (2010).

The GHG emissions data for refined palm oil was published in 2011 using attributional life cycle analysis (LCA) methodology. The summary of the data on GHG emissions of the entire palm oil supply chain (from fresh fruit bunch to palm biodiesel) are shown in Table 2.27 (Choo et al., 2011; Mortimer, 2010).

Table 2.27: Summary of the Data on GHG Emissions of Palm Oil Supply Chain

Production	GHG Emissions (kg CO_2 equivalent)	
1 ton fresh fruit bunch (FFB)	119	
	Without biogas capture	With biogas capture at 85% efficiency
1 ton crude palm oil (CPO)	971	506
1 ton refined palm oil (RPO)	1,113	626
1 MJ of palm biodiesel	GHG Emissions (g CO_2 equivalent)	
	33.19	21.20

g = gram, GHG = greenhouse gas, kg = kilogram, MJ = megajoule.
Sources: Choo et al. (2011); Mortimer (2010).

By comparing the GHG emissions from utilising one megajoule (MJ) of fossil diesel in the transport sector with the GHG emissions from utilising one MJ of palm biodiesel, the emissions savings potential is shown in Table 2.28 (ISCC, 2016). The higher palm biodiesel blending of as much as 30% can provide 18% more emissions savings when used in automotive diesel applications.

Table 2.28: Comparison of GHG Emissions from Diesel and Palm Biodiesel

	GHG Emissions (g CO_2 equivalent)	
	Without biogas capture	**With biogas capture at 85% efficiency**
One MJ of palm biodiesel	33.19	21.20
One MJ of fossil diesel	83.8	
	GHG savings potential (%) compared to fossil diesel used in transport sector	
Palm biodiesel (B100)	60.39	74.70
B7	4.22	5.23
B10	6.04	7.47
B20	12.08	14.94
B30	18.12	22.41

g = gram, GHG = greenhouse gas, MJ = megajoule.
Source: ISCC (2016).

C. Philippines

Fuel information was gathered from the PNS, PDOE's Energy Research and Testing Laboratory Services and 2019 Energy Balance Table. For gasoline, density is set at 0.783 kg/litre at a maximum temperature of 15°C, while its heating value is estimated at 19,000 British thermal unit per pound (Btu/lb) and well-to-tank was computed at around 13.59 metric tons of CO_2 equivalent ($MTCO_2e$) (University of the Philippines Los Baños, 2019; Watabe, 2011). In the case of diesel, density is set at 0.82–0.86 kg/litre at a maximum temperature of 15°C, with an estimated heating value of 19,500 Btu/lb and well-to-tank data of about 19.31 $MTCO_2e$. Also based on the existing quality standards, density of bioethanol and biodiesel are required to be 0.7915 kg/litre and 0.86-0.90 kg/litre at a maximum temperature of 20°C, respectively.

D. Thailand

Regarding well-to-wheel CO_2 emissions, the Thai government uses national life cycle inventory data from survey for well-to-tank portion while referring to Intergovernmental Panel on Climate Change (IPCC) Tier 2 default emissions factor (MTEC, 2021) (Table 2.29 and Table 2.30).

Table 2.29: Well-to-Tank Greenhouse Gas Emissions for Ethanol in Thailand

Fuel Type	**Supply Fraction (%)**	**WTT GHG Emissions Factor ($kgCO_{2,eq}$/GJ)**	**Notes**
Ethanol from molasses	67.46	18.1920	Silalertruksa, 2015
Ethanol from sugarcane juice	5.09	30.1474	Garcia et al., 2011
Ethanol from cassava	27.45	65.3046	Papong and Malakul, 2010
Average ethanol		31.7315	
E0 (pure gasoline)		13.7262	
E10 with E100 for Thai ethanol mix		14.9927	
E20 with E100 for Thai ethanol mix		16.3456	
E85 with E100 for Thai ethanol mix		28.0259	

GHG = greenhouse gas, GJ = gigajoule, kg = kilogram, WTT = well-to-tank.
Source: MTEC (2021).

Table 2.30: Well-to-Tank Greenhouse Gas Emissions for Biodiesel in Thailand

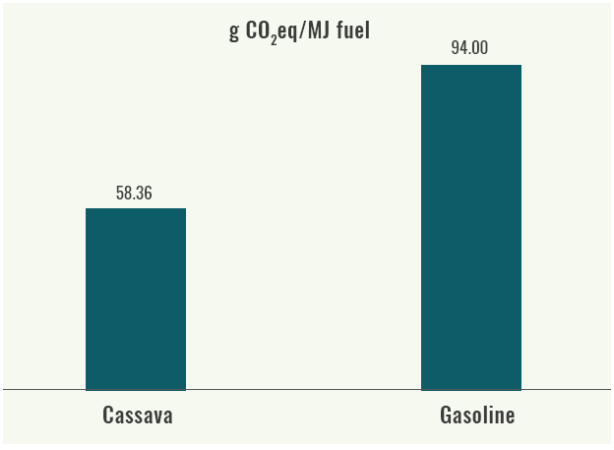
Fuel Type	GHG Emissions (kg $CO_{2,eq}$/GJ)	Notes
Biodiesel from palm	53.5748	MTEC, 2021
B0 (pure diesel)	7.4382	
B7 with B100 from FAME	10.2939	
B10 with B100 from FAME	11.5325	
B20 with B100 from FAME	15.7295	

FAME = Faster Adoption and Manufacturing of (Hybrid &) Electric Vehicles, GHG = greenhouse gas, GJ = gigajoule, kg = kilogram.
Source: MTEC (2021).

E. Viet Nam

According to the report of the Food and Agriculture Organization of the United Nations (FAO, 2018) for cassava-based ethanol production, the stages of the value chain included in the LCA were feedstock production, transformation, and delivery to the ethanol plant; biomass processing into biofuels; and biofuel transportation, storage and distribution. The amount of CO_2 equivalent from all steps of cassava-based ethanol production in Viet Nam was evaluated and compared with those of gasoline, as shown in Figure 2.18 (FAO, 2018). It shows that ethanol production and use (for transportation) result in average total GHG emissions of 58.36 gCO_2eq/MJ of product, which is a 37%–39% (depending on where cassava is cultivated) GHG emissions saving in comparison to gasoline.

Figure 2.18: Comparison of Total CO_2 Equivalent between Cassava-based Ethanol and Gasoline



G = gram, MJ = megajoule.
Source: FAO (2018).

For biodiesel, a study shows that Jatropha-based biodiesel production and use based on the conditions in Viet Nam result in 12.3 gCO_2eq/MJ that can be reduced by 86.56% compared to

fossil diesel (Khang, 2019). In calculation CO_2 emissions of gasoline and diesel use on stationary and mobile sources, the emissions factors can be referred to the IPCC Guidelines (IPCC, 2006).

4. Discussion

As seen from the rich content and journey of biofuel policies and implementation schemes in the selected EAS countries of India, Indonesia, Malaysia, Philippines, Thailand, and Viet Nam, each country has its own unique approach and target. For instance, India has focused more on bioethanol than biodiesel due to its large sugarcane industry, even with second generation cellulosic ethanol under the PM-JIVAN scheme. While 10% bioethanol blend (E10) is sold by various retailers, only 50% of gasoline sold in the market is E10. For Indonesia and Malaysia, biodiesel is more focused than bioethanol due to the large oil palm industry with higher blending ratio (B30) in Indonesia. Effective biodiesel promotion mechanism in Indonesia comes from the Palm Plantation Fund, which is collected from fees and export levies from palm oil plantation products or derivatives for biodiesel subsidy to gain market price attractiveness. For Malaysia, the effective role of the Ministry of Plantation Industries & Commodities (MPIC), together with the Malaysian Palm Oil Board (MPOB), has served as a framework for biodiesel industry development in Malaysia. For the Philippines, both bioethanol and biodiesel are being mandated as E10 and B2 by the Philippine Department of Energy (PDOE) with unique feedstock for biodiesel from coconut. For Thailand, both bioethanol and biodiesel are being promoted as commercial fuels with various blends (E10, E20, E85 and B7, B10, B20) under the cross-subsidy schemes levied from less biofuel blending to subsidising high blending ratios so that retail prices of higher biofuel blending are more attractive. For Viet Nam, bioethanol is more focused with nation-wide blending and especially the ban of RON92 gasoline (but RON95 gasoline still available) in 2018, which significantly boosted bioethanol consumption.

In addition, multiple benefits of biofuel implementation not only lie in reduced fossil fuel imports and reduced tank-to-wheel CO_2 emissions, but also value added and demand creation for agriculture products. However, these biofuel policies and implementation schemes must be carefully pursued within the context of sustainability, especially during the transition towards electric mobility in the future.

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