Chapter 3

Biofuel Market and Supply Potential in East Asian Countries

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CHAPTER 3
Biofuel Market and Supply Potential in East Asian Countries

Methodology of Demand Projection

(1) Methodologies

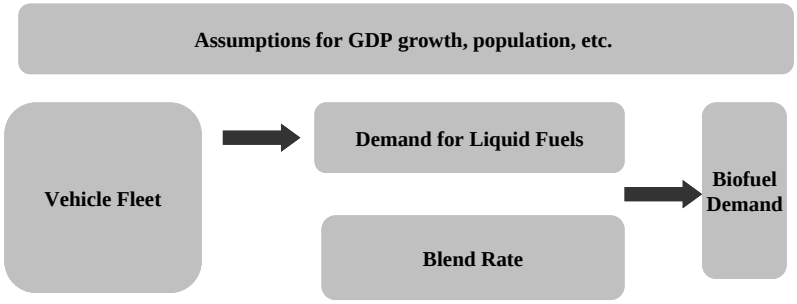
Biofuels could be used in various sectors, including the industrial, power generation, and transport sectors. Within the transport sector, biofuels can be used as vehicle, marine, and aviation fuels. However, since road transport is currently the largest market for biofuels (and for petroleum fuels), for most countries, road transport is the primary sector to promote biofuel use (as an alternative to petroleum fuels), hence, the projection of future biofuel demand was focused on road transport. The basic formula used for calculating biofuel consumption for road transport is as follows:

$$Biofuel = TotalDemandofCertainLiquidFuel \times BlendRate$$

Most governments have their targets for biofuel utilisation and these targets are always in the form of blend rates. Usually, biofuel is blended into petroleum fuels (ethanol blended into gasoline, biodiesel blended with diesel). The percentage of biofuel in the fuel mixture is the blend rate, which is calculated in terms of heat value rather than volume.

Demand for two types of biofuels—bioethanol and biodiesel—are projected in this study. Bioethanol is used for blending with gasoline and biodiesel with diesel, thus, the demand for gasoline equivalent and diesel equivalent will be projected. Since liquid fuel consumption depends significantly on the number of vehicles on the road, ownership of vehicles is projected first to calculate the liquids demand.

Figure 3.1 Framework to Forecast Biofuel Demand



Source: Compiled by author.

Dargay and Sommer (2007) found that the relationship between ownership of passenger cars and income (gross domestic product [GDP]/capita) level can be represented by an 'S' shaped curve. There are a number of different functions that can describe such a curve. In this paper, the Gompertz function is used (which is also the function used in the study though the function form used in this paper is more simple). The Gompertz model can be written as follows:

$$P=K*\exp(\alpha*\exp(\beta*(GDP/Capita)))$$

Where:

P = represents the passenger cars per 1,000 people,

K = represents the saturation level of passenger cars per 1,000 people, and

α and β = are the negative parameters defining the shape or curvature of the curve.

Each country's parameters α and β can be estimated by regression analysis using history data of the respective countries. The saturation level of passenger car ownership per capita (constant K, the unit of which is passenger cars per 1,000 people) of each country needs to be decided exogenously. The constant K is estimated by considering the population density and urbanisation rate.

The future passenger car ownership is the product of passenger car ownership per capita and total population. Apart from passenger cars, buses and trucks also need to be considered to project future gasoline (equivalent) and diesel

(equivalent) consumption. Buses and trucks are put under one category because the statistics used in this paper counts trucks and buses as one category ‘Truck & Bus’. Being different from passenger cars, the projection of future ‘Truck & Bus’ is done by time-series regressions using GDP and/or population as drivers (independent variables).

The projection of fuel demand from road transport was carried out through two approaches: the top-down approach and the bottom-up approach. The top-down approach in this study is a time-series regression using the stock of cars and fuel price as independent variables. In the bottom-up approach, the annual fuel demand is the product of car stock and stock average fuel intensity (average annual fuel consumption per car per year).

Bottom-up approach

For the “Truck & Bus”, the stock average fuel intensity was assumed primarily from the IEA SMP Transport Model and adjusted depending on the fuel consumption characteristics of each country. The share of each kind of fuel (gasoline, diesel, and natural gas) in total fuel demand was assumed (mainly based on history trends) to calculate demand for each kind of fuel. For passenger cars, the fleet was further disaggregated into four categories: gasoline consumption cars, diesel consumption cars, compressed natural gas (CNG) cars, and electricity vehicle (EV) cars. To simplify calculation, it was assumed that each type of car consumes only one kind of fuel (e.g., gasoline consumption cars only burn gasoline). At the core of the bottom-up approach for passenger cars is a stock counting module by which the stock turnover (service life was considered) and the stock average fuel intensity for each type of cars were calculated. The stock for the whole passenger car fleet was calculated by using the Gompertz function, and the stock for each category of cars would be calculated in the stock counting module. In calculating stock turnover, the vintage (category and starting year of use) of each car and its fuel intensity were recorded, and annual sales of cars of each vintage was counted, through which the annual stock and stock average fuel intensity of each category of cars were calculated, after which the annual demand for each kind of fuel was estimated. Similar to that of ‘Truck & Bus’, the fuel intensity of each type of new car was set primarily from the IEA SMP Transport Model and adjusted depending on the fuel consumption characteristics of each country.

(2) Assumptions

The macro social and economic assumptions, i.e., the GDP and population growth, were in line with that of the Energy Saving Potential Working Group of ERIA. The assumptions for biofuel blending were made based on government policies and the analyst's judgment, while for the four countries in the working group (WG), the WG member from each country was consulted on the future prospect of biofuel use in their respective countries.

Table 3.1 Assumptions of GDP Growth

	2000~2011	2011~2020	2020~2035	2011~2035
Australia	3.0	3.1	2.7	2.9
Brunei Darussalam	1.4	2.8	2.6	2.7
Cambodia	7.9	6.8	4.1	5.1
China	10.4	7.4	4.4	5.5
India	7.4	6.8	6.2	6.4
Indonesia	5.3	5.8	5.1	5.4
Japan	0.6	1.7	1.2	1.4
Lao PDR	7.2	7.2	7.0	7.1
Malaysia	4.7	4.0	3.1	3.4
Myanmar	10.9	7.3	7.2	7.2
New Zealand	2.2	2.7	1.9	2.2
Philippines	4.7	6.7	6.0	6.3
Singapore	5.6	4.1	3.2	3.6
South Korea	4.1	3.3	2.5	2.8
Thailand	3.9	4.3	3.9	4.1
Viet Nam	6.6	6.2	7.1	6.8

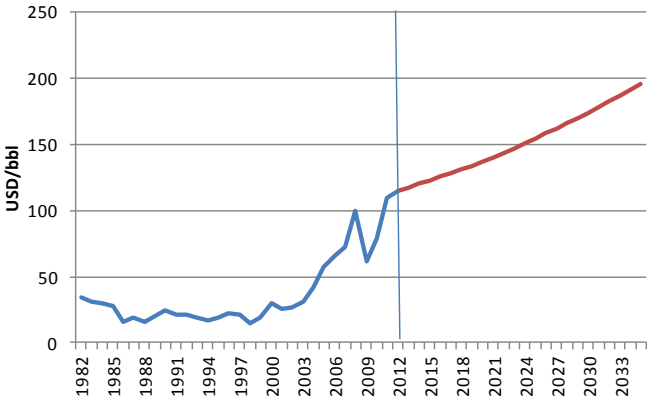
Sources: The World Bank for 2000–2011 data; ERIA and IEEJ for other data.

Table 3.2 Assumptions for Population Growth

	2000~2011	2011~2020	2020~2035	2011~2035
Australia	1.4	1.5	1.3	1.3
Brunei Darussalam	1.9	1.9	1.6	1.7
Cambodia	1.6	1.7	1.7	1.7
China	0.6	0.5	0.1	0.2
India	1.5	1.2	0.8	0.9
Indonesia	1.4	1.2	0.8	0.9
Japan	0.1	-0.2	-0.4	-0.3
Lao PDR	1.8	1.5	1.5	1.5
Malaysia	1.9	1.5	1.0	1.2
Myanmar	0.7	1.0	1.0	1.0
New Zealand	1.2	0.9	0.7	0.8
Philippines	1.9	1.9	1.4	1.6
Singapore	2.3	1.2	0.7	0.9
South Korea	0.5	0.3	0.1	0.2
Thailand	0.6	0.3	0.3	0.3
Viet Nam	1.1	1.0	0.6	0.8

Sources: The World Bank for 2000–2011 data; ERIA and IEEJ for other data.

Figure 3.2 Assumptions for Crude Oil Price



Sources: West Texas Intermediate (WTI) price for data from 1982 to 2012; IEEJ for data from 2013 to 2035.

Table 3.3 Assumptions for Bioethanol Blending

	2011	2015	2020	2030	2035
Australia	2	3	5	8	10
Brunei Darussalam	0	0	0	0	0
Cambodia	0	0	1	4	5
China	2	2.6	2.6	2.6	2.6
India	1	5	5	5	5
Indonesia	0	5	10	20	20
Japan	0	0	1	2	3
Lao PDR	0	10	10	10	10
Malaysia	0	0	0	0	0
Myanmar	0	1	2	4	5
New Zealand	0	2	4	8	10
Philippines	4	10	20	20	20
Singapore	0	0	0	0	0
South Korea	0	0	0	0	0
Thailand	4	13	25	25	25
Viet Nam	0	1	3	5	5

Sources: IEA for the 2011 data; ERIA and IEEJ for the data from 2015 to 2035.

Table 3.5 Assumption for Biodiesel Blending

	2011	2015	2020	2030	2035
Australia	1	2	2	4	5
Brunei Darussalam	0	0	0	0	0
Cambodia	0	0	0	0	0
China	1	4	4	4	4
India	0	1	2	4	5
Indonesia					
Road Transport	2	10	20	25	25
Industry Sector	0	5	20	25	25
Power Generation	0	8	20	30	30
Japan	0	0	0	0	0
Lao PDR	0	10	10	10	10
Malaysia					
Road Transport	0	5	5	5	5
Industry Sector	0	0.5	1.6	3.9	5
Myanmar	0	0	0	0	0
New Zealand	0	1	2	4	5
Philippines	2	5	10	20	20
Singapore	0	0	0	0	0
South Korea	2	3	3	3	3
Thailand	4	7	10	10	10
Viet Nam	0	1	3	5	5

Sources: IEA for the 2011 data; ERIA and IEEJ for the data from 2015 to 2035.

Methodology of Estimating the Supply Potential

(1) Methodologies

In the last phase, the Cobb-Douglas production function was used on crop production analysis where production is determined by cultivation area (A), labour (L), and investment or input (K) and parameter a, α, β, γ as shown below:

$$Y = aA\alpha L\beta K\gamma$$

The modification for the model will be based on the price of crop and export in the new phase. The production of crop (Y) is determined by cultivation area (A) and productivity (YH) of the land.

$$Y = f(A, YH)$$

The cultivation area is determined by the price of the crop and the price of the competitive crops.

$$\log A = (1+a1)*\log A_{t-1} + a2*\log*(P_{0,\,t-1}/P_{0,\,t-2}) + a3*\log*(P_{1,\,t-1}/P_{1,\,t-2}) + \ldots$$

Where;

a1, a2, a3 = Parameter

P_0 and P_1 = Price of crop 0 and crop 1

t-1, t-2 = time lag

The productivity (YH) of each of the crop is determined by technology variable as shown below:

$$YH = YHt\text{-}1 * (1+a4)$$

Where;

a4 = Technology parameter

On export, the quantity of export (EX) is determined by international crop price.

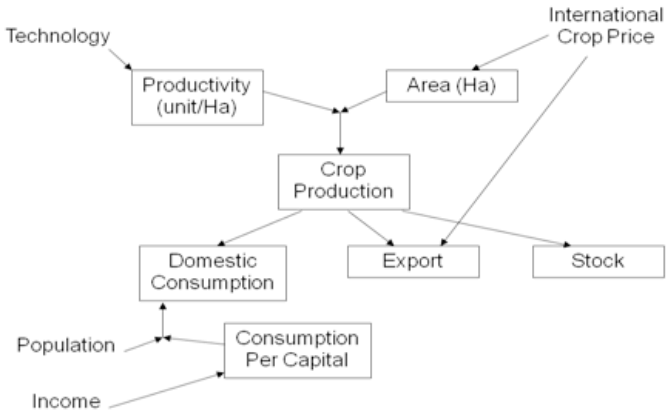
$$EX = (1+a5)*\log EX_{t-1} + b*\log (IP0/IP_{0,\,t-1})$$

Where;

a5 and b = Parameter

IP_0 = International price for crop 0

Figure 3.3 Model Framework for Biofuel Supply Potential



Source: Compiled by author.

(2) Assumptions

1) Macroeconomic

The assumption for GDP and population is the same as demand projection (refer to Table 3.1-1 and Table 3.1-2).

2) Crop Price

The assumption for crop prices is based on the World Agriculture Outlook 2012 of the Food and Agricultural Policy Research Institute–Iowa State University (FAPRI-ISU). The historical international crop price is adopted from the World Bank statistics, and the historical domestic crop price is adopted from the FAO Statistics Division.

Table 3.5 Assumption of International Crop Price

		1971	1980	1990	2000	2010	2020	2030	2035
International Crop Price (World Bank)									
Maize	US$ per metric ton	58	125	109	89	186	316	341	355
Wheat	US$ per metric ton	62	173	136	114	224	339	377	397
Rice	US$ per metric ton	112	411	271	202	489	587	621	638
Soy bean	US$ per metric ton	126	296	247	212	450	629	681	710
Palm Oil	US$ per metric ton	261	584	290	310	901	1,060	1,145	1,191
Coconut Oil	US$ per metric ton	366	674	337	450	1,124	1,199	1,324	1,393

Source: FAPRI-ISU (2012).

3) Scenario

Supply (business-as-usual or BAU scenario)

Food constraint scenario is based on the definition of the FAO Statistics Division. The utilisation of each crop in FAO is statistics is classified as feed, seed, processing, food and other utilisation (including waste). Feed, seed, and processing are not directly used as food but are consumed as food in final production. For this reason, these are classified as food in the projection.

Table 3.2-2 shows the utilisation of each crop in world consumption. The estimation for the utilisation structure in 2035 is calculated by the historical trend. Only the share of “other utilization” is suitable to become the potential of feedstock in the modelling calculation process.

Table 3.6 World Consumption of Main Crops, by Utilisation (%)

Consumption by Utilization	1971	1980	1990	2000	2010	2020	2030	2035
Molasses								
Feed	39	40	34	32	26	25	24	24
Seed	0	0	0	0	0	0	0	0
Processing	41	46	47	48	47	48	48	48
Food	0	0	0	0	0	0	0	0
Other Utilization	20	15	19	20	27	27	28	28
Total	100	100	100	100	100	100	100	100
Cassava								
Feed	32	36	42	31	34	35	35	35
Seed	0	0	0	0	0	0	0	0
Processing	0	0	2	1	1	1	1	1
Food	54	52	45	50	41	41	40	40
Other Utilization	14	12	12	18	23	24	24	24
Total	100	100	100	100	100	100	100	100
Wheat								
Feed	23	20	22	17	18	18	17	17
Seed	9	8	6	5	5	5	5	5
Processing	0	1	1	1	1	1	1	1
Food	64	65	65	71	69	70	70	71
Other Utilization	5	6	7	6	7	7	7	7
Total	100	100	100	100	100	100	100	100
Rice (Paddy base)								
Feed	5	4	5	6	6	6	7	7
Seed	5	5	3	3	3	2	2	2
Processing	1	1	1	1	1	1	1	1
Food	84	84	84	82	79	79	78	78
Other Utilization	5	6	7	9	12	12	12	12
Total	100	100	100	100	100	100	100	100
Maize								
Feed	73	73	62	66	55	54	53	53
Seed	2	2	1	1	1	1	0	0
Processing	3	4	8	8	20	20	21	21
Food	15	14	16	16	14	14	14	14
Other Utilization	7	8	12	9	10	10	11	11
Total	100	100	100	100	100	100	100	100

Source: FAOSTAT (May 2014).

Table 3.7 World Consumption of Main Oil Crops, by Utilisation (%)

Consumption by Utilization	1971	1980	1990	2000	2010	2020	2030	2035
Palm oil								
Feed	0	0	0	0	0	0	0	0
Seed	0	0	0	0	0	0	0	0
Processing	0	0	0	0	0	0	0	0
Food	70	61	56	45	37	35	33	32
Other Utililization	30	39	44	55	63	65	67	68
Total	100	100	100	100	100	100	100	100
Coconut Copra								
Feed	0	0	0	0	0	0	0	0
Seed	0	0	0	0	0	0	0	0
Processing	64	67	58	49	42	40	38	38
Food	30	26	30	35	35	35	36	36
Other Utilization	5	7	12	15	23	25	25	26
Total	100	100	100	100	100	100	100	100
Soybean								
Feed	2	1	3	4	3	4	4	4
Seed	5	4	3	4	3	3	3	3
Processing	77	85	83	84	85	85	85	85
Food	13	8	7	6	5	4	4	3
Other Utilization	3	2	4	3	4	5	5	5
Total	100	100	100	100	100	100	100	100
Animal fats								
Feed	7	6	8	8	6	6	6	6
Seed	0	0	0	0	0	0	0	0
Processing	1	1	1	1	1	1	1	1
Food	63	63	60	61	62	61	61	61
Other Utilization	30	29	31	30	31	31	31	31
Total	100	100	100	100	100	100	100	100

Source: FAOSTAT (May 2014).

Supply (Alternative 1:Maximum land use)

"Alternative 1" is a case where the land utilisation for each of the crop in this region is maximised by 2035 by increasing the cultivated area and maximising the utilisation of arable land, following the definition of FAO.

Supply (Alternative 2: Maximum land use and productivity)

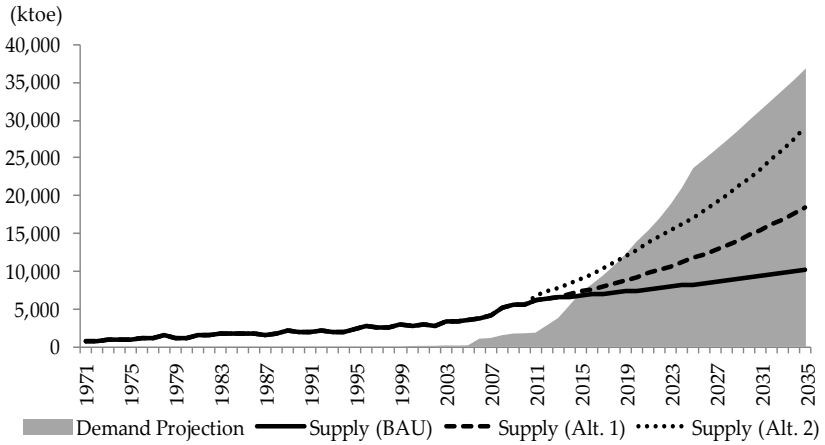
"Alternative 2" is a case where land utilisation and productivity per cultivated area for each of the crop in this region is maximised by 2035. The most advanced productivity of each crop in this region has been assumed as the baseline value, and technology and high productivity variety are available to be shared and transferred in the region.

Demand and Supply Balance in Asia

Total aggregated bioethanol demand in the 16 countries is projected to reach 36,859 thousand tonnes of oil equivalent (ktoe) in 2035 while the total supply potential (in a BAU scenario) is estimated to be 10,120 ktoe in 2035. Total aggregated biodiesel demand in the 16 countries in 2035 is projected to be 37,790 ktoe and the total supply potential (in a BAU scenario) is estimated at 35,607 ktoe. In the supply potential estimation, surplus after domestic consumption was counted as biofuel feedstock potential without an open market in the last study. This study, under a BAU scenario, has shown the quantity of surplus after the food constraints. As a result, the estimated potential of the biofuel feedstock is much lower than that of the previous study. The projected regional biofuel supply–demand balance suggests that the region will face a shortage of bioethanol sometime around 2015 and a biodiesel deficit starting around 2034.

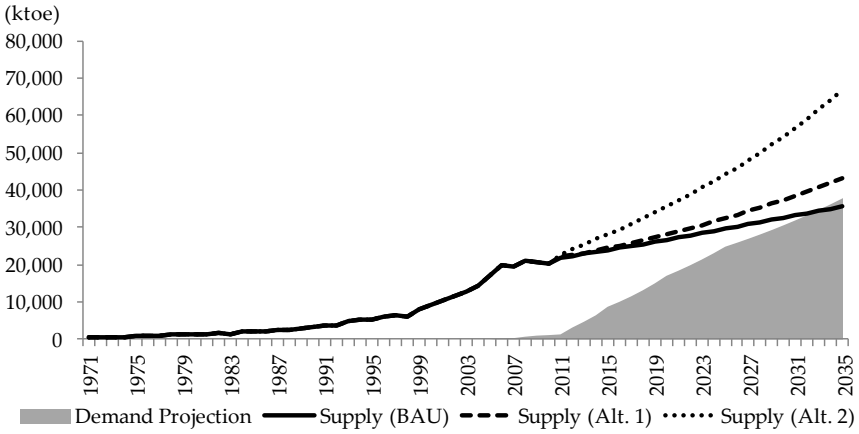
The total aggregated bioethanol supply potential for "Alternative 1" is projected to reach 18,538 ktoe while "Alternative 2" is estimated to be 29,085 ktoe in 2035. Both of these cases cannot meet the demand based on the existing program on bioethanol in this region. Biodiesel supply potential has increased to 42,453 ktoe in "Alternative 1" and 66,980 ktoe in "Alternative 2". The expansion of arable land and maximised productivity are enough to increase the supply potential for biodiesel demand in the region.

Figure 3.4 Bioethanol Demand and Supply Potential



Source: Estimation was done for this study by author/s.

Figure 3.5 Biodiesel Demand and Supply Potential

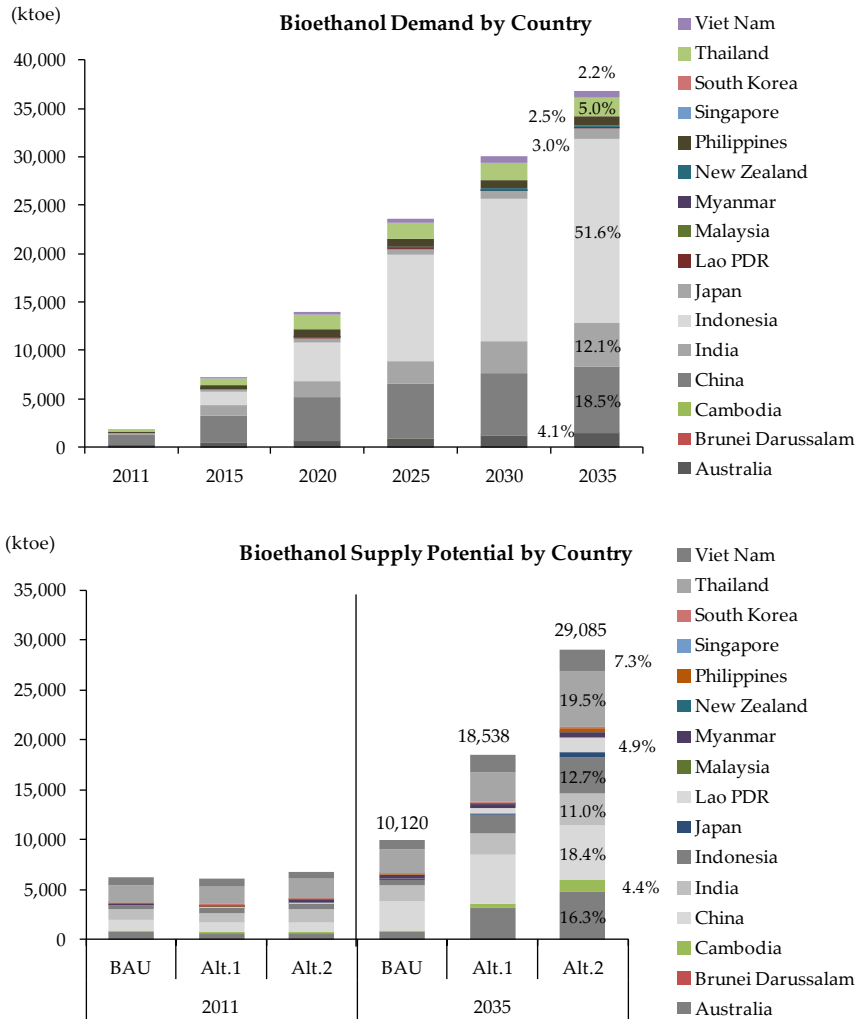


Source: Estimation was done for this study by author/s.

Looking at the demand and supply potential of bioethanol and biodiesel by country, it can be observed that the country with large biofuel demand in the future does not necessarily have sufficient supply potential, and vice versa. For example, Indonesia is expected to have the largest bioethanol demand, accounting for 51.6 percent (19,035.1 ktoe) of the region's total aggregated bioethanol demand in 2035, while the country's supply potential of bioethanol (in a BAU scenario) is estimated to be only 5.8 percent (589 ktoe) of the region's total. On the other hand, while Malaysia is supposed to be the region's largest biodiesel supplier with 41.5 percent (14,774 ktoe) of the region's total supply in 2035, its domestic biodiesel demand is projected to account for only 2.1 percent (584 ktoe) of the region's total. This mismatch of

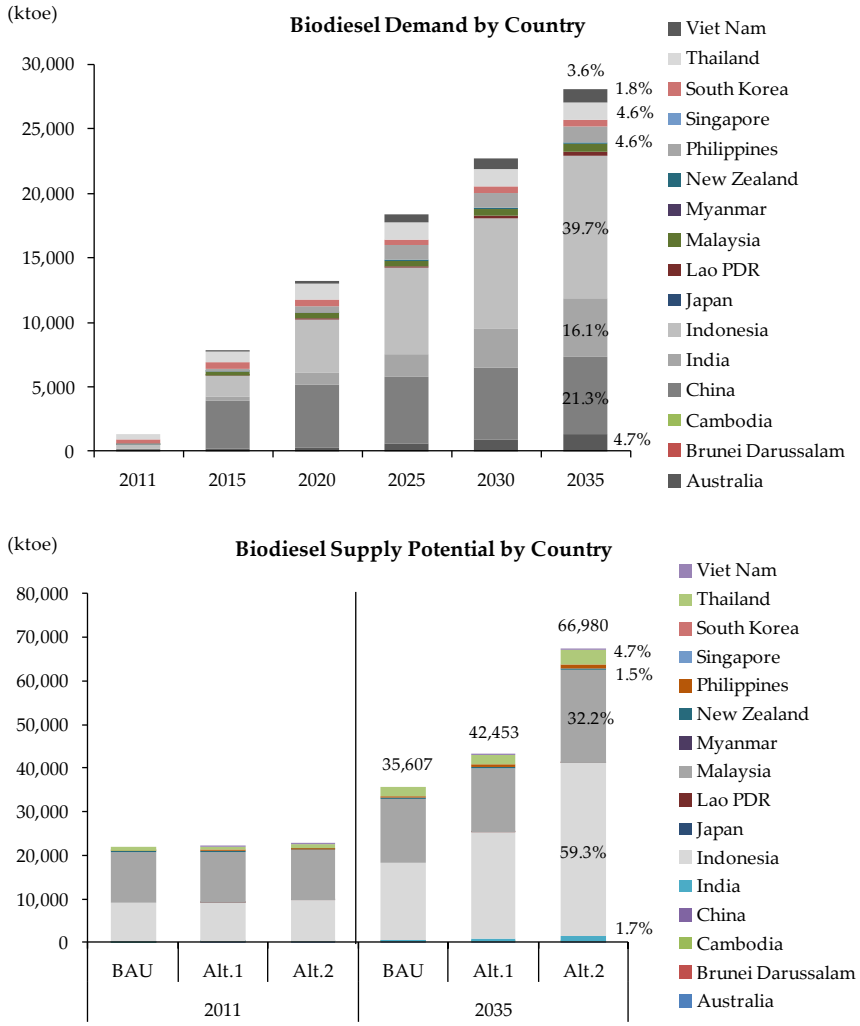
demand and supply indicates that cross-country biofuel trade is necessary to optimise the region's biofuel utilisation.

Figure 3.6 Bioethanol Demand and Supply Potential by Country



Source: Estimation was done for this study by author/s.

Figure 3.7 Biodiesel Demand and Supply Potential by Country



Source: Estimation was done for this study by author/s.

3.3.1. Australia

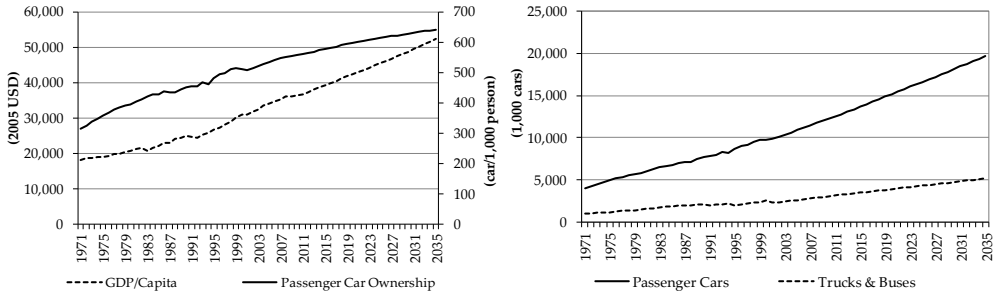
Biofuel Demand

Although passenger car ownership per capita is expected to approach saturation limit by 2035 driven by population expansion, total passenger car stock will have a substantial increase over the projection period. Stock of "Trucks & Buses" is also supposed to grow moderately.

There is no clear policy on target of biofuel use in Australia. In *The Fuel Quality Standards Act 2000*, the standard for biofuels is set as follows: the ethanol content of gasoline is 10 percent or less (E10), and the biodiesel content of diesel is 5 percent or less (B5). It is assumed that the use of E10

and B5 will be fully penetrated by 2035. Bioethanol demand in Australia is projected to grow from 259 ktoe in 2011 to 1,505 ktoe in 2035 while biodiesel demand is expected to reach 1,317 ktoe (from 84 ktoe in 2011) at the end of the projection period.

Figure 3.8 Passenger Car Ownership per Capita vs. Income Level and Stock of Passenger Cars and Trucks & Buses



Source: IEEJ.

Biofuel Supply Potential

Australia is an exporter of sugar and wheat, which accounts for the large share in the international market. The country's supply potential of bioethanol is estimated based on these two crops. The result from food constraints projection (in a BAU scenario) showed that Australia is supposed to have a significant potential of raw materials that can be converted into biofuel after domestic consumption and food supply. Australia's supply potential of bioethanol is estimated to be 793 ktoe in 2035. Based on the data from FAO, Australia still has arable lands and 23.2 million hectares (ha) is not a harvested area, which mean that it can further improve the productivity. "Alternative 2" has projected the supply potential increase to 4,740 ktoe in 2035, when the unused arable land and productivity would have been maximised.

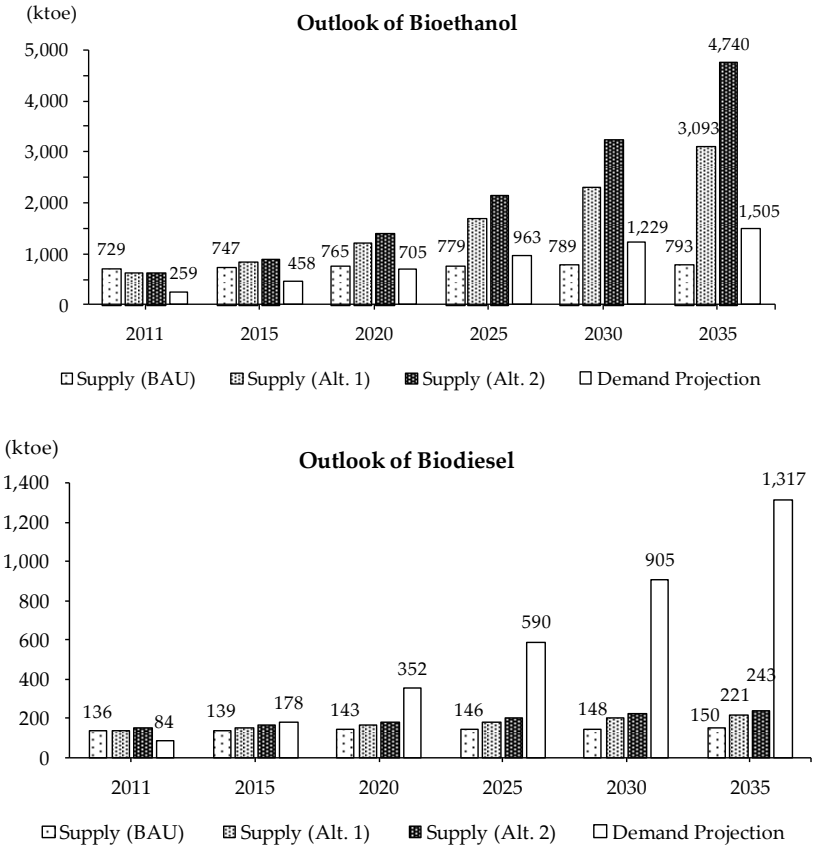
When it comes to biodiesel, animal fat and rapeseed (small quantity) are the main potential feedstock. Supply potential for biodiesel in a BAU scenario is estimated to be 150 ktoe in 2035. Feedstock for biodiesel will increase to 243 ktoe by 2035 because of the increased feed supply as a result of maximised land utilisation and productivity.

Biofuel Outlook

Australia has the second-largest agriculture land, next to China in the East Asian region. According to the FAO's statistics, the agricultural land in Australia is 4.1 million square kilometres (km^2), 10 times larger than the land area of Japan. Hence, the supply potential of energy crops that can be converted into biofuel is high. Based on projection results, Australia is expected to have more than enough supply potential to cover domestic bioethanol demand if E10 were to be fully penetrated in the market. Moreover, Australia also has the potential export bioethanol in the international market. On the other hand, under the assumption that B5 will be fully launched by 2035, Australia may face a shortage of domestic biodiesel supply around 2025.

Australia is a premier supplier of food in the world market, especially wheat, rapeseed oil, and animal fat. The introduction of biofuels in the country will have an impact on international food supply.

Figure 3.9 Biofuel Outlook in Australia through 2035



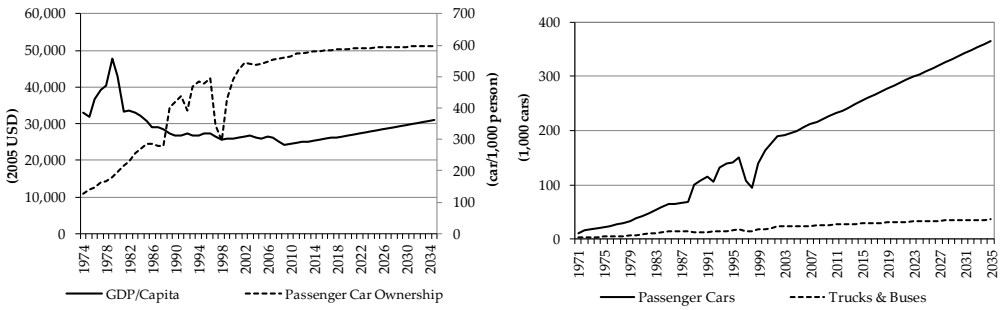
Source: Estimation was done for this study by author/s.

3.3.2. Brunei Darussalam

Biofuel Demand

Car ownership per capita in Brunei Darussalam has already entered a saturation state. Nevertheless, driven by population growth, total car stock is expected to increase at a moderate rate. Since Brunei Darussalam is an oil exporter and the country has little potential for biofuel supply it is assumed that no biofuel use is expected.

Figure 3.10 Passenger Car Ownership per Capita vs. Income Level and Stock of Passenger Cars and Trucks & Buses



Source: Estimation was done for this study by author/s.

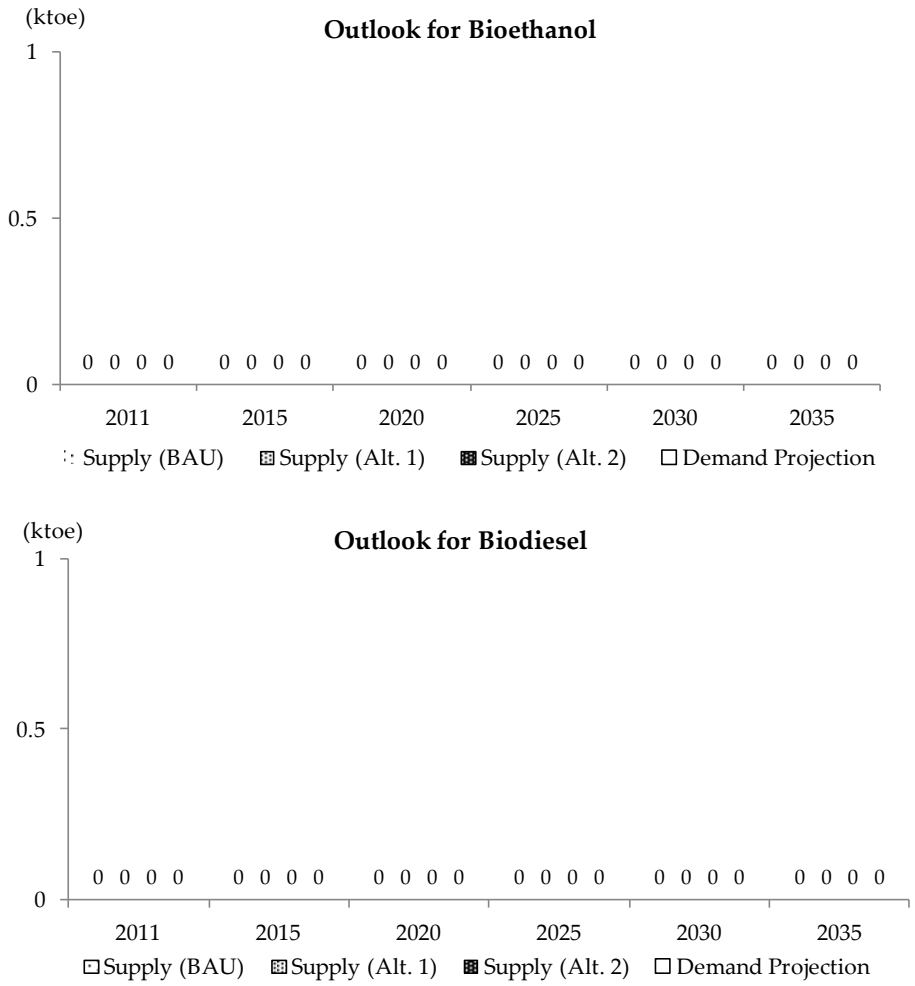
Biofuel Supply Potential

Brunei Darussalam's land area is 577,000 ha where only 14,700 ha (2.6%) of land qualifies as an agricultural land. Based on the data in 2012, permanent crops such as rubber (4,270 ha), coconut (215 ha), and pepper (75 ha) account for 43.9 percent of total agricultural land. Although Brunei Darussalam has grown crops, such as cassava, maize, and rice, their local production are not enough to supply the domestic market.

Biofuel Outlook

In this study, it is assumed that Brunei Darussalam does not have spare feedstock to produce biofuel. At the same time, the country also has no biofuel policy to promote its domestic market.

Figure 3.11 Biofuel Outlook in Brunei Darussalam through 2035



Source: Estimation was done for this study by author/s.

3.3.3. Cambodia

Biofuel Demand

Due to the lack of car ownership statistics in Cambodia, the projection of the country's gasoline and diesel demand is calculated based on the historical data of liquid fuel consumptions.

Though there was no clear policy on biofuel development in Cambodia at the time of the study, given the government's intention to promote biofuel production and utilisation to reduce the country's reliance on import petroleum fuels, it is assumed that 5 percent of the country's gasoline demand for road transport will be substituted by bioethanol in 2035. Under this assumption, Cambodia's demand for bioethanol is projected to reach 22.8 ktoe.

Biofuel Supply Potential

Cassava, maize, rice, and sugarcane (molasses) are supposed to be the main feedstocks for bioethanol production in Cambodia. Since cassava is not a major food crop in Cambodia, a lot of foreign capital has been invested in cassava plantation to produce bioethanol, making it a potential export industry of the country. The supply potential (under a BAU scenario) of bioethanol is estimated to reach 139 ktoe in 2035, expanding from 99 ktoe in 2011.

Cambodia has a large undeveloped agriculture land of around 1.68 million ha. "Alternative 1" has shown that the supply potential can increase to 419 ktoe in 2035 by maximising the arable land. This potential will increase to 1,298 ktoe in "Alternative 2" by maximising productivity.

At the time of the study, the major oilseed crop in Cambodia is soybean. Soybean production has just a small of amount of surplus after domestic consumption and export. However, given the rapid growth of population, demand for edible oil is expected to increase accordingly, leaving little potential for export. Supply potential (in a BAU scenario) of biodiesel is

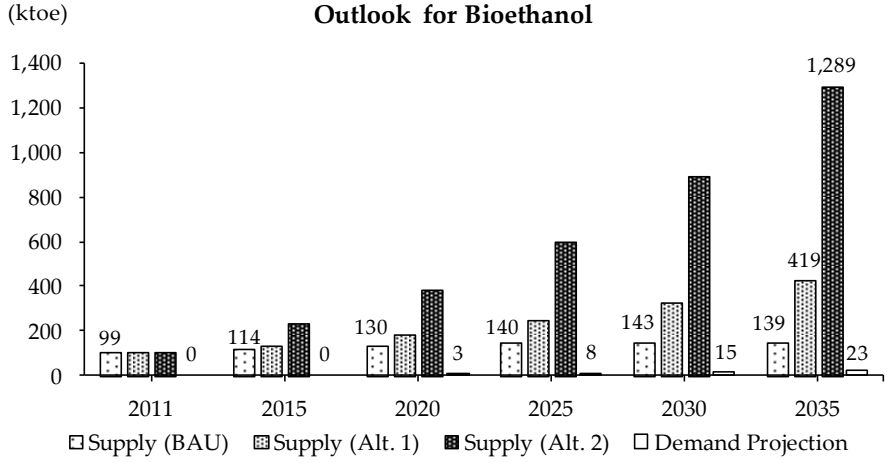
estimated to be 0.3 ktoe in 2035, decreasing from 0.5 ktoe in 2010. Under "Alternative 1", the supply potential for biodiesel is projected to reach 0.6 ktoe while under "Alternative 2", it is projected to reach 1.9 ktoe in 2035.

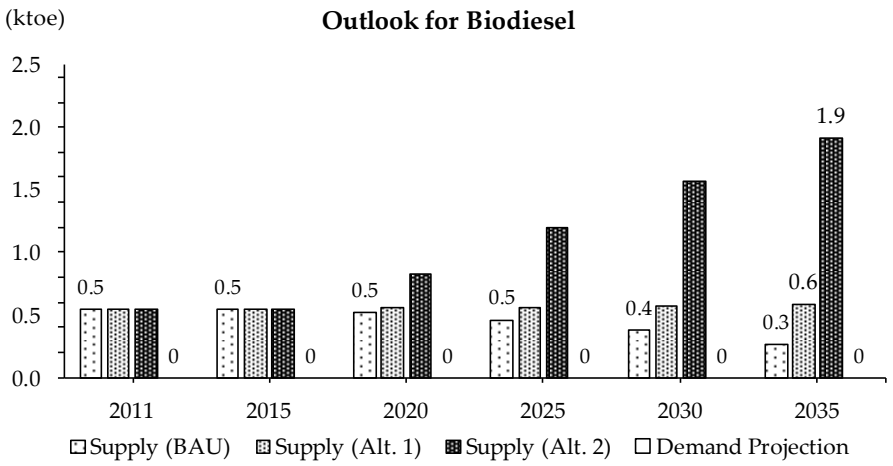
Biofuel Outlook

Since the years of civil conflicts ended, agricultural activity in Cambodia has recovered significantly and crop production has increased rapidly. The country's cultivated land is large but its population is relatively small. Hence, Cambodia might have a good potential to export crops in the future. The government has formulated a plan to promote the use of biodiesel, but there is no mandatory move. At present, production of oil crops is low, and an import of edible oil is required. However, the government's intention to promote biodiesel use is largely built on its perception of jatropha being inedible, but could be used to produce diesel. The Cambodian government is planning to attract more foreign investment in the cultivation of jatropha, but no significant results have yet been observed.

Meanwhile, the production of rice, cassava, corn, and sugarcane has expanded rapidly and the export is increasing steadily, driven mainly by demand (both for domestic consumption and re-export) from Thailand. Foreign investment in cassava cultivation to produce bioethanol has also increased. Cambodia has the potential to become a bioethanol exporter in the future.

Figure 3.12 Biofuel Outlook in Cambodia through 2035





Source: Estimation was done for this study by author/s.

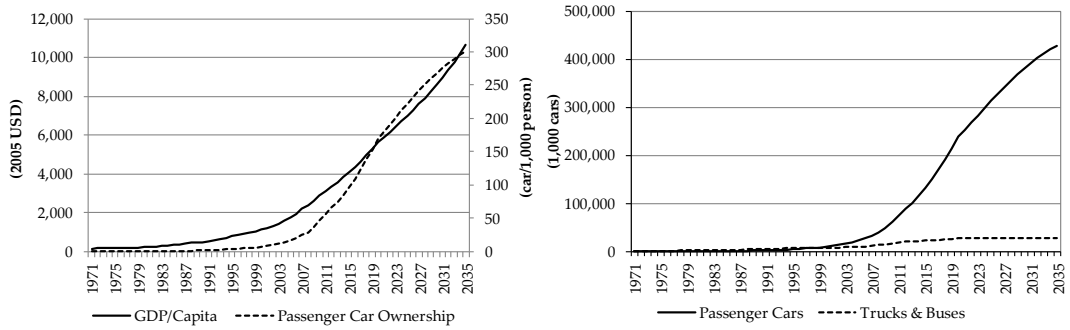
3.3.4. China

Biofuel Demand

Since 2009, China has become the world's largest vehicle market. The country's demand for cars is expected to remain strong over the near- to mid-term period driven by the country's increasing income level. However, in the long-run, car demand in China is supposed to slow down to a moderate growth.

Biofuel utilisation in China is expected to reach the government's target in its 12th Five-Year Plan (4 million litres of bioethanol and 1million litres of biodiesel till 2015). From 2016 to 2035, the blending rate for both bioethanol and biodiesel is assumed to stay the same as that of 2015, which will translate into a demand of 6,832.2 ktoe of bioethanol and 5,973.5 ktoe of biodiesel in 2035.

Figure 3.13 Passenger Car Ownership per Capita vs. Income Level and Stock of Passenger Cars and Trucks & Buses



Source: IEEJ.

Biofuel Supply Potential

Potential feedstock crops for bioethanol production in China are maize, sugarcane (molasses), rice, and cassava. Among these, cassava and molasses are expected to become major feedstocks for bioethanol production because these are not main food crops for Chinese consumers. A few state enterprises are allowed to use the old storage of rice and corn to produce bioethanol. The supply potential (under a BAU scenario) of bioethanol is estimated to expand from 1,130 ktoe in 2011 to 2,900 ktoe in 2035. Agricultural land expansion is still available in the southern region by maximising the cultivation of sugarcane and cassava. But the northern region's agricultural land development is limited because of desertification and land transfer for construction purposes that will improve the infrastructure. Under "Alternative 1", the supply potential is projected to reach 5,050 ktoe in 2035 while under "Alternative 2", it is projected to reach 5,364 ktoe in 2035.

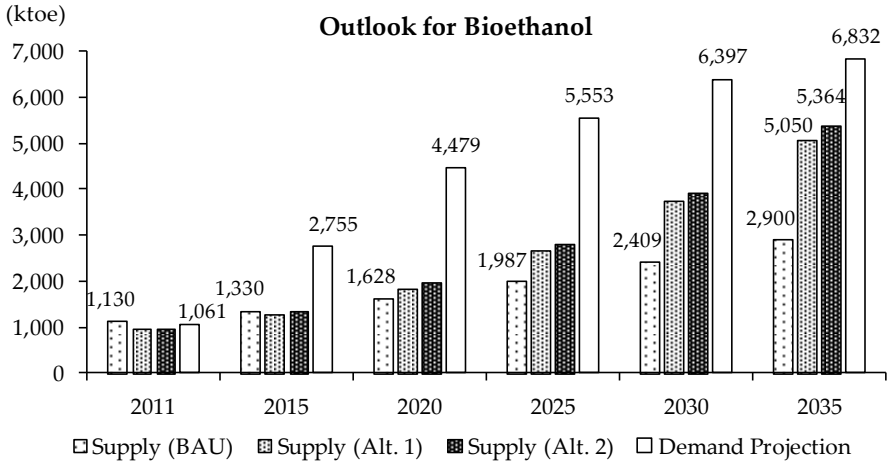
China's rapeseed production is one of the largest in the world. According to the FAO statistics, China produced 13.43 million tonnes of rapeseed in 2011, accounting for 21.5 percent of the world's total. Although China is also one of the largest producers of cooking oil, including soybean oil and cotton oil, the country is currently a net importer of cooking oil. Therefore, in this study, it is assumed that China does not have the spare feedstock to produce biodiesel.

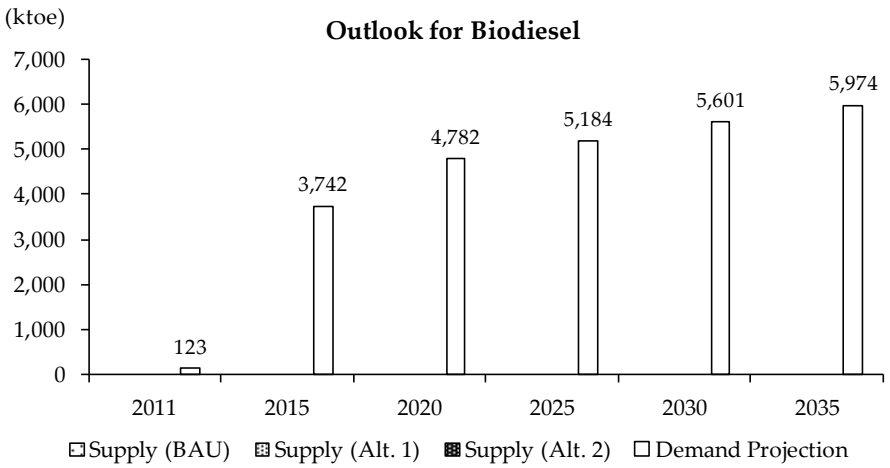
Biofuel Outlook

China is a country with high self-sufficiency of food supply in Asia. FAO data shows that China's self-sufficiency rate in food was more than 95 percent in 2011. Nevertheless, food supply security is at the top of the government's policy agenda, given the country's large population and its history of social chaos caused by food shortage. The use of crops to produce biofuel is tightly regulated by the government. Only a few state-owned enterprises have the permission to use the old storage of maize to produce bioethanol. Meanwhile, the cultivation area of cassava is expanding rapidly in the southern region of the country, driving up feedstock supply for bioethanol.

Since the domestic production of cooking oil is not enough to meet the consumption, China is importing cooking oil. Under this condition, spare feedstock for biodiesel production is hardly expected. There are some programs on biodiesel production from used cooking oil, but these are not spread nationwide.

Figure 3.14 Biofuel Outlook in China through 2035





Source: Estimation was done for this study by author/s.

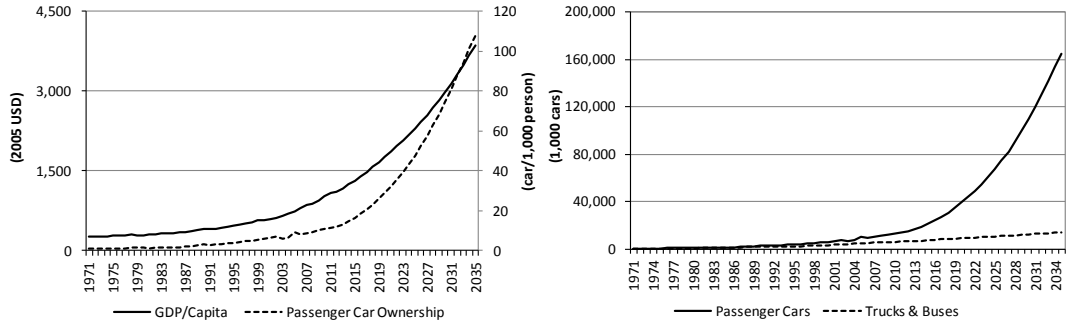
3.3.5. India

Biofuel Demand

Passenger car ownership per capita in India is expected to enter a high growth stage from the mid- to long-term with the country's rising income level. Combined with population growth, total car stock is also supposed to increase rapidly.

In 2009, the government of India approved the National Policy on Biofuels. The policy called for larger use of renewable fuels in the transport sector and proposed an indicative target to replace 20 percent of petroleum fuels in the transport sector with biofuels by 2017. However, due to the shortage of feedstock supply and other difficulties in implementation, the target is supposed to be hard to meet. It is assumed that the blending rate of bioethanol in India will reach 5 percent in 2015 and that blending rate will remain the same through 2035. For biodiesel, the blending rate is assumed to increase to 5 percent by 2035. The annual demand for bioethanol is projected to reach 4,661 ktoe and 4,521 ktoe for biodiesel in 2035.

Figure 3.15 Passenger Car Ownership per Capita vs. Income Level and Stock of Passenger Cars and Trucks & Buses



Source: Estimation was done for this study by author/s.

Biofuel Supply Potential

Although several kinds of energy crops are grown in India, most are not available for fuel production because most of these crops are consumed domestically as food. Only sugarcane (molasses) and a small volume of maize have the potential to become feedstock for bioethanol production. Based on this situation, it is estimated that the supply potential (in a BAU scenario) of bioethanol in 2035 will reach 1,600 ktoe, increasing from 1,001 ktoe in 2011. Since the unutilised agricultural land area of India is not that large for expansion, "Alternative 1" resulted in an estimated supply potential of 2,047 ktoe in 2035. The result of "Alternative 2" showed a much more improvement than "Alternative 1" and will reach 3,206 ktoe in 2035 by increasing productivity.

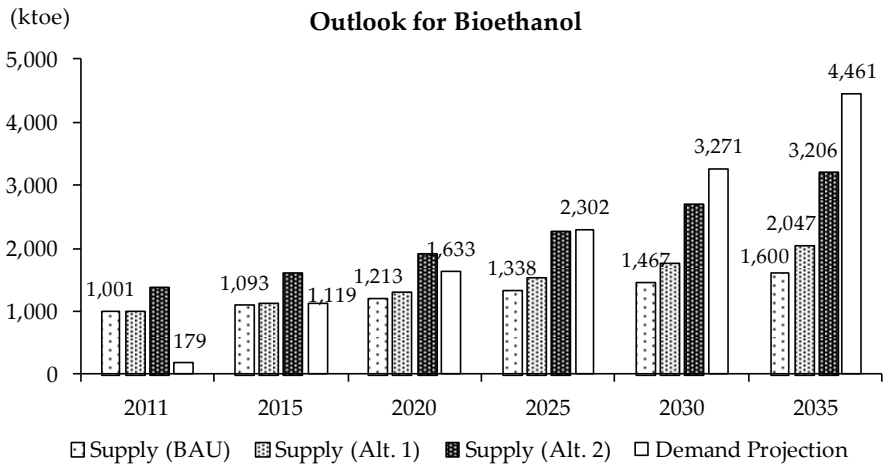
Coconut, rapeseed, and soybean are the major oilseed crops in India. India's production of rapeseed accounted for 13.1 percent of the world's total in 2011. However, given the country's large and growing population, the demand for cooking oil in India will continue to increase in the future. Thus, spare capacity of oilseed crop that can be converted into biodiesel can hardly be expected to expand significantly. The supply potential (under a BAU scenario) of biodisel is estimated to reach 591 ktoe in 2035. Because agriculture land is limited, the "Alternative 1" result showed small improvement from the BAU case to just 725 ktoe. In "Alternative 2", the supply potential is projected to reach 1,131 ktoe in 2035.

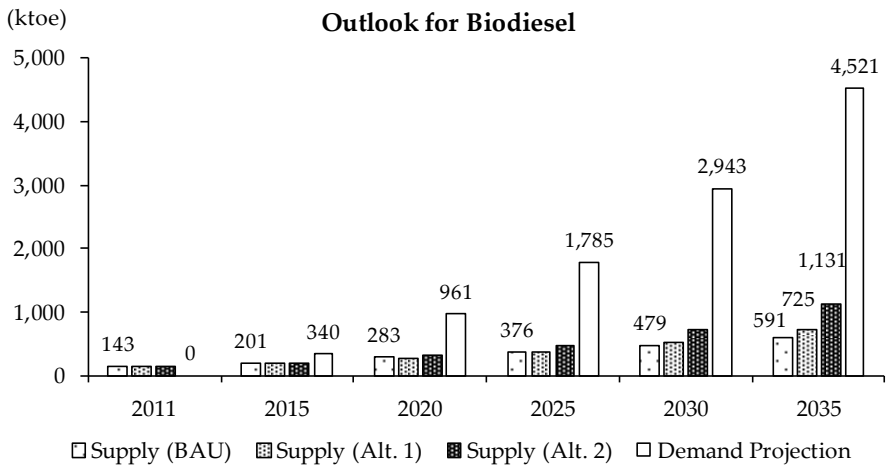
Biofuel Outlook

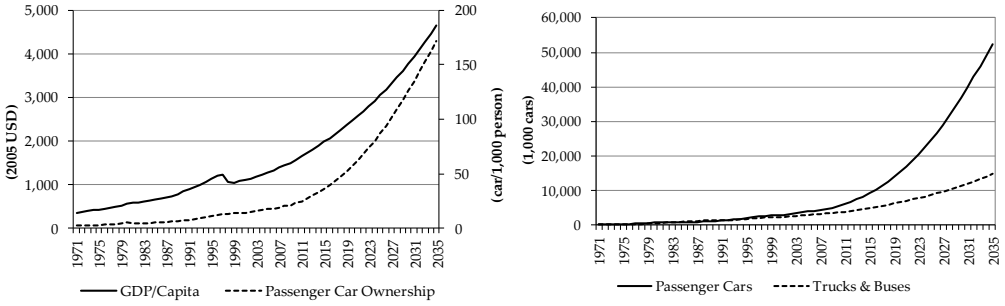
India is a country that has maintained a higher than 90 percent food self-sufficiency. However, the country relies on import for wheat, cooking oil, and animal fat used as cooking oil. The projection results indicate that if the target for biodiesel use were to be fulfilled by domestic supply alone, it will have a negative impact on the domestic supply of cooking oil. The government of India is trying to develop the non-edible crop, jatropha, but the program does not bring about a clear outcome. To realise the penetration of B5 (5%), it is necessary to rebuild the biodiesel feedstock supply system.

Meanwhile, maize and molasses have a production surplus after domestic consumption. The surplus could be used as a feedstock for bioethanol production. However, results show that around 2025, there is an expected shortage of bioethanol supply to meet the domestic demand (driven by government biofuel policies), thus, extra measures to promote the domestic production of bioethanol feedstock is required in the medium to long term.

Figure 3.16 Biofuel Outlook in India through 2035







Source: IEEJ.

Biofuel Supply Potential

Cassava and sugarcane (molasses) are the major feedstocks for bioethanol production in Indonesia. Based on these two feedstocks, the supply potential (under a BAU scenario) of bioethanol in 2035 is estimated to reach 589 ktoe, rising moderately from 429 ktoe in 2011. Indonesia has approximately 14.4 million ha of unused agricultural land. By maximising these unused agriculture land in "Alternative 1", the bioethanol supply potential is estimated to rise to 1,837 ktoe. With a maximised productivity in "Alternative 2", the projected supply potential will improve to 3,961 ktoe.

Feedstock of biodiesel is mainly from palm oil. Indonesia is one of the largest palm oil producers in the world. Crude palm oil production in 2011 reached 2,145 million tonnes, accounting for 44.2 percent of the global market. The supply potential (under a BAU scenario) of biodiesel from palm oil is estimated to be 17,418 ktoe in 2035. The supply potential is estimated to

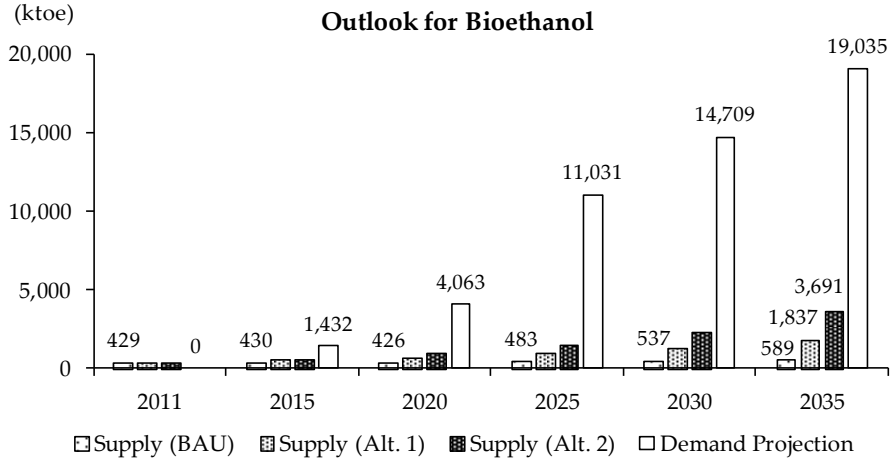
reach 24,255 ktoe in the case of "Alternative 1" and 39,692 ktoe in "Alternative 2".

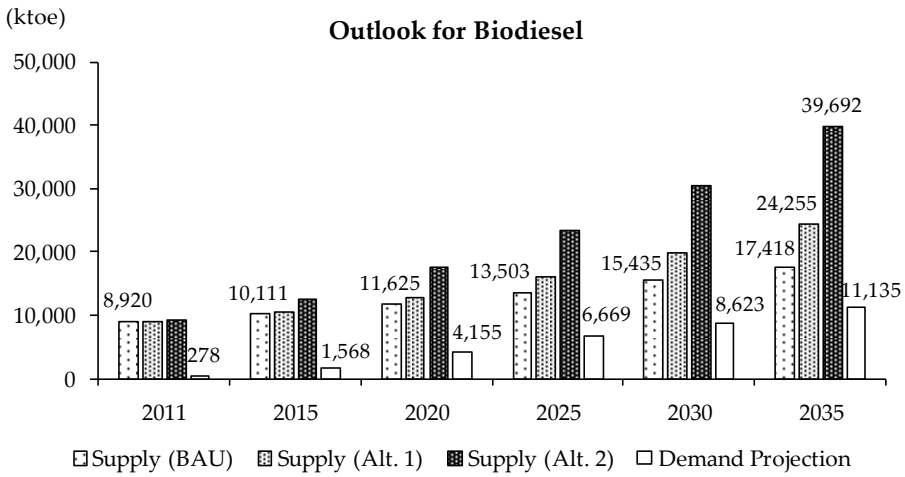
Biofuel Outlook

The government of Indonesia is getting more active in promoting the production and utilisation of biofuels, driven by concerns on energy security, climate change, and poverty mitigation in the rural areas. Given the country's rapidly increasing demand for liquid fuels and the government's ambitious target for biofuel blend, Indonesia's demand for both bioethanol and biodiesel is expected to grow fast in the future.

According to the estimation results, the domestic production of bioethanol in Indonesia will not be enough to meet the national target. One of the possible solutions is cassava, which is less demanding in terms of the quality of soil. Cassava has the potential to be cultivated in a broader variety of lands, even on scattered small-scale land with low investment using existing technology. As for biodiesel, Indonesia has more than enough feedstock, palm oil, to achieve the target. Policies should be focused on biodiesel manufacturing, distribution infrastructure, and price issues. Forest protection is supposed to became the main issues in the future. The development of new lands should be carried out with careful management.

Figure 3.17 Biofuel Outlook in Indonesia through 2035





Source: Estimation was done for this study by author/s.

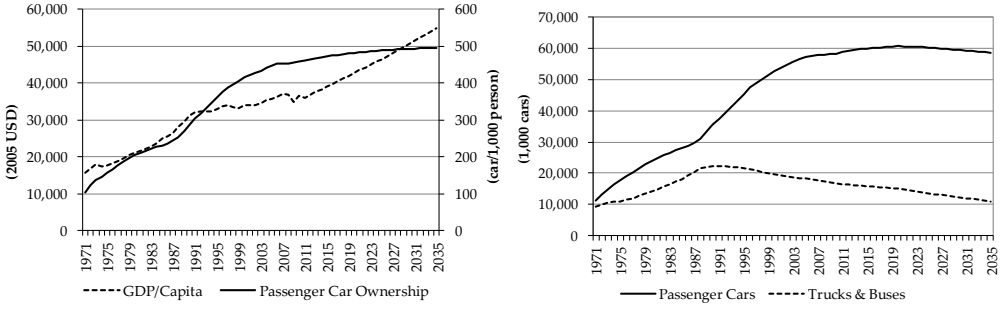
3.3.7. Japan

Biofuel Demand

The passenger car ownership per capita in Japan has already entered the saturation stage and the situation is supposed to persist through 2035. Moreover, due to a decreasing population, the stock of passenger cars is supposed to decline over the long term. The stock of Trucks & Buses has already started shrinking and the trend is expected to continue over the projection period.

It is assumed that bioethanol blending will reach 3 percent in 2035, which will require 1,101.8 ktoe of bioehtanol in the same year. Since diesel demand in road transport is declining and will continue to decrease in the future, no biodiesel use is expected through the projection period.

Figure 3.18 Passenger Car Ownership per Capita vs. Income Level and Stock of Passenger Cars and Trucks & Buses



Source: IEEJ.

Biofuel Supply Potential

Japan is a net importer of rice, maize, and sugar and, generally, the country has little feedstock supply potential for bioethanol. However, there is still small domestic potential of bioethanol supply, with the cultivation of sugarcane in Okinawa, which is subsidised by government. The by-product of molasses, though in small quantity, could be used to produce bioethanol. In this study, it is estimated that bioethanol supply potential (in a BAU scenario) will keep the level of 11 ktoe in 2035.

It seems that this production is decreasing due to the loss of subsidy benefits. According to the official announcement, Japan has 396,000 ha of paddy fallow land and 233,000 ha of unused agricultural land. Based on a maximised use of the unused agriculture land in "Alternative 1", estimation showed that the bioethanol supply potential is projected to reach 171 ktoe in 2035. The supply potential can still be improved by maximising productivity in "Alternative 2" to reach 488 ktoe in 2035.

Japan has no oilseed crops for feedstock supply of biodiesel except some scattered small-scale biodiesel production using waste cooking oil in local areas. The practice is not expected to scale up, given the country's declining population.

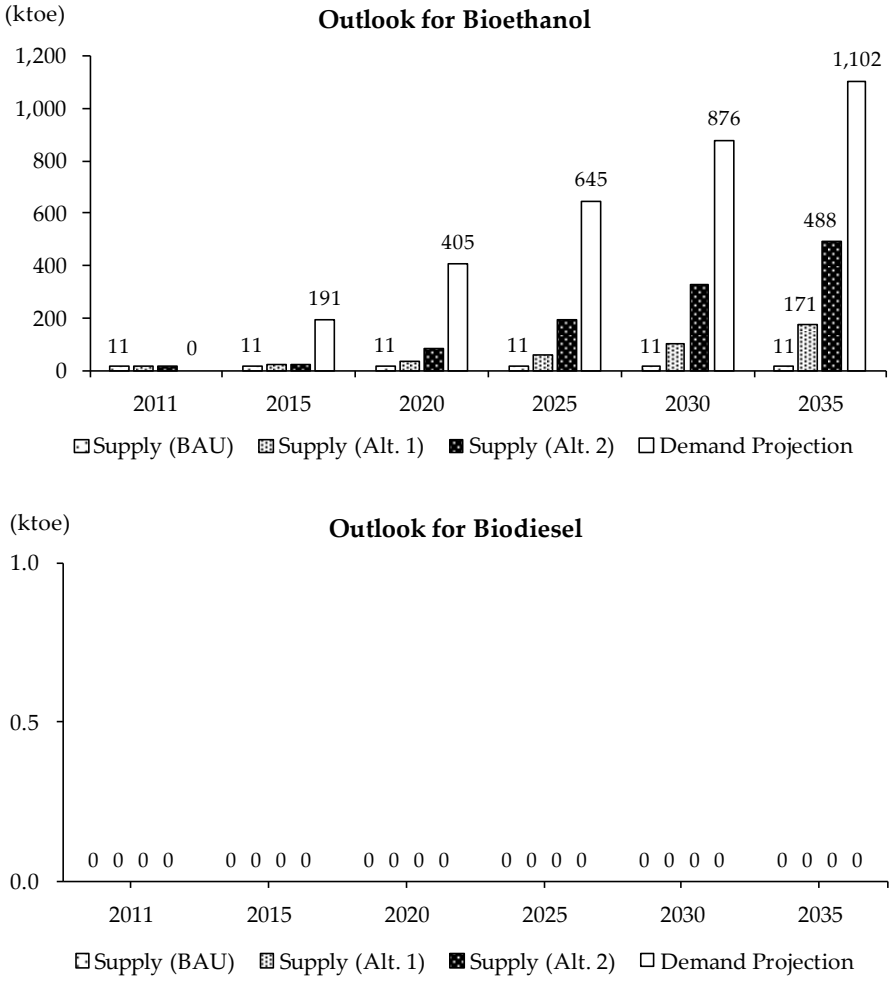
Biofuel Outlook

The oil industry in Japan carried out a voluntary biofuel program targeting the use of 500,000 kL of E3. To meet the target, supply is dependent on imports from Brazil because there is little feedstock potential in the country. Even though Japan has potential to utilise the fallow paddy land to increase its feedstock supply for bioethanol, there is no benefit in the domestic market to produce bioethanol because imported bioethanol is cheaper than its domestic production.

For biodiesel, the situation is similar because Japan has to rely on import. Therefore, economic benefits associated with biofuel utilisation in Japan are

low. However, Japan has the advantage in the research and development (R&D) of second-generation biofuel production in Asia.

Figure 3.19 Biofuel Outlook in Japan through 2035



Source: Estimation was done for this study by author/s.

3.3.8. Lao PDR

Biofuel Demand

To reduce the country's reliance on oil import, the government of Lao PDR has outlined a tentative target for biofuel use, requiring a mandatory blending of 10 percent bioethanol into gasoline and 10 percent biodiesel into diesel

from 2015 onward. Under the assumption that the target would be implemented, annual bioethanol demand is projected to reach 27 ktoe and annual biodiesel demand is projected to grow to 291 ktoe in 2035.

Biofuel Supply Potential

In Lao PDR, cassava, maize, and sugarcane (molasses) are the major feedstocks for bioethanol. Foreign companies have entered the market aggressively in cassava plantation for export, and the cultivation area is expanding rapidly in recent years. The supply potential (in a BAU scenario) of bioethanol in Lao PDR is estimated to expand from 23 ktoe in 2011 to 52 ktoe in 2035. According to FAO data, Lao PDR has approximately 940,000 ha of unused agriculture land. In "Alternative 1", the full expansion of the unused agriculture land can increase the supply potential for bioethanol to 507 ktoe in 2035. If productivity has been maximised in "Alternative 2", the supply potential can improve to 1,421 ktoe in 2035.

Meanwhile, soybean is the only oilseed crop growing in Lao PDR, and the cultivation area is relatively small. As Lao PDR is a net importer of cooking oil, the country is supposed to have little feedstock for biodiesel production. Even if the scenario is "Alternative 1" or "Alternative 2", there will only be a small increase in biodiesel supply potential.

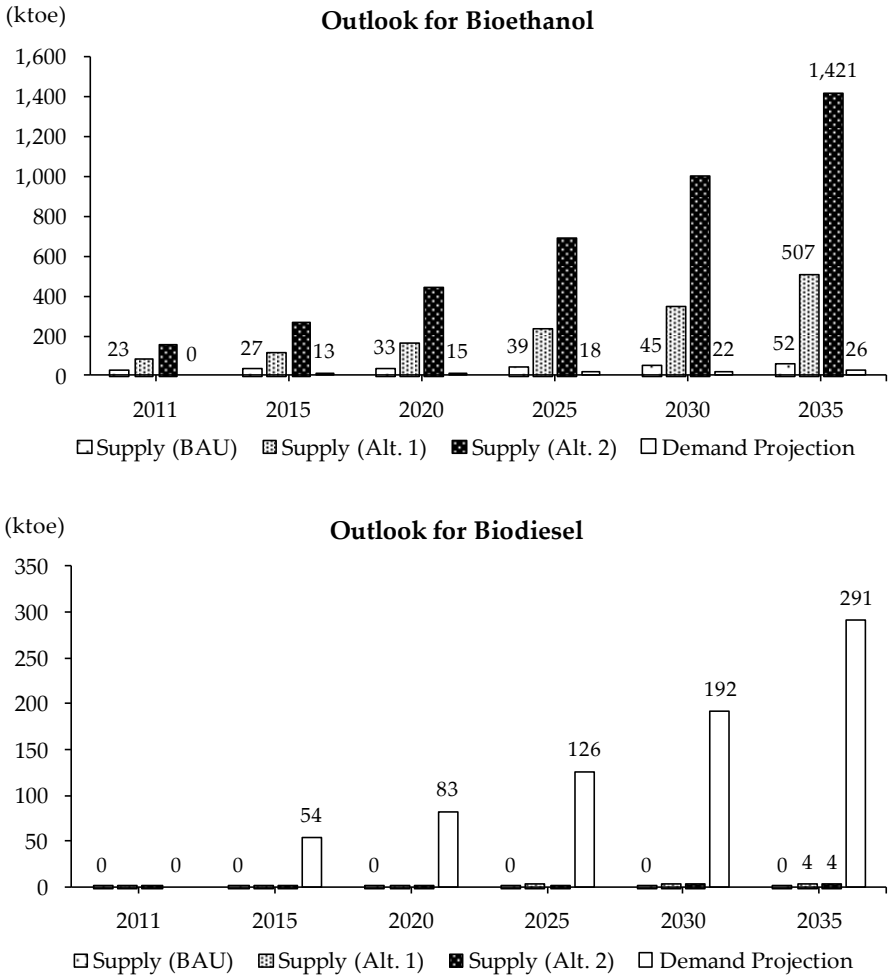
Biofuel Outlook

Lao PDR is a country with a land area of 237,000 square kilometres and a population of 6.2 million people. According to the statistics of FAO, the country has developed agricultural land of 2.4 million ha, accounting for 10.3 percent of the total land area. In the future, agricultural development for the purpose of exports is expected to expand. Foreign companies have been investing in Lao PDR's agricultural sector, some of whom invest not only in cultivation activities but also in the production of bioethanol for export.

Meanwhile, cultivation of oilseed crops is not popular in Lao PDR and the small population does not consume a high volume of cooking oil. Most of the

cooking oil demand has been covered by small amounts of import and domestic consumption. However, the government is looking for new oilseed crops, like jatropha, to supply the feedstock for biodiesel to meet the possible demand driven by the country's national biofuel program.

Figure 3.20 Biofuel Outlook in Lao PDR through 2035



Source: Estimation was done for this study by author/s.

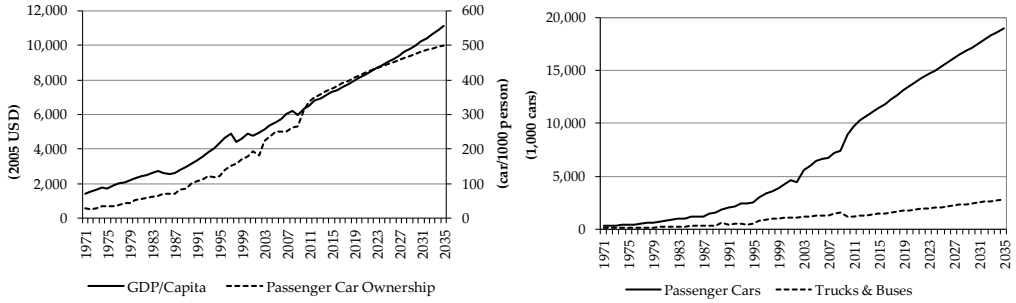
3.3.9. Malaysia

Biofuel Demand

Car ownership in Malaysia is supposed to increase substantially over the projection period.

The B5 program is currently underway in Malaysia and the government will continue to focus on the B5 program in the future. It is assumed that the blending rate for biodiesel will remain 5 percent over the projection period. Besides, biodiesel is supposed to be used also in the industry sector. The blending rate of biodiesel in the industry sector is assumed to reach 5 percent by 2035. Under these assumptions, the annual biodiesel demand is projected to reach 584 ktoe in 2035. Meanwhile, there is no bioethanol use in Malaysia at present and without government intention to promote use of bioethanol, the situation is expected to persist in the future.

Figure 3.21 Passenger Car Ownership per Capita vs. Income Level and Stock of Passenger Cars and Trucks & Buses



Source: IEEJ.

Biofuel Supply Potential

In Malaysia, there is little cultivation of crops that can be used as feedstock for bioethanol production. In this study, it is assumed that Malaysia has little feedstock supply for bioethanol.

On the other hand, Malaysia's palm oil production accounted for 40.0 percent of world's total in 2011, and Malaysia is one of the world's largest palm oil exporters. In this analysis, palm oil is supposed to be the major biodiesel feedstock in Malaysia. The supply potential (in a BAU scenario) of biodiesel of Malaysia is estimated to be 14,774 ktoe in 2035.

According to FAO data, Malaysia's agricultural land area is 7.87 million ha, where 6.76 million ha is harvested area. Unutilised agricultural land area would be approximately 1.1 million ha. In the BAU case, the actual cultivated oil palm area reached 4.36 million ha in 2012 and is projected to reach 5.19 million ha in 2035. These will mean the full expansion of unutilised agriculture land in the country. In "Alternative 1", the increase in the supply potential by land expansion will be limited by arable land. However, that still might be resolved by improving productivity. According to the actual data in 2012, the productivity of palm oil in Malaysia has reached an annual average of 4.4 tonnes per ha (crude palm oil [CPO]-based). The development of varietal breed may improve the productivity to 5.5~6.0 tonnes per ha in Malaysia. Based on the breed developed with the climatic conditions in the country, "Alternative 2" has projected that over the next 25 years, if all palm oil plantations in Malaysia were planted to this breed (5.5 tonnes per hectare), the supply potential is expected to reach 21,559 ktoe in 2035.

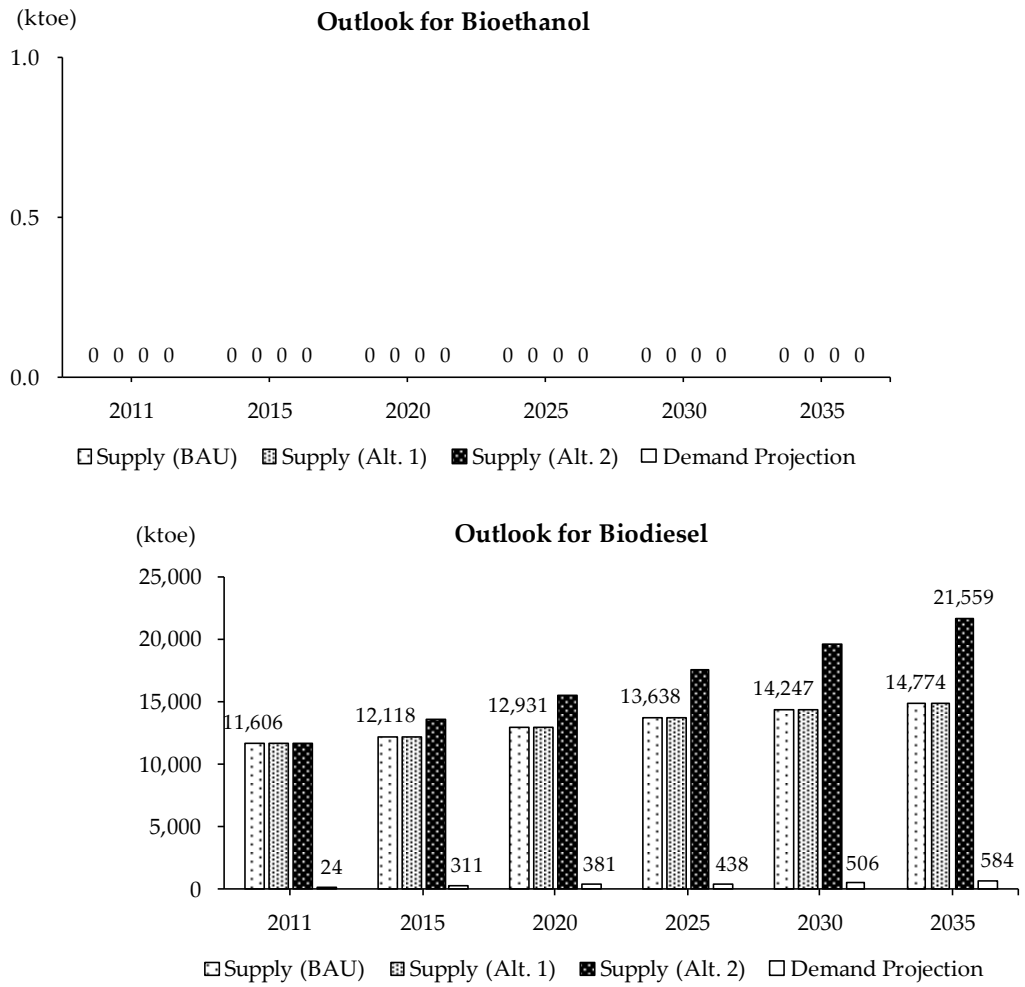
Biofuel Outlook

It is assumed that Malaysia will have no bioethanol demand and supply in the projection period because of the lack of feedstock supply. However, the country has a huge potential for biodiesel supply. The government of Malaysia is planning to raise the blending rate of biodiesel to B7 by 2014.

However, the full implementation of B5~B7 in the domestic market can raise the demand only to 500~700 ktoe in 2035. Compared to the supply potential of 14,744 ktoe under a BAU scenario in 2035, Malaysia is supposed to become a main exporter of biodiesel in this region. The availability of land for palm oil plantation will be the major issue in the future. To reduce forest

exploitation, there should be policies to support the replanting and improving the productivity for palm oil.

Figure 3.22 Biofuel Outlook in Malaysia through 2035



Source: Estimation was done for this study by author/s.

3.3.10. Myanmar

Biofuel Demand

Although the government of Myanmar has put forward a plan to replace petroleum fuels with bioethanol and biodiesel, the details of the plan is not clear. It is assumed that Myanmar will achieve 5 percent bioethanol blending by 2035. Under this assumption, the annual demand for bioethanol is projected to reach 57 ktoe in 2035.

Biofuel Supply Potential

Rice, maize, cassava, and sugarcane, which can be used to produce bioethnol, are being planted in large areas in Myanmar. The country has a production surplus of all these crops and exports these crops to other countries. In this study, it is estimated that the supply potential (in a BAU scenario) of bioethanol in Myanmar would increase from 122 ktoe in 2011 to 378 ktoe in 2035. Since the unused agricultural land is not too large in this country, there is only a small increase in "Alternative 1". The supply potential gets much more improvement in "Alternative 2" by maximising the productivity to reach 628 ktoe in 2035.

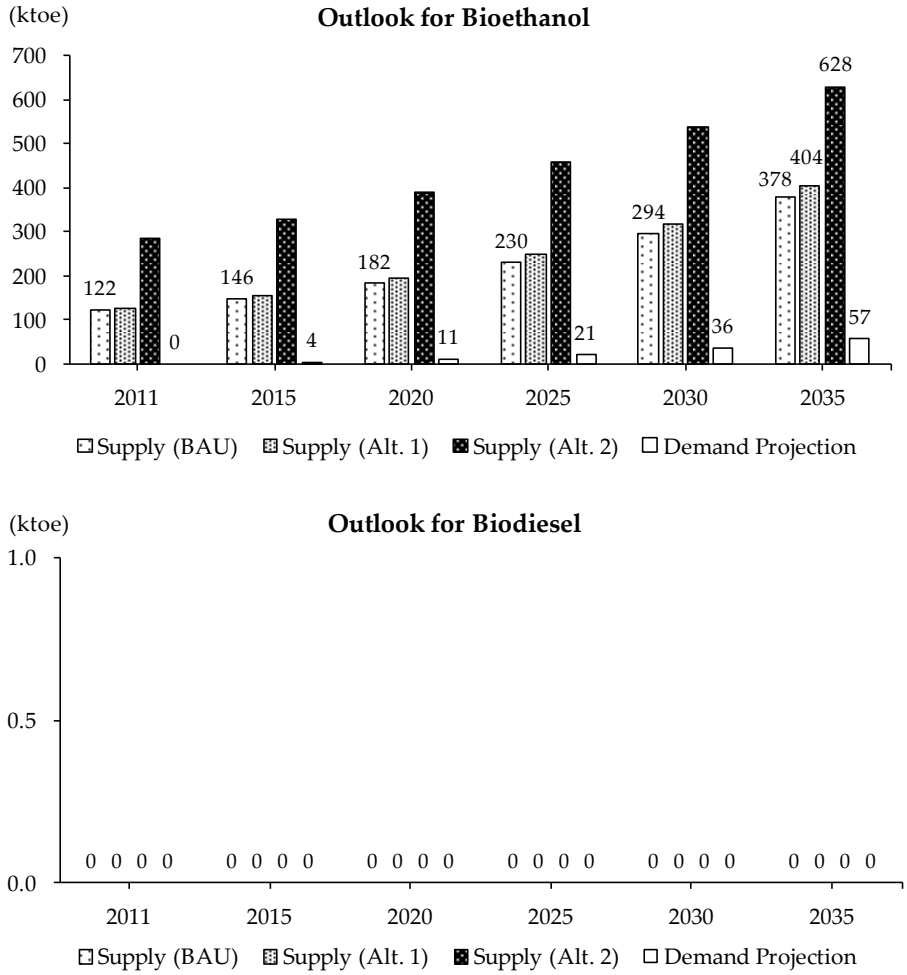
The cultivation area of oilseed crops is relatively small in scale. In this study, it is assumed that there is little feedstock for biodiesel production in Myanmar.

Biofuel Outlook

Although there has been little bioethanol consumption in Myanmar, the country has a feedstock supply potential of bioethanol. The country also has the potential to export bioethanol in the future.

At present, the mandatory blend of biodiesel is not implemented, but the target on biodiesel use was set by the government. The government has drafted a plantation plan of jatropha in the scale of several million hectares. However, more than six years have passed since the plan was set and no significant results were obtained.

Figure 3.23 Biofuel Outlook in Myanmar through 2035



Source: Estimation was done for this study by author/s.

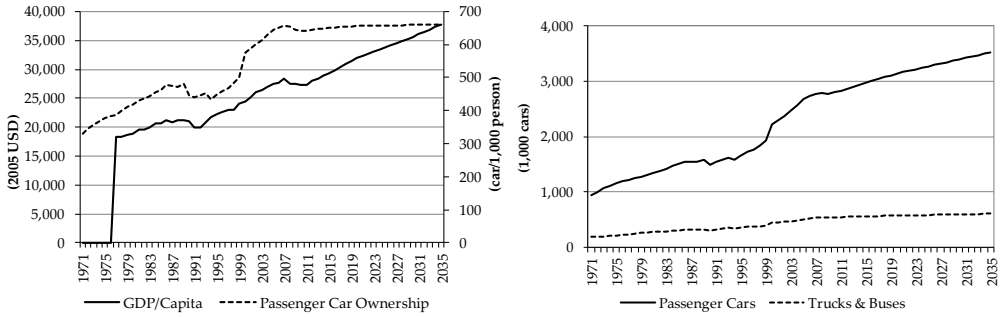
3.3.11. New Zealand

Biofuel Demand

Passenger car ownership per capita in New Zealand has already been in a saturation status and the situation is supposed to persist through 2035.

There is no clear policy on the target of biofuel use in New Zealand. In the Engine Fuel Specification Regulation 2011, the standard for biofuels is set as follows: blend of bioethanol up to 10 percent of gasoline (E10), and blend of biodiesel up to 5 percent of diesel (B5). It is assumed that the use of E10 and B5 will be fully penetrated by 2035. Under this condition, the annual demand for bioethanol is projected to reach 277 ktoe and 105 ktoe for biodiesel in 2035.

Figure 3.24 Passenger Car Ownership per Capita vs. Income Level and Stock of Passenger Cars and Trucks & Buses



Source: IEEJ.

Biofuel Supply Potential

Due to limited crop production, it is assumed that New Zealand has little potential on feedstock supply for bioethanol. Most of the agricultural lands in this country are categorised as permanent meadows and pastures, which are not suitable for crop cultivation activities.

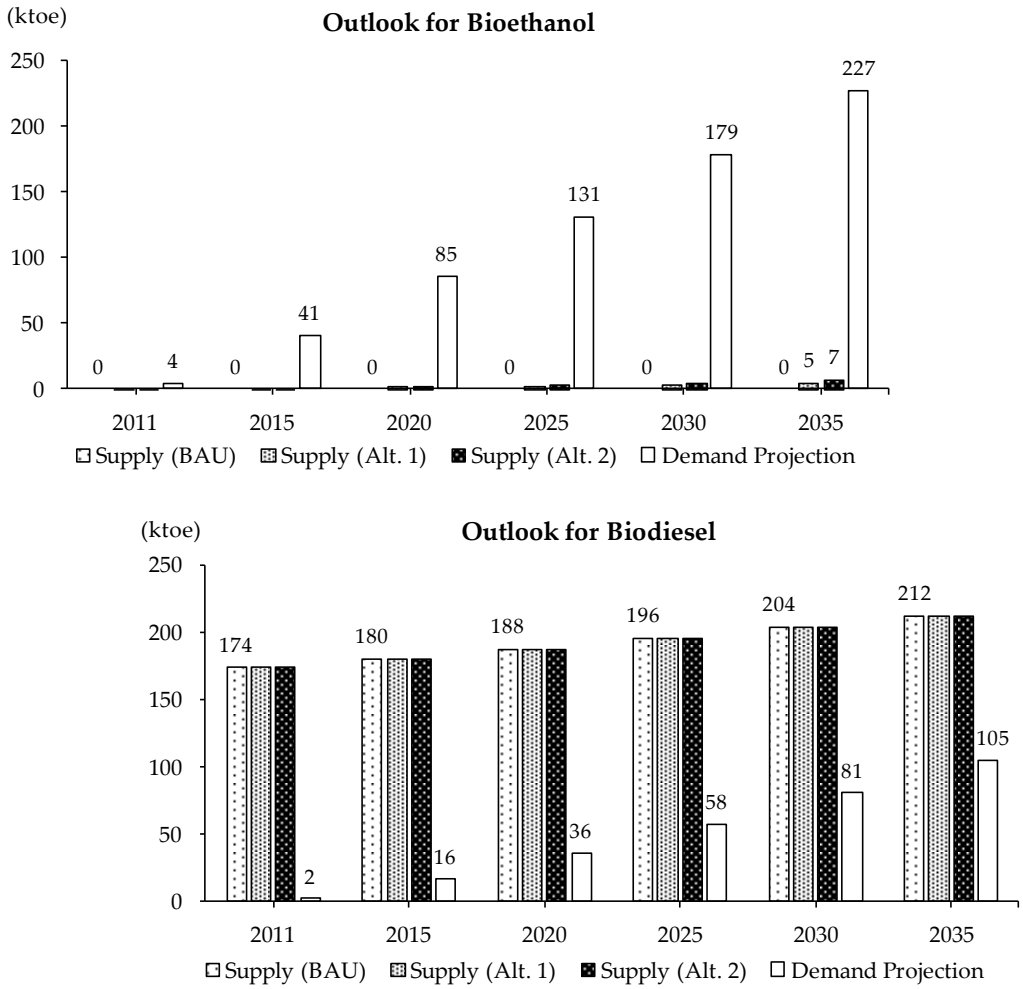
Meanwhile, the country has a potential supply of livestock fat that could be used to produce biodiesel. It is estimated that the supply potential of biodiesel will expand from 174 ktoe in 2011 to 212 ktoe in 2035.

Biofuel Outlook

There is not much cultivation of energy crops that can be converted into biofuels in New Zealand. Most of the agricultural lands in this country are utilised to produce highly valued production of fruits and for livestock activity. New Zealand needs to import bioethanol to meet its domestic bioethanol demand.

New Zealand's economy is heavily dependent on agriculture and associated food processing. Dairy is an important export industry in New Zealand. The development of biodiesel industry from livestock fat would bring the industry an added value and a hedge against price fluctuations.

Figure 3.25 Biofuel Outlook in New Zealand through 2035



Source: Estimation was done for this study by author/s.

3.3.12. Philippines

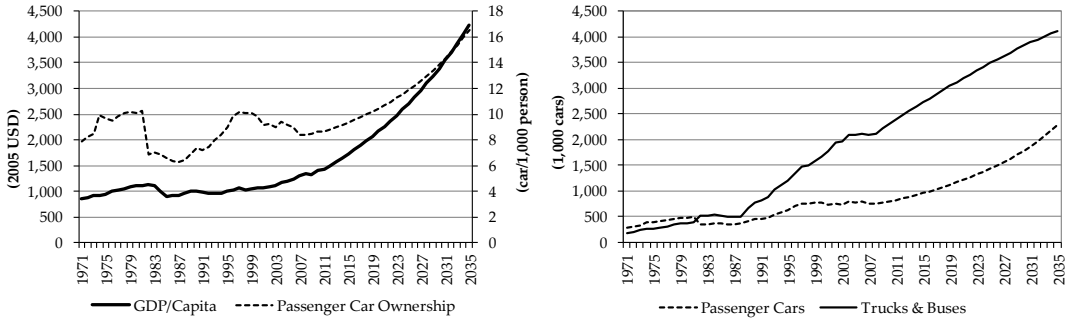
Biofuel Demand

From a small base, car ownership in the Philippines is expected to have an accelerating growth with its rising income level and strong economic development.

The assumption of future biofuel blend rate is made based on a Department of Energy (DOE) study (see Table 3.1-3 and Table 3.1-4). The blend rates for both bioethanol and biodiesel are assumed to stay unchanged from 2030 to

2035. It is projected that the annual demand in 2035 for bioethanol will reach 935 ktoe and 1,282 ktoe for biodiesel**.**

Figure 3.26 Passenger Car Ownership per Capita vs. Income Level and Stock of Passenger Cars and Trucks & Buses



Source: IEEJ.

Biofuel Supply Potential

In the Philippines, only sugarcane (molasses) has the potential to be a major feedstock for bioethanol production. However, because it is a net importer of sugar, only molasses is expected to be used to produce bioethanol. Supply potential (in a BAUscenario) of bioethanol is estimated to expand slightly from 111 ktoe in 2011 to 135 ktoe in 2035. In "Alternative 1", the expansion of unused agricultural land is not expected to be high; the supply potential for bioethanol has a small increase to reach 229 ktoe in 2035. Because of limited land, although productivity is maximised in "Alternative 2", the supply potential can improve only up to 329 ktoe in 2035.

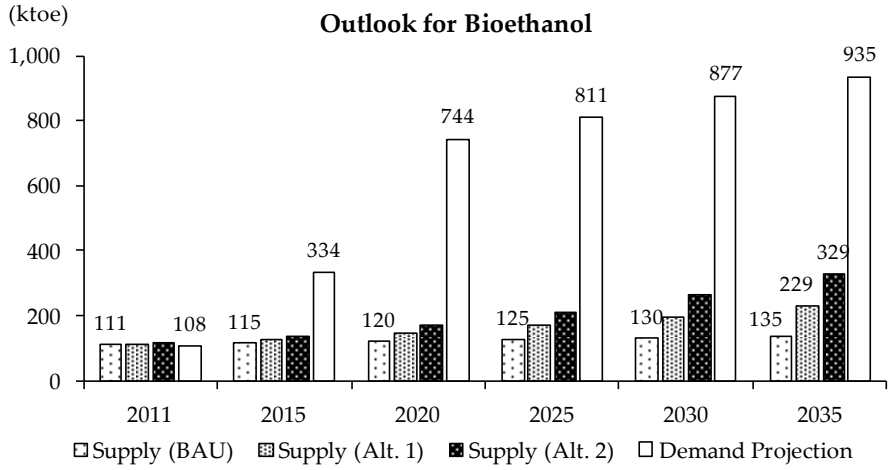
Coconut is the main feedstock for biodiesel production in the Philippines. The country is one of the world's largest coconut producers and is also a major exporter of coconut products. By promoting the use of biodiesel, the income of coconut farmers and that of coconut industries are expected to increase. In this study, coconut production is estimated based on the government's promotion program on coconut cultivation. As a result, the supply potential of biodiesel is expected to increase from 201 ktoe in 2011 to 488 ktoe in 2035. The supply potential in "Alternative 2" can be further improved by

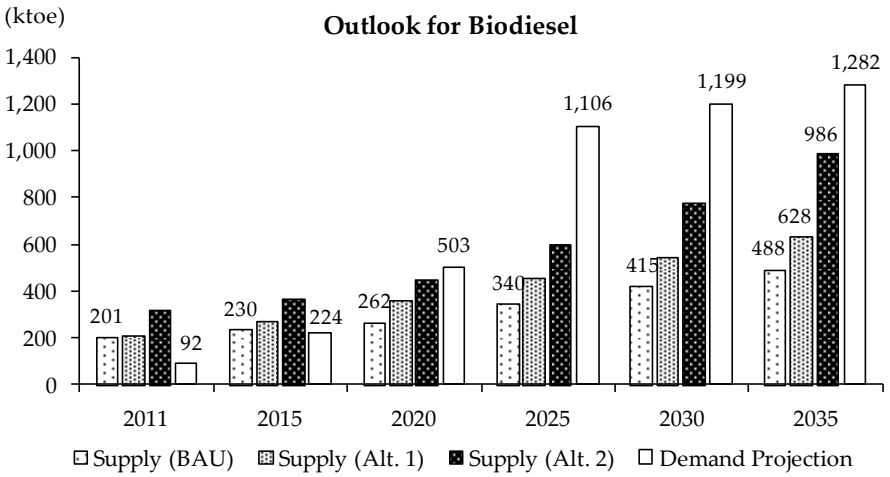
maximising the productivity, which will result in projection improvements to reach 986 ktoe in 2035.

Biofuel Outlook

Driven by concerns on energy security coupled with the intention to increase farmers' income, the Philippine government is very active in promoting biofuels' production and utilisation. The government is planning to raise the mandated blend rate of bioethanol to 20 percent by the end of 2035, while allowing consumers to have an option for E85 (85% of bioethanol). The supply and demand gap is anticipated for both bioethanol and biodiesel. However, domestic feedstock supply is unlikely to be enough to cover the demand driven by the mandatory blending target. Under competitive pressure from other crops as well as imports, sugarcane is becoming less attractive to farmers. Whether cassava plantation using marginal land is another feedstock option or not is now under discussion. As for biodiesel, the expansion in coconut cultivation is too slow in contrast to the rapid increase of domestic consumption of coconut for food, driven by the growing population. In this regard, biodiesel from coconut will not be enough in the long term. Alternative crops, such as oil palm in Mindanao and in other islands in southern Philippines, should be considered.

Figure 3.27 Biofuel Outlook in the Philippines through 2035





Source: Estimation was done for this study by author/s.

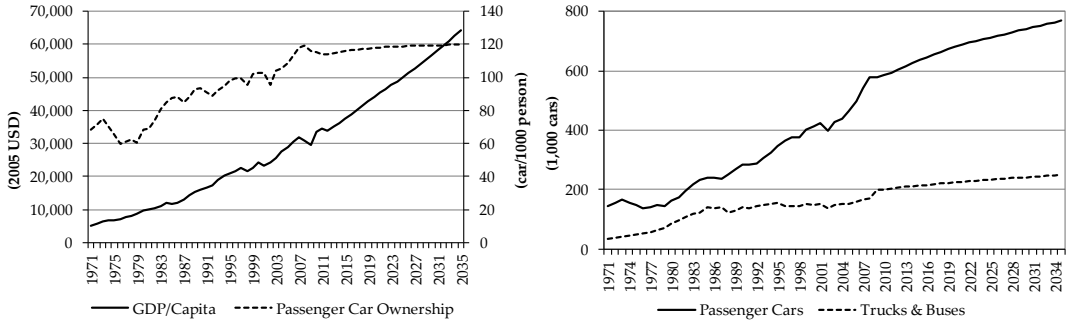
3.3.13. Singapore

Biofuel Demand

Car ownership in Singapore is supposed to remain in a saturation status through 2035.

Although the government of Singapore has carried out several initiatives on the R&D of biofuel to develop a national biofuel industry, little intention was shown in promoting the utilisation of biofuels. Therefore, it is assumed that there will be no biofuel demand in Singapore over the projection period.

Figure 3.28 Passenger Car Ownership per Capita vs. Income Level and Stock of Passenger Cars and Trucks & Buses



Source: IEEJ.

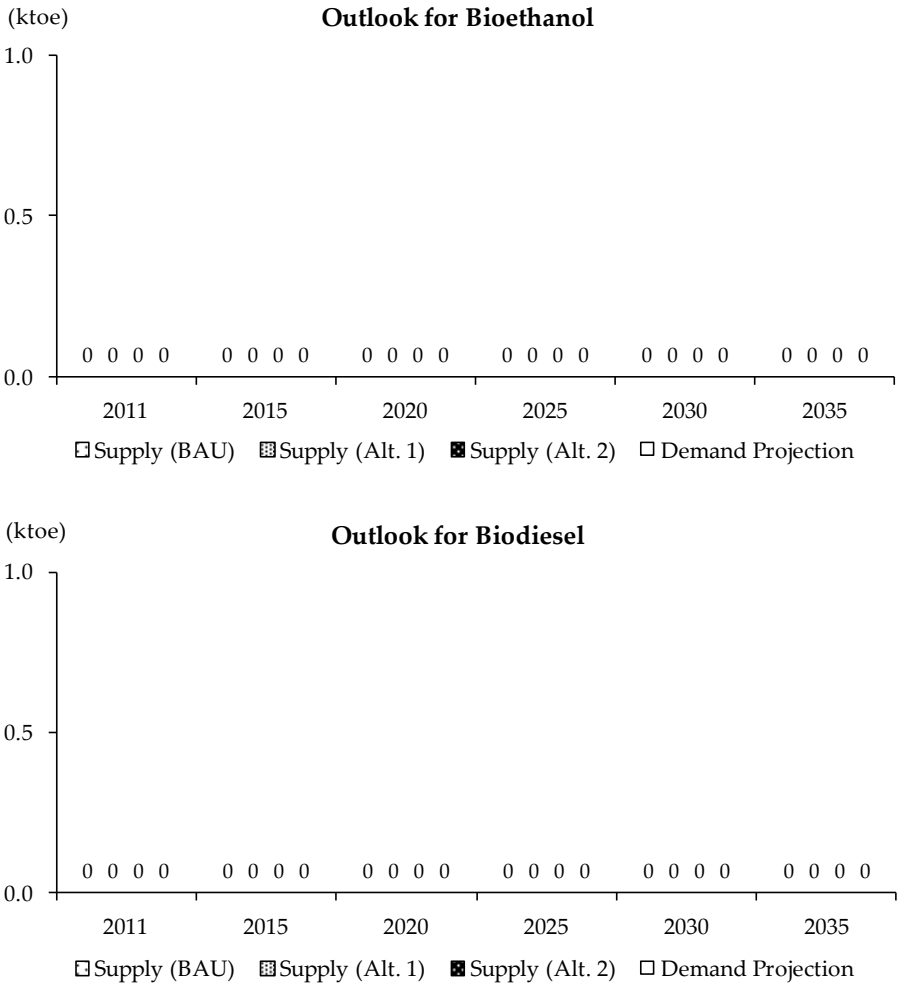
Biofuel Supply Potential

Singapore has no potential in biofuel feedstock supply from domestic production because of the country's limited agricultural land. Almost 100 percent of the country's food supply is dependent on import, mainly from Malaysia and Indonesia.

Biofuel Outlook

Although Singapore has no domestic feedstock for biofuel production, Singapore is targeting to become one of the main exporters of biodiesel and the biofuel trade centre in Asia. The government is also trying to promote infrastructure development to become the hub of biodiesel refinery in this region. Nestle Oil is one of the biggest investors in Singapore in the biodiesel industry with a production capacity of 800,000 tonnes per year.

Figure 3.29 Biofuel Outlook in Singapore through 2035



Source: Estimation was done for this study by author/s.

3.3.14. South Korea

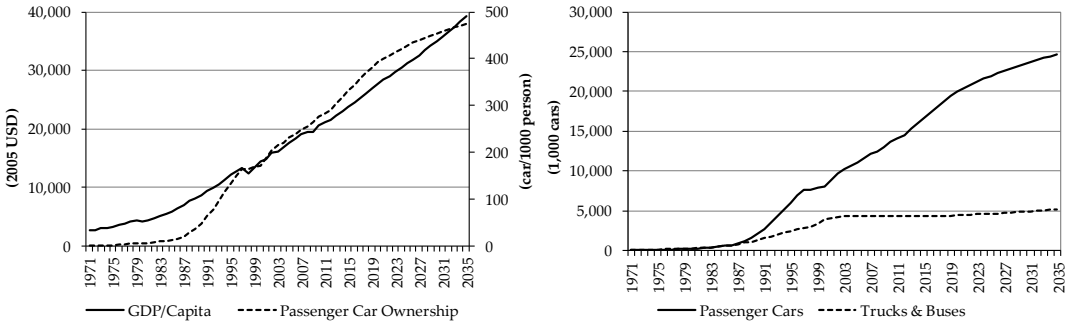
Biofuel Demand

South Korea has experienced rapid growth of mobilisation since late 1980s. However, it is expected that car ownership in South Korea is going to approach saturation through 2035.

Based on the government's biofuel policy, it is assumed that B5 (5% blend of biodiesel) will be fully penetrated in the country by the end of 2035. However, since there is no clear policy on the utilisation of bioethanol, no

usage of bioethanol is expected during the projection period. According to the assumption, it is projected that the annual demand for biodiesel will grow to 515 ktoe in 2035.

Figure 3.30 Passenger Car Ownership per Capita vs. Income Level and Stock of Passenger Cars and Trucks & Buses



Source: IEEJ.

Biofuel Supply Potential

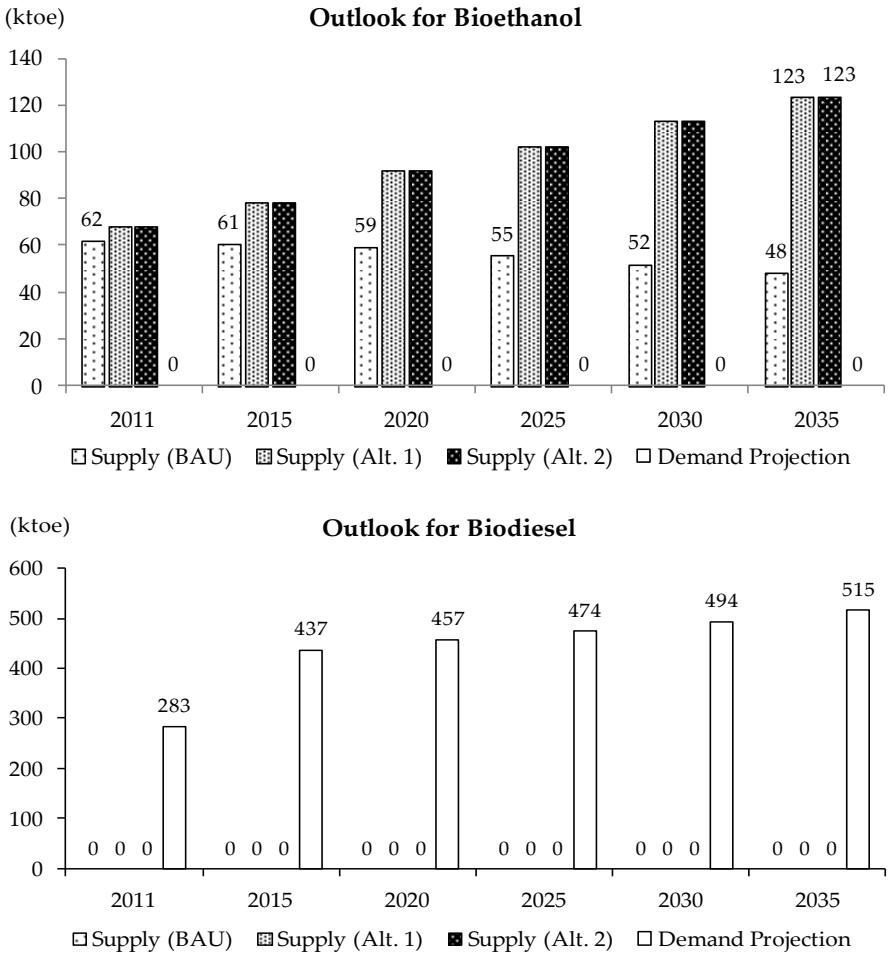
The food self-sufficiency in South Korea is only about 20 percent. The country is a net importer of sugar and maize, which could be used to produce bioethanol. Only rice production have surplus after domestic consumption. However, the excess capacity of rice production is small. In this study, it is estimated that bioethanol supply potential will decline from 62 ktoe in 2011 to 48 ktoe in 2035. According to FAO data, South Korea has approximately 110,000 ha of fallow paddy land. In "Alternative 1", the full expansion of these fallow paddies can increase the supply potential for bioethanol to 123 ktoe in 2035. "Alternative 2" case will not bring much improvement on supply potential by maximising the productivity since the yield of paddies in this country is already high.

South Korea has no oilseed crops for biodiesel production. Small-scale biodiesel production using waste cooking oil has been carried out in some area. Although the mandatory biodiesel blending plan is being currently promoted, South Korea will have to import feedstock for biodiesel production, or biodiesel itself, to meet the target.

Biofuel Outlook

Lacking feedstock supply for bioethanol production, South Korea has not yet laid out a bioethanol mandate. However, the program of mandatory blending of biodiesel is underway. With a few domestic feedstock supplies, the country has to rely on import to meet domestic demand. The major force behind the biofuel promotion policy is environmental concerns. Many South Korean companies are moving actively to secure feedstock supply by investing in the cultivation of oil crops in Southeast Asian countries.

Figure 3.31 Biofuel Outlook in South Korea through 2035



Source: Estimation was done for this study by author/s.

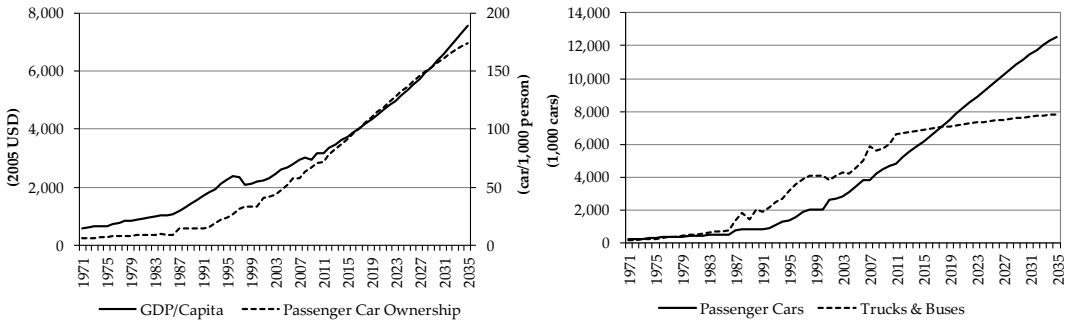
3.3.15. Thailand

Biofuel Demand

The substantial growth of passenger car ownership in Thailand is expected to persist over the projection period. However, the growth of the Trucks & Buses stock is supposed to slow down.

The biofuel utilisation in Thailand is assumed to reach the government's target set by 2022, after which the blend rates are assumed to stay the same till the end of the projection period. The annual demand for bioethanol is projected to increase to 1,849 ktoe and 1,299 ktoe for biodiesel in 2035.

Figure 3.32 Passenger Car Ownership per Capita vs. Income Level and Stock of Passenger Cars and Trucks & Buses



Source: IEEJ.

Biofuel Supply Potential

Thailand has a good potential for feedstock resources (mainly sugarcane and molasses) for bioethanol production. The supply potential (in a BAU scenario) of bioethanol is estimated to reach 2,348 ktoe in 2035. According to FAO data, Thailand has approximately 249,000 ha of unused agricultural land. In "Alternative 1", the full expansion of these unused agriculture lands can increase the supply potential for bioethanol to 2,944 ktoe in 2035. If

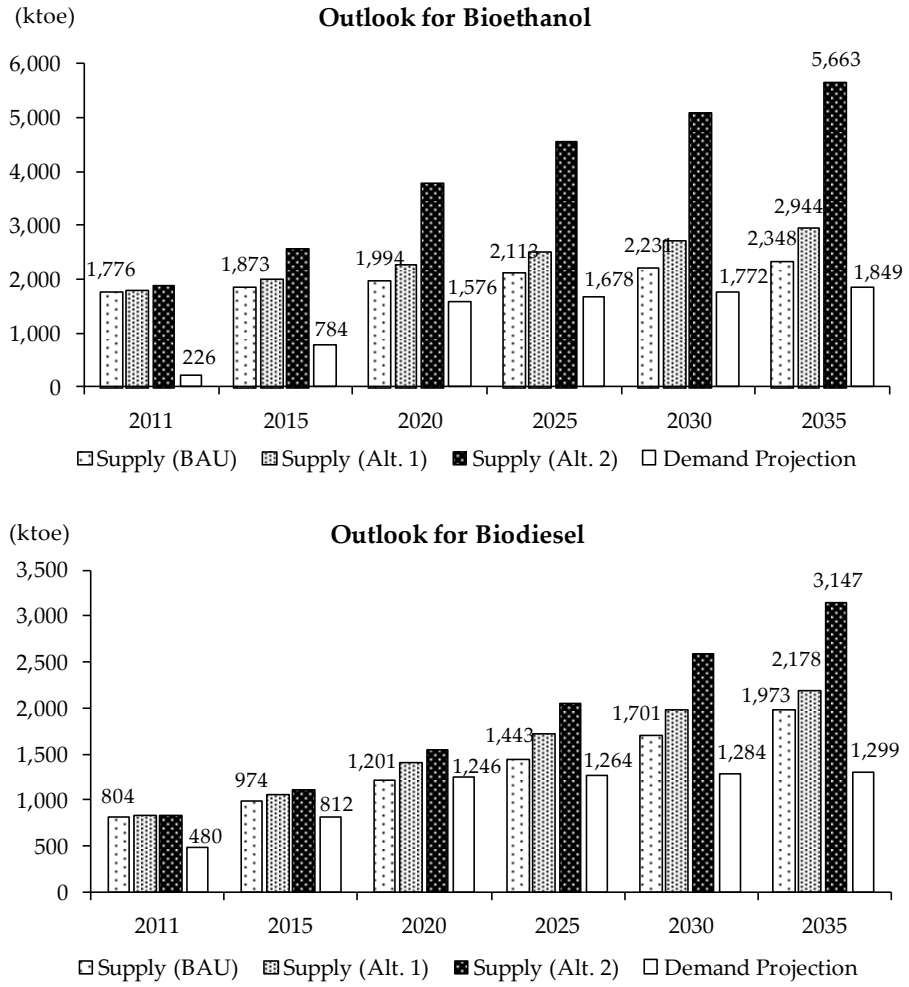
productivity is maximised in “Alternative 2”, the supply potential can improve to 5,663 ktoe in 2035.

The major biodiesel feedstock is palm oil. Thailand is the world's third-largest palm oil producer. It is projected that Thailand’s supply potential of biodiesel will increase from 804 ktoe in 2011 to 1,973 ktoe in 2035. There are some programs to promote and expand the cultivation areas of palm oil in the southern part of Thailand. In “Alternative 1”, the supply potential for biodiesel will reach to 2,178 ktoe in 2035 and could improve to 3,147 ktoe in “Alternative 2” in 2035 by maximising productivity.

Biofuel Outlook

Among the ASEAN countries, Thailand is the most advanced country in terms of production and utilisation of bioethanol. With its abundant domestic supply and the government’s support, it is expected that the country’s demand for bioethanol will remain strong over the projection period. As an exporter of sugar and cassava, the country has enough capacity to provide raw materials for domestic bioethanol production. However, for biodiesel, although Thailand has the potential to supply palm oil as feedstock for biodiesel in the short to medium term, depending on the international price of palm oil, the producers might be more interested in exporting palm oil because of higher profits. Therefore, this requires more price incentives to attract domestic palm oil producers to undertake biodiesel production. However, as suitable land for oil palm cultivation is limited in the southern area of Thailand, alternative crops or second-generation technologies would be necessary in the long term.

Figure 3.33 Biofuel Outlook in Thailand through 2035



Source: Estimation was done for this study by author/s.

3.3.16. Viet Nam

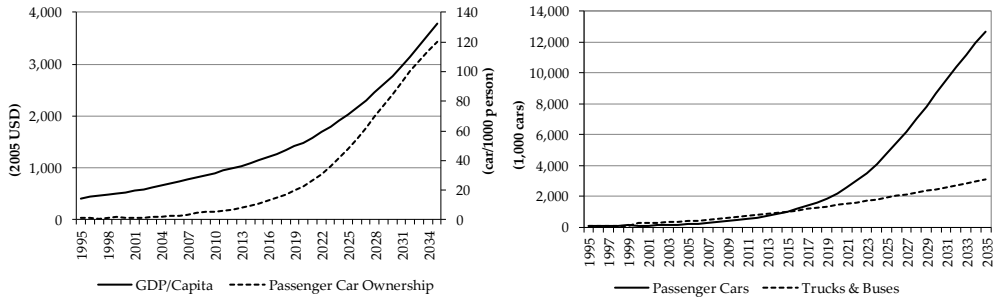
Biofuel Demand

Car ownership in Viet Nam is expected to have a rapid growth through 2035, driven by its increasing income level and strong economic development.

The government of Viet Nam has set a target to substitute 1 percent of the total transport fuel with biofuels by 2015 and 5 percent by 2025. If the target is realised, Viet Nam is expected to see an annual demand of 490 ktoe of bioethanol and 654 ktoe of biodiesel in 2025. It is assumed that the blend

rates of both bioethanol and biodiesel would stay the same after 2025. Annual demand of bioethanol is projected to grow to 807 ktoe in 2035 and biodiesel to reach 1,022 ktoe in the same year.

Figure 3.34 Passenger Car Ownership per Capita vs. Income Level and Stock of Passenger Cars and Trucks & Buses



Source: IEEJ.

Biofuel Supply Potential

The potential feedstocks for bioethanol production in Viet Nam are rice and sugarcane (molasses). It is estimated that the supply potential (in a BAU scenario) of bioethanol will increase from 725 ktoe in 2011 to 1,128 ktoe in 2035. Under "Alternative 1", the supply potential is estimated to increase to 1,708 ktoe in 2035 by expanding the agricultural land and in "Alternative 2", the supply potential will increase to 2,135 ktoe in 2035 if productivity is improved.

Since Viet Nam is a net importer of cooking oil, it is assumed that the country has little potential on feedstock supply for biodiesel production.

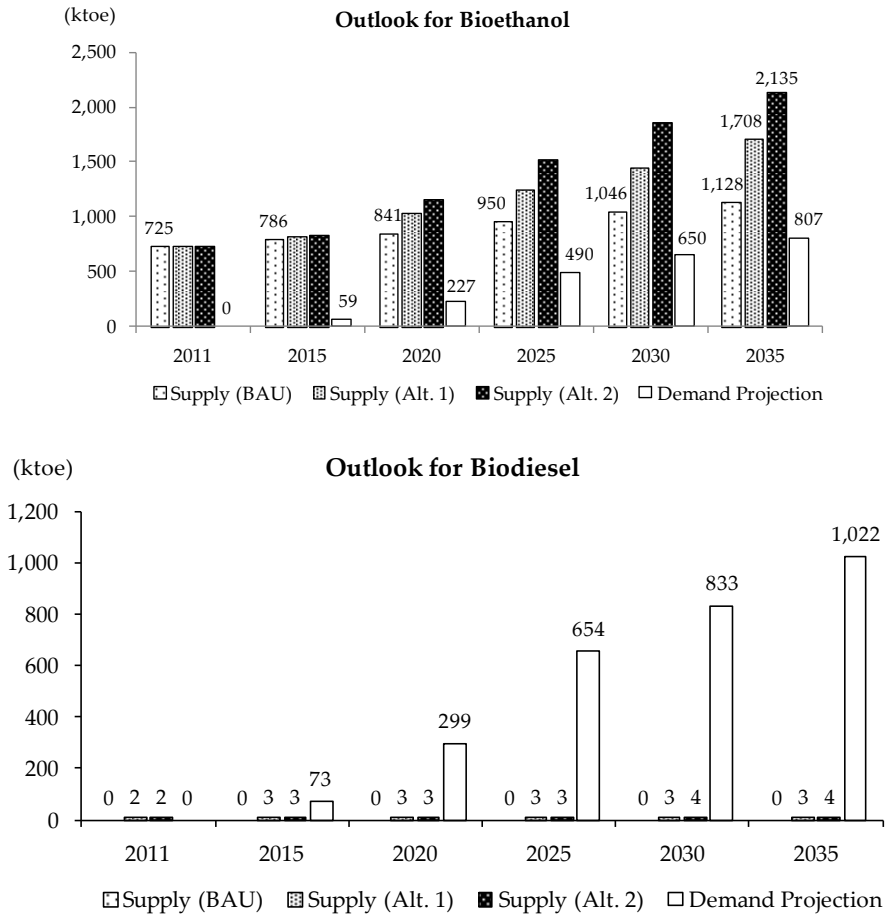
Biofuel Outlook

Viet Nam is slowly pushing forward plans to promote the use of bioethanol. There is enough feedstock (sugarcane, rice, and cassava) supply potential for bioethanol in the country. For the long term, the country has the potential to export bioethanol. At the time of this study, some cassava plantation projects

invested in by foreign companies are underway, the purpose of which is for export.

Although there is no mandatory blending of biodiesel in Viet Nam at the time of this study, the target for biodiesel use was set. The government has launched a plan for the cultivation of jatropha as a source of new feedstock. Most of the projects are promoted by foreign companies. However, the feasibility of producing biodiesel from jatropha still needs to be proven.

Figure 3.35 Biofuel Outlook in Viet Nam through 2035



Source: Estimation was done for this study by author/s.