Chapter 3

Biofuel Market and Supply Potential in East Asia Countries

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CHAPTER 3

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1.1. Methodology of Demand Projection

(1) Methodologies

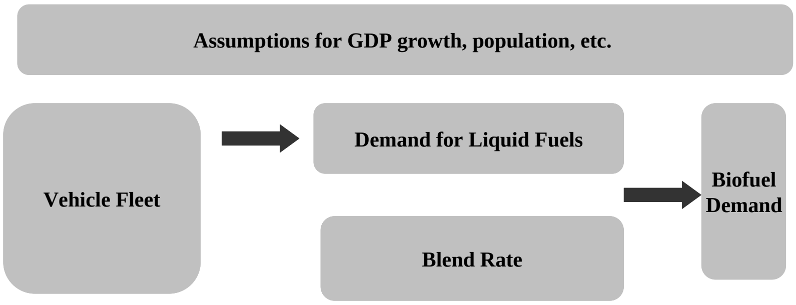
Biofuels could be used in various sectors, including industry sector, power generation, and the transport sector. Within the transport sector, biofuels can be used as vehicle fuels, fuels in marine, as well as aviation fuels. However, since road transport is currently the largest market for biofuels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

$$Biofuel = TotalDemandofCertainLiquidFuel \times BlendRate$$

Most governments have their targets for biofuels utilization and the targets are always in the form of blend rates. Usually, biofuel is blended into petroleum fuels for use (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.

Demands for two types of biofuels are projected in this study, bioethanol and biodiesel. 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 1.1-1 Framework to Forecast Biofuels Demand



Joyce Dargay (2007)[1] found that the relationship between ownership of passenger cars and income (GDP/Capita) level can be represented by a '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:

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

Where P is the passenger cars per 1000 persons

K is the saturation level of passenger cars per 1000 persons

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

[1] Joyce Dargay, Dermot Gately and Martin Sommer. 2007. *Vehicle Ownership and Income Growth, Worldwide: 1960-2030*. http://www.xesc.cat/pashmina/attachments/Imp_Vehicles_per_capita_2030.pdf

Each country's parameters α and β can be estimated by regression analysis using history data of the respective country. The saturation level of passenger cars ownership per capita (constant K, the unit of which is passenger cars per 1000 persons) of each country needs to be decided exogenously. The constant K is estimated by considering the population density and urbanization rate.

The future passenger car ownership is the product of passenger car ownership per capita and total population. Apart from passenger cars, to project future gasoline (equivalent) and diesel (equivalent) consumption, buses and trucks also need to be considered. Buses and Trucks are put under one category because the statistics used in this paper counts trucks and buses as one category 'Truck & Bus'. Different from passenger cars, 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[2] and adjusted depending on the fuel consumption characteristics of each country. The share of each kind of fuel (gasoline, diesel, natural

[2] The spreadsheet model is available at http://www.wbcsd.ch/plugins/DocSearch/details.asp?type=DocDet&ObjectId=MTE0Njc

gas) in total fuel demand was assumed (mainly based on history trends) to calculate demand for each kind of fuel. For the passenger cars, the fleet was further disaggregated into 4 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 an 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 Gompertz function, and the stock for each category of cars would be calculated in the stock counting module. In the calculation of stock turnover the vintage (category and year start using) 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 and then the annual demand for each kind of fuel was estimated. Similar to that of 'Truck & Bus', the fuel intensity of new car of each type 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, was 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 4 countries in the WG the WG member from each country was consulted on the future prospect of biofuel use in the country concerned.

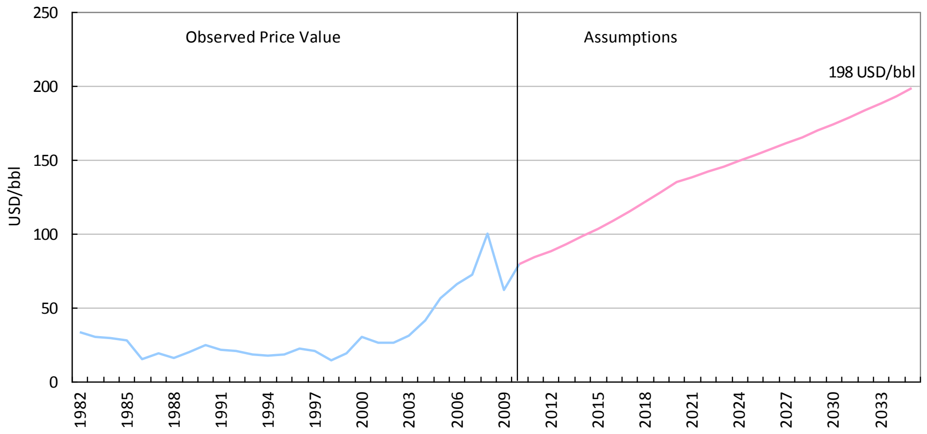
Table 1.1-1 Assumptions for GDP Growth

	2000~2010	2010~2020	2020~2035	2010~2035
Australia	3.1	4.1	3.7	3.9
Brunei Darussalam	1.4	2.9	2.6	2.7
Cambodia	8.0	5.1	5.1	5.1
China	10.5	8	4.3	5.8
India	7.7	8.1	6.2	7.0
Indonesia	5.2	5.8	5.1	5.4
Japan	0.7	1.4	1.1	1.2
Laos	7.2	7.1	7	7.0
Malaysia	4.6	4.4	3.4	3.8
Myanmar	11.5	7	7	7.0
New Zealand	2.4	2.6	1.8	2.1
Philippines	4.8	6.6	5.1	5.7
Singapore	5.6	5.2	3.1	3.9
South Korea	4.1	4	2.5	3.1
Thailand	4.3	4.5	3.5	3.9
Vietnam	7.3	7.0	7.1	7.1

Table 1.1-2 Assumptions for Population Growth

	2000~2010	2010~2020	2020~2035	2010~2035
Australia	1.5	1.5	1.3	1.4
Brunei Darussalam	2.0	2.0	1.6	1.8
Cambodia	1.3	1.8	1.8	1.8
China	0.6	0.4	0.0	0.1
India	1.5	1.3	0.9	1.0
Indonesia	1.2	1.2	0.1	0.5
Japan	0.1	-0.4	-0.7	-0.6
Laos	1.5	1.5	1.5	1.5
Malaysia	1.9	1.5	1.1	1.3
Myanmar	0.6	1.0	1.0	1.0
New Zealand	1.2	1.0	0.7	0.8
Philippines	1.9	1.9	1.4	1.6
Singapore	2.6	1.3	0.7	0.9
South Korea	0.5	0.4	0.1	0.2
Thailand	0.9	0.3	0.3	0.3
Vietnam	1.1	1.0	0.6	0.8

Figure 1.1-2 Assumption for Crude Oil Price



Notice: WTI for historical data.

1.2. Methodology of Supply Potential Estimation

Model framework

There have been differences in investigations on the production function in different parts of the world in both developing and developed countries. In this study, the Cobb-Douglas Production Function was used for calculating the production of Energy Crops in each country. The basic formula for calculating production of energy crops was as shown below:

$Y = aA^{\alpha}L^{\beta}K^{\gamma}$

A double log equation was used and the estimated formulas were as follows:

$LN(Y) = LN(aA^{\alpha}L^{\beta}K^{\gamma})$

Where;

Y = Output (Production of Energy crops)

A = Land (Cultivation Area)

L = Labor

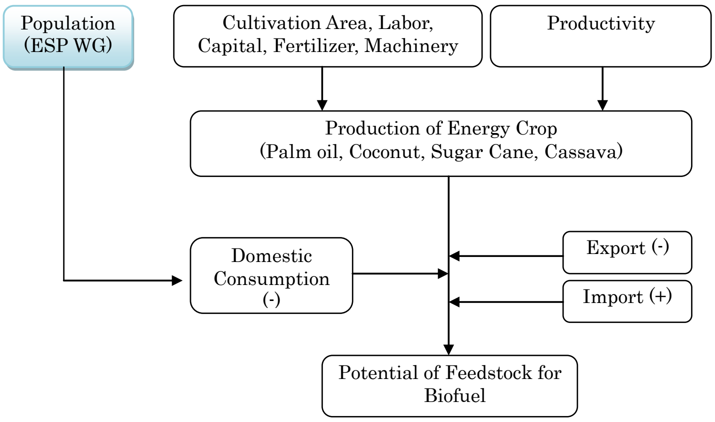
K = Capital Stock, or I = Input (Machinery, Fertilizer)

The time variant (TREND) was used in this calculation because the production was explicitly dependent on time.

The purpose for this analysis was to estimate the potential feedstock supply for biofuel, rather than the capacity for biofuel supply (production). Biofuel production capacity has more complex prerequisites with respect to construction of plans, policy, technology and data, which this study will not cover. The definition of potential feedstock supply in this analysis implies the redundant production after domestic consumption. The structure of the model is as shown in the diagram below.

Notice should be paid that though domestic consumptions of the feedstocks (which are: cassava, sugar cane, molasses, maize, rice, coconut oil, palm oil, rapeseed, waste oil, and livestock fat) for food and industrial material were subtracted from the biofuel supply potential, the export of the feedstocks (whether they are for food or for other use) was counted as part the biofuel supply potential.

Figure 1.2-1 Model Framework for Biofuel Supply



The history statistics for crop production, land area, and labor were obtained from the FAO. The assumptions for GDP and Population are the same with that used in the demand projection.

Agriculture activity

- Palm oil, soy, coconut, sunflower, canola, peanuts, jatropha, rice, maize, cassava, sugar cane, and sorghum were available as raw materials for biofuel in these four countries.

- Maize and rice are important grain crops that should be secured from the perspective of security of food supplies, and hence both of these crops are difficult to become feedstock for biofuel conversion.
- The short term crops such as sorghum, soy, sunflower, canola and peanut are not suitable as energy crops because our target countries rely on imports for consumption as a food.
- Only jatropha as a non-food plant is noted for its high potential. However, jatropha is not suitable as an energy crops in the short term due to its shorter history as a crop and lack of cultivation experiences,.
- Energy crops available as raw material for biofuels under present production conditions will be palm oil, coconut, sugar cane (molasses) and cassava.

1.3. Demand and Supply Balance of Asia

Total bioethanol demand in the 16 countries is projected to reach 49425.3ktoe in 2035 while the total supply potential is estimated to be 69986.4ktoe in 2035. Total biodiesel demand in the 16 countries in 2035 is projected to be 37479.2ktoe and the total supply potential is estimated at 56867.2ktoe. The results indicate that the region as a whole holds enough potential to full fill all the countries' biofuel targets. In the demand projection constraints of domestic supply was not considered, assuming that the demand would be met either by domestic production or import. Also, as mentioned above, though domestic consumption of crops was exclude from biofuel supply counting, current exports of crops were counted as part of the biofuel supply potential. This implies that though the regional biofuel target could be met without imposing issues on food security in biofuel exporting countries, it might negatively impact the regional or global food supply depending on the (biofuel exporting) country's importance in global food supply chain.

Figure 1.3-1 Bioethanol Demand and Supply Potential

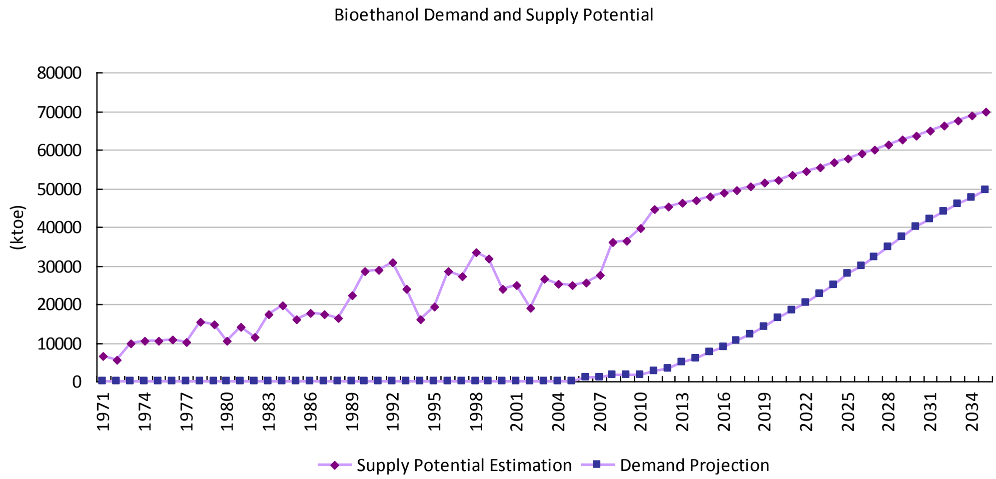
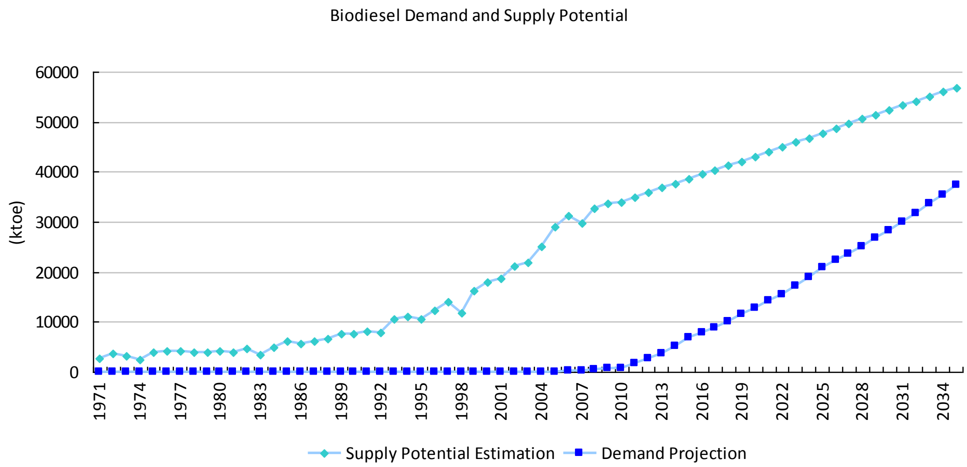


Figure 1.3-2 Biodiesel Demand and Supply Potential



When look at the demand and supply potential of bioethanol and biodiesel by country it could be observed that the country with large biofuel demand in the future not necessarily has sufficient potential of supply, and vise versa. For example, Indonesia is expected to be country with the second largest bioethanol demand accounting for 27.6% (13621.2ktoe) of the region's total bioethanol demand in 2035 while is supply potential of bioethanol is estimated to be only 3.3% (2320.9ktoe) of the region's total. On the other hand, while Malaysia is supposed to be the region's second largest biodiesel supplier with 39.7% (22557.3ktoe) of the region's total supply in 2035, its domestic biodiesel demand is projected to account for only 3.0% (1118.0ktoe) of the region's total. This mismatch of future biofuel demand and supply potential indicates that cross country biofuel trade is necessary to optimize the region's biofuel utilization. The details about the issues on regional biofuel market integration will be discussed on the next chapter.

Figure 1.3-3 Bioethanol Demand and Supply Potential by Country

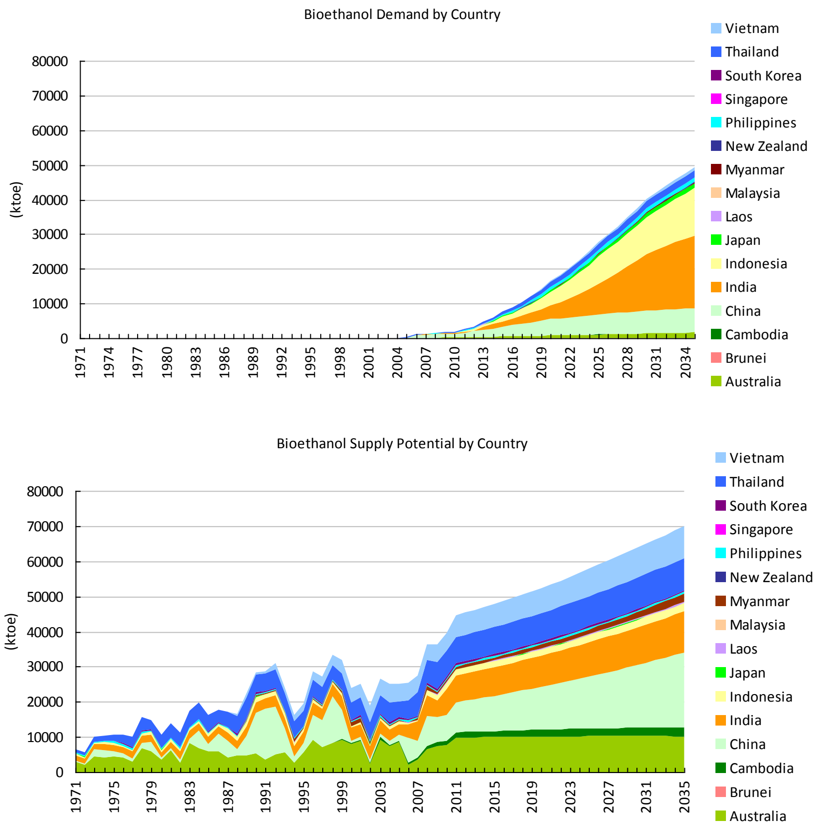


Figure 1.3-4 Biodiesel Demand and Supply Potential by Country