STUDY ON ASIAN POTENTIAL OF BIOFUEL MARKET

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DISCLAIMER

This report was prepared by the Working Group for the "Study on Asian Potential of Biofuel Market" under the Economic Research Institute for ASEAN and East Asia (ERIA) Energy Project. Members of the working group are from Indonesia, Japan, Malaysia, the Philippines, and Thailand. They discussed and agreed to key assumptions, modelling approaches, and the outcome of the study. These assumptions and modelling approaches may differ from those normally used in each country. Therefore, the outcome here does not necessarily represent the official views of the participating countries.

The views in this publication do not necessarily reflect the views and policies of the Economic Research Institute for ASEAN and East Asia (ERIA), its Academic Advisory Council, and the Management.

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Foreword

The increasing oil prices have accelerated the efforts for energy security through the utilisation of renewable energies. Among renewable energies, the option of biofuel emerged in the mid-2000, including the "Call for Biofuel" in Thailand in 2005, "jatropha" cultivation order in Myanmar in 2006, presidential instruction for a national biofuel team in Indonesia in 2006, and the Biofuel Act of 2006 in the Philippines in 2006.

These Asian responses to the rising crude oil prices were accumulated in the Second East Asia Summit in Cebu, Philippines in January 2007. One of the most expected solution was the utilisation of biomass, especially in the form of biofuels, which can replace the imported crude oil and/or oil products and can create new industries, which directly contribute to the income generation of rural farmers and the poor.

Biofuels can largely be categorised into two types. One is bioethanol, which can substitute gasoline. Another is biodiesel, which can substitute mineral diesel oil. At the current stage of commercially competitive technologies available in Asia, those that can produce biodiesel and bioethanol are so-called first generation technologies, which utilise agricultural residue and/or products. As such, the promotion of biofuels could conflict with food security and environmental sustainability if not planned carefully.

This study focused on the Asian potential of two types of biofuel—bioethanol and biodiesel. The objectives are to find ways and policies to promote the sustainable use of biofuels.

Key issues are analysed to find policy solutions for problems related to the domestic supply of alternative fuels, energy security, economic development, and climate change and to increase understanding of the potential of biofuels.

Dr. KaoruYamaguchi
Leader of the Working Group
2014

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List of Abbreviations and Acronyms

ABRI	Australian Biofuels Research Institute
ADB	Asian Development Bank
AEDP	Alternative Energy Development Plan
AFTA	ASEAN Free Trade Area
ANRE	Agency for Natural Resources and Energy
APEC	Asia-Pacific Economic Cooperation
Aprobi	Biofuels Producers Association of Indonesia
ARENA	Australian Renewable Energy Agency
ASEAN	Association of Southeast Asian Nations
ASTM	American Society for Testing and Materials
ATIGA	ASEAN Trade in Goods Agreement
B1	Mix of 1% biodiesel and 99% diesel
B2	Mix of 2% biodiesel and 98% diesel
B5	Mix of 5% biodiesel and 95% diesel
B10	Mix of 10% biodiesel and 90% diesel
B20	Mix of 20% biodiesel and 80% diesel
B25	Mix of 25% biodiesel and 75% diesel
B100	100% biodiesel
BAA	Biofuels Association of Australia
BANZ	Bioenergy Association of New Zealand
BAU	business-as-usual
BDF	biodiesel fuel
BE	bioethanol
BPPT	Agency for the Assessment and Application of Technology, Indonesia
CO2	carbon dioxide
CAAC	Civil Aviation Administration of China
CAPEX	capital expenditure
CCS	carbon capture and storage
CCT	clean coal technology
CDM	Clean Development Mechanism
CEPO	Clean Energy Program Office, Singapore
CERP	Clean Energy Research Program
CIF	common intermediate format

CME	coco methyl ester
CNG	compressed natural gas
CNO	coconut oil
CO2	carbon dioxide
CP	commonwealth preferences
CPO	crude palm oil
DEDE	Department of Alternative Energy Development and Efficiency, Ministry of Energy of Thailand
DEMR	Ministry of Energy and Mineral Resource
DME	Energy Self-Sufficient Village Program
DOEM	Department of Environment of Malaysia
DOE	Department of Energy, Philippines
DOST	Department of Science and Technology, Philippines
E3	Fuel mixture of 3% ethanol and 97% gasoline
E5	Fuel mixture of 5% ethanol and 95% gasoline
E10	Fuel mixture of 10% ethanol and 90% gasoline
E15	Fuel mixture of 15% ethanol and 85% gasoline
E20	Fuel mixture of 20% ethanol and 80% gasoline
E25	Fuel mixture of 25% ethanol and 75% gasoline
E85	Fuel mixture of 85% ethanol and 15% gasoline
EAS	East Asia Summit
ECTF	Energy Cooperation Task Force
EFB	empty fruit bunch
EFTA	European Free Trade Association
EIPO	Energy Innovation Program Office, Singapore
EMA	Energy Market Authority, Singapore
EMM	EAS Energy Ministers Meeting
EPA.US	Environmental Protection Agency of United States
EPA	Economic Partnership Agreement
EPPO	Energy Policy and Planning Office, Thailand
ERIA	Economic Research Institute for ASEAN and East Asia
ESP WG	Energy Saving Potential Working Group of ERIA
ETBE	ethyl tertiary butyl ether
EU	European Union
EV	electricity vehicle

FAME	fatty acid methyl esters
FAO	Food and Agriculture Organization of the United Nations
FFV	flexible fuel vehicle
FIT	feed-in tariff
F/S	feasibility study
FTA	Free Trade Agreement
GAIN	Global Agriculture Information Network
GDP	gross domestic product
GEN 2	second-generation biofuels
GHG	greenhouse gas
GMAC	Genetic Modification Advisory Committee
GNS	Institute of Geological and Nuclear Science
GOI	Government of Indonesia
GSP	Generalized System of Preferences
GST	goods and services tax
GSTP	Global System of Trade Preferences
GTA	Global Trade Atlas
HS	Harmonised Commodity Description and Coding System
HSD	high-speed diesel oil
ICRIER	Indian Council for Research on International Economic Relations
IEA	International Energy Agency
IEEJ	The Institute for Energy Economics, Japan
IPCC	Intergovernmental Panel for Climate Change
ITDI	Industrial Technology Development Institute
ITH	income tax holiday
JARI	Japan Automobile Research Institute
JBEDC	Japan Bio-Energy Development Corporation
JDI	Japan Development Institute
JETRO	Japan External Trade Organization
JOil	JOil (Singapore) Pte. Ltd.
JPJ	Road Transport Department, Malaysia
KEN	National Energy Policy
KKPE	Credit for Food and Energy Security
KMUTNB	King Mongkut's University of Technology North

	Bangkok
KPEN-RP	Bio-energy Development and Revitalization of Plantations
KPPK	Ministry of Plantation Industries and Commodities, Malaysia
Lao PDR	Lao People's Democratic Republic
LIPI	Indonesian Institute of Sciences
LIRE	Lao Institute for Renewable Energy
LLC	limited liability company
LNG	liquefied natural gas
LPG	liquefied petroleum gas
MAA	Malaysian Automotive Association
MAFF	Ministry of Agriculture, Forestry and Fisheries, Japan
MAI	Ministry of Agriculture and Irrigation, Myanmar
MEWR	Ministry of the Environment and Water Resources, Singapore
METI	Ministry of Economy, Trade and Industry, Japan
MFN	most favoured nation
MIC	Myanmar Investment Committee
MOE	Ministry of Energy, Myanmar
MOMG	Malaysian Oleochemical Manufacturers Group
MPOB	Malaysia Palm Oil Board
MPP	minimum purchase price
MS	methyl esters (Malaysian Standard on Biodiesel)
MSP	minimum support price
MTI	Ministry of Trade and Industry, Singapore
NBB	National Biofuel Board, Philippines
NBPM	National Biofuel Policy, Malaysia
NBPP	National Biofuel Policy, Philippines
NCCC	National Climate Change Committee, Singapore
NDRC	National Development and Reform Commission, China
NEA	National Environment Agency, Singapore
NOLCO	net operating loss carry over
NPC	National Power Corporation
NSTDA	National Science and Technology Development

	Agency
NZEECS	New Zealand Energy Efficiency and Conservation Strategy 2011-2016
NZES	New Zealand Energy Strategy, 2011-2021
NZFOA	New Zealand Forest Owners Association
OAM	Office of Agricultural Economics
OCSB	Office of Cane and Sugar Board
OECD	Organisation for Economic Co-operation and Development
OMC	oil marketing companies
PCA	Philippine Coconut Authority
PCAMRD	Philippine Council for Aquatic and Marine Research and Development
PCIERD	Philippine Council for Industry and Energy Research and Development
PCRDF	Philippine Coconut Research Development Foundation PEN, Blueprint for National Energy Plan; PEN 2005 ~ 2025
PETRONAS	Petroliam Nasional Berhad
PI	Presidential Instruction
PLN	Perusahaan Umum Listrik Negara
PM	particulate matter
PME	palm methyl esters
PMK	Regulation of the Ministry of Finance
PNOC-ERDC	Philippine National Oil Company–Energy Research and Development Center
PNS	Philippine National Standards
PPKS	Centre for Oil Palm Research, Medan
PPO	pure plant oil
PPP	public–private partnership
PSI	pollutant standards index
PSO	public service obligation
PTC	Philippine Tariff Commission
PTT	Petroleum Authority of Thailand
PV Oil	PetroVietnam Oil
RA	Republic Act (of the Philippines)
RBD	refined, bleached and deodorised

R&D	research and development
RD&D	research, development, and demonstration
RE	renewable energy
REDP	Renewable Energy Development Plan
RFS	renewable fuel standards
RITE	Research Institute of Innovative Technology for the Earth
RPS	renewable portfolio standards
SIRIM	Standards and Industrial Research Institute of Malaysia
SNI	Standar Nasional Indonesia
SO2	sulfur dioxide
STL	shale-to-liquids
SVO	straight vegetable oil
SWG	sub-working group
TBO	tree-borne oilseeds
TCPPA	Technical Committee on Petroleum Products and Additives
TimNas BBN	National Team for Biofuels Development
TISTR	Thailand Institute of Scientific and Technological Research
TLL	Temasek Life Science Laboratory
TPES	total primary energy supply
UAC	Universal Absorbents and Chemicals
UGR91	Gasoline Octane 91
UPV	University of the Philippines at Visayas
UPLB	University of the Philippines in Los Banos
U.S./US	United States
USDA	United States Department of Agriculture
VAT	value-added tax
VPI	Vietnam Petroleum Institute
WG	working group
WTO	World Trade Organization

UNIT

bbl	barrel
GW	gigawatt
ha	hectare
kg	kilogram
kL	kilolitre
ktoe	thousand tonnes of oil equivalent
kW	kilowatt
kWh	kilowatt-hour
L	litre
ML	million litre
Mtoe	million tonnes of oil equivalent
MtC	million tonnes carbon (may be converted to million tonnes of CO2 by multiplying by 44/12)
MW	megawatt
MWh	megawatt-hour
NCV	net calorific value
PJ	petajoules
tC	tonnes of carbon
toe	tonnes of oil equivalent
TWh	terawatt-hour
µg/m3	microgram/cubic meter

CURRENCY

A$	Australian dollar
NZ$	New Zealand dollar
RM	Malaysian ringgit
Rp	Indonesian rupiah
Rs	Indian rupee
S$	Singapore dollars
THB	Thailand baht
US$	US dollar
VND	Vietnamese dong

Executive Summary

Background, objectives, and scope

With a growing population, rising income levels, and expanding urbanisation, Asia's demand for oil is expected to increase rapidly. However, due to limited resource reserves, most of the countries in the region are heavily dependent on imports for their oil supply, which is a major, if not the most critical, concern in their energy policies. Though it has been debated intensively, biofuel is perceived as one possible option to address the oil security issue, since expanding the use of biofuels will not only result in reducing demand for oil, but will also contribute to the diversification of import sources for liquid fuels. Moreover, biofuel production also provides an additional way to increase the income of farmers.

This study focused on the Asian potential on the two types of biofuel—bioethanol and biodiesel. The objectives are to find the methods and policies for promoting the sustainable use of biofuels. The study is endorsed and supported by the Economic Research Institute for ASEAN and East Asia (ERIA), with a Working Group (WG) set up to oversee and coordinate the study. The WG is composed of biofuel policymakers from Indonesia, Malaysia, the Philippines, and Thailand; and researchers from The Institute of Energy Economics, Japan (IEEJ), who conducted the study and prepared the study report.

The study was conducted through three phases. The first phase focused on the biofuel development status and future biofuel demand and supply possibilities in four WG member countries—Indonesia, Malaysia, the Philippines, and Thailand. The second phase expanded the scope of the study to 16 countries, including all of the ASEAN countries and other countries in the region such as Australia, China, India, Japan, New Zealand, and South Korea. Although the scope of the study in the first and second phases was limited to the energy sector, the third phase expanded the analysis of the supply side to include the constraints of food and agriculture in addition to the potential of biofuel trade. In all phases, the study focused on conventional (or first generation) biofuels.

Major Findings

a. Sustainability (Reduction of fossil fuel consumption and CO_2 emissions)

With increasing energy demand, developing Asia will continue to increase its energy consumption. The prospect of fossil fuel shares in the final energy demand will continue to increase, with increasing oil demand, especially in the transport sector. Thus, replacing oil consumption with non-fossil energy is critical for preventing the increase of fossil fuel consumption in the future. The most cost-effective way is to replace oil consumption with the cost-competitive biofuels, as their competitiveness will improve with the prospect of rising oil prices in the long run.

b. Demand projection

Through this study, determinants of fuel consumption in the transport sector and biofuel-related policies were surveyed for the 16 countries. First, econometric models were applied to estimate future liquid fuel demand in the transport and power sectors.[1] Then, future biofuel demands of the region and each country were estimated by applying future demand prospects from the biofuel policies of each country. The result was that the total demands of the ASEAN and East Asian countries will reach nearly 36 million tonnes of oil equivalent (toe) of bioethanol and 37 million toe of biodiesel by 2035. The total demand of biofuels—over 70 million toe by 2035—is close to Indonesia's total oil consumption in 2011.

Demand outlook differs widely by country. This study shows that bioethanol demand will be topped by Indonesia from the early 2020s, followed by China, India, Thailand, and the Philippines. Similarly, biodiesel will be also be topped by Indonesia after the early 2020s followed by China, Thailand, India, and Malaysia. The results show an ambitious demand outlook by ASEAN countries, especially by Indonesia.

[1] Estimation for the power sector is limited to Indonesia and Malaysia because of their policies for using biofuel in the power sector.

c. Supply potential

The supply potential of biofuels was estimated by quantitative modelling using agricultural production function with an econometric analysis of each country and the region. Here, the potential of biofuels is defined as a residual from total agricultural feedstock production potential, minus the estimated demand for food. Assuming the market in the region is fully open, under the business-as-usual (BAU) scenario, the situation of no improvement in productivity and no utilisation of unused land shows that the current growth rate of supply potential is not quick enough to support the projected demand for biofuels. The result is that the total feedstock supply of the ASEAN and East Asian countries will reach nearly 10.1 million toe of bioethanol and 35.6 million toe of biodiesel by 2035. Although agricultural feedstock production for biodiesel (mainly palm oil) could be supported until around the 2030s, the bioethanol requirement or demand will reach the limit of supply by around 2015.

An alternative scenario—with full utilisation of unused lands and improved productivity— found that the total feedstock supply of the ASEAN and East Asian countries would reach nearly 22.6 million toe of bioethanol and 42.5 million toe of biodiesel by 2035. The results imply that this alternative scenario, with productivity improvements and effective land use, could expand so that supply can meet the region's demand until the 2020s for bioethanol, and the 2040s or later for biodiesel.

d. Needs of next-generation technologies

Although conventional technologies could continue to be the primary competitive technologies, next-generation technologies will be required to meet the additional future demand of biofuels, especially for bioethanol, by the 2020s.

It should be noted that the above timing of shortages assumes that productivity will improve, and that projected increase in demand will not change. This means the timing could be sooner if productivity fails to improve, whereas the timing could be delayed if future demand for biofuels could be decreased.

e. Biofuel trade

The above analysis is based on regional supply and demand. The supply potential and demand of each country differs widely, and this study found mismatches in supply potential and market sizes (demand). Countries with high biofuel supply potential may have a small domestic biofuel market, and vice-versa. Because of this mismatch, if there is no trade, the quantity of supply and consumption of biofuels in the region will be much smaller than if there is a fully open market in the future. Both types of biofuels could be down to about a half or less than that of a fully opened market by the 2030s.

The role of trade is very important. However, the current development of biofuel trades is still limited, compared to its potential. The prospects of limited trade could continue. There are two primary reasons for this, which could be shared in developing Asia. One reason is that biofuels are expected to contribute to rural and agricultural development through domestic production. In fact, in Asia, the biofuel market is linked to both food and energy markets, and whether the products can be domestically consumed or exported depends on not only the prices of oil products but also food prices. Another concern is energy security, especially for oil-importing countries. Therefore, the national biofuel policies of many Asian countries are oriented to promote the domestic production of food–biofuel–compatible feedstocks for both the energy and agriculture markets, which makes it challenging to become fully open in the future.

Trade limitations could bring different future prospects of shortage or surpluses by country, depending on the profile of the policies and agricultural characteristics of each country. The ambitious demand by ASEAN countries, especially by Indonesia, implies that some ASEAN countries (most likely including Indonesia) may face shortages earlier; whereas some countries (most likely including Malaysia) can sustain the surplus longer than those of assumed fully integrated markets.

f. Competitiveness

The current crude oil price level of around US$100/barrel (bbl) causes most of conventional biofuels in Asia to compete with oil products.[2] However, this study found there are cases where higher energy prices in a domestic market do not necessarily increase the supply of domestic biofuels. One case is the higher selling prices in international markets, which could be for food or energy. Another case is the higher prices in domestic food markets. The result is shortages of domestic biofuels, notably in Indonesia and Malaysia, which lack stringent implementation of biofuel mandates. If there are higher prices in domestic food markets, it should have contributed to the food security.

From an international perspective, the prices of energy and food in developing Asian countries are generally low compared to those in developed countries. The increase of feed stocks in export markets could benefit domestic farmers, but not domestic energy consumers. A stringent mandate for biofuels should be drafted in consideration of the interactions and relative competitiveness of domestic and international energy and food markets.

g. Food vs. fuel

It is generally believed that the global food crisis of 2007/08 was partly due to biofuel production. The experience in Asia also highlighted serious concerns about the rise of food prices and shortages in imports. Although later studies, including those of the World Bank, concluded that the contribution of biofuels' production on food prices was not as large as originally presumed[3], the concern is put into priority in this study.

Nonetheless, one of the findings in this study is that food-compatible biofuels have become very important as alternatives to oil products, and promoting these has become a national priority in energy and agricultural policies in many Asian countries, including ASEAN countries that suffered from rises in food prices like Indonesia, the Philippines, and Malaysia.

Policy Implications

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[2] IEA (2013b).
[3] The World Bank (2010).

a. Main Arguments

As reviewed, liquid fuels could be a major energy source in Asia in the coming decades. Here, the collective benefits of the expansion of biofuels are not only regional energy security, but also the mitigation of global warming. The expansion of biofuels in Asia could benefit not only individual countries, but also the region. The issues are to find and expand the Asian potential of biofuels.

The potential depends on demand and supply outlook. The study's major finding on the demand side is the exceptionally large demand by Indonesia. Assuming Indonesia's demand will not change, one of the most important findings is that a shortage of bioethanol may soon be experienced, if there is no progress in the efforts to increase productivity and in using unused land effectively. Another important message from the findings is that biofuels in Asia should not be separately considered from agriculture, as it is already integrated into the market. The success of biofuel utilisation in Brazil and Thailand indicates that there are methods of sustainably developing food-compatible biofuels. In Asia, food-compatible biofuels will continue to be the primary sources; however, the supply potential of agriculture-oriented conventional biofuels in the region of 16 countries may fail to catch up to the fast growth of demand before the 2020s.

The core strategy suggested in this study is to improve the enabling environment: improve productivity and enhance regional cooperation for trade and energy security. Also, the development of next generation biofuels as a mid- to long-term solution should also be pursued in line with the development of energy–agricultural integration for the security of both sectors.

b. Policy Implications

1) Supply side

- Give incentives for increasing productivity and utilising unused agricultural land as energy–agriculture joint policy initiatives. The policy could benefit both the energy and agriculture sectors.

-Improve conversion efficiency from solid to liquid biomass.

2) Demand side

-Promote regional energy security through the biofuel trade.

-Promote best local practices of "sustainable" consumption/utilisation of biofuels.

-Promote domestic/local use of biofuels, including waste oil products from food industries.

3) Enabling market

-Use a domestic biofuel mandate to stimulate the local market to improve productivity and promote the use of unused agricultural lands.

-Share biofuel standard for interregional trade.

4) Sustainability/Food security

-Secure food allocation (production allocation or preferably through distribution).

-Enable domestic/local use of biofuels as a buffer for food security.

-Develop a sustainable development map of biomass utilisation in the future energy mix, with a vision of the role of biofuels.

5) Importance of collaborative study and development of next-generation biofuels

-Commercialise next generation biofuels within the next decade.

6) Different implications by type of country

-For energy importing countries like the Philippines and Thailand, policies to increase productivity and efficient use of land (utilisation of unused land) should be enhanced, as a joint effort of both the energy and agriculture sectors. For Indonesia, whose future demand is exceptionally large, further efforts will be required.

-Exporting countries with abundant supply source like Malaysia should pursue more stringent implementation of policies, such as the B5 mandate.

-A regional framework such as ASEAN could contribute to the research of next generation biofuels for the sake of the common interests of the region.

CHAPTER 1
Introduction: The Growing Importance of Biofuels in Asia

Introduction

With a growing population, rising income levels, and expanding urbanisation, Asia's demand for oil is expected to increase rapidly. However, due to limited resource reserves, most of the countries in the region are heavily dependent on import for their oil supply, which is a major, if not the most critical, concern in their energy policies. Biofuels are perceived as one of the possible options to address the oil security issue since expanding the use of biofuels will not only result in oil demand reduction but also contribute to the diversification of liquid fuels' import sources. Moreover, biofuel production also provides an additional means to increase farmers' income.

The use of biofuels started in the late 19th century. Such utilisation continued until the 1940s, but the falling fossil fuel prices stopped their further development.[1] Interest in commercial production of biofuels for transport rose again in the mid-1970s, when ethanol began to be produced from sugarcane in Brazil and later from corn in the United States.

The world consumption of biofuels has increased from 8,082 thousand tonnes of oil equivalent (ktoe) in 2001 to 52,219 ktoe in 2011. Biofuels provided 2.1 percent of the world's total transport fuel demand. Today's leading market, the United States and Brazil, together accounted for 81 percent of global bio-gasoline consumption in 2011. Europe leads in the use of biodiesel, with 58.9 percent of the world's biodiesel consumed by the Organisation for Economic Co-operation and Development (OECD) member countries in 2011. The Asia

[1] IEA (2011).

and Pacific region accounted for only 5.6 percent of the world's total biofuel production in 2011 and 5.1 percent of biofuel use.[2]

But the growth is expected in Asia. With this growing interest in biofuels in Asia, the focus of this study was on the Asian potential of the biofuels market. The objectives are to find the potential of biofuels—bioethanol and biodiesel—in Asia and to find policy options to promote the sustainable use of biofuels. The features of this study are the (1) quantitative results in both supply and demand outlooks; (2) use of energy–agriculture integrated models with surveys of the latest biofuel policies; and (3) analyses of regional prospects including those of supply–demand gaps within the region, which consists of 16 Asian countries that include ASEAN 10 countries, Australia, China, India, Japan, New Zealand, and South Korea.

This study was conducted with the support and endorsement of the Economic Research Institute for ASEAN and East Asia (ERIA). A working group (WG) was established in 2011, comprising biofuel policy makers from Indonesia, Malaysia, the Philippines, and Thailand, and with the Institute of Energy Economics, Japan (IEEJ) working as the coordinator.

Growing Importance of Biofuels in Asia

1.2 Growing importance of biofuels in Asia

One of the critical findings of the Internal Energy Agency (IEA) is that the demand growth centre of oil demand is moving toward developing Asia, which accounts for almost two-thirds of the gross increase in demand over the projection period.[3] According to IEA, the share of biofuels will increase from 1.5 percent in 2012 to 2.9 percent by 2035 in its current policy scenario, whereas it has to reach 8.9 percent by 2035 in its CO_2 emission stabilisation scenario.[4] The prospect of biofuel use in Asia will become critical to reduce the fossil oil consumption in the region.

[2] IEA (2013a).

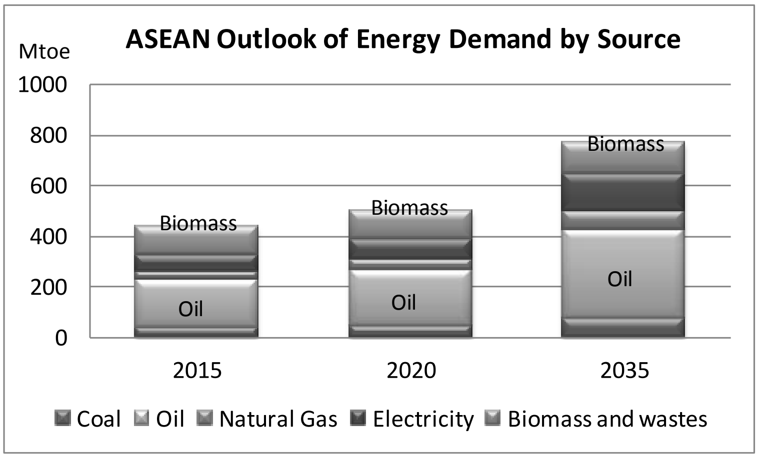
[3] IEA (2013c).

[4] So-called 450 scenario by IEA sets the energy system on track to have a 50% chance of keeping to 2°C the long-term increase in average global temperature (Table A.15.1).

The importance of biofuels as alternatives to oil products can be highlighted further if the prospect of the growing share of oil consumption in Asia is to be considered. According to the Asian Development Bank (ADB),[5] the share of oil consumption will continue to grow (Figure 1.1). Another important fact is the dependence on traditional use of biomass, such as firewood and charcoal, in the residential sector. This share is expected to decrease in the future with the progress of electrification. The most cost-effective way is to replace oil consumption with cost-competitive biofuels as their competitiveness would improve further with the prospects of rising oil prices in the long run.

This outlook implies that the growth of biofuels as an alternative to oil could greatly contribute to the prospects of CO_2 reduction in the future.

Figure 1.1 Growing Oil Demand in Final Energy Consumption of the ASEAN Region



Source: ADB (2013).

The concern for fossil fuel consumption has become an important driver in the introduction of renewables. Biofuel is renewable. Thus, the production and consumption of biofuels have become very important in considering energy security and agricultural benefits in many Asian countries, especially in the ASEAN. As will be explained in more detail in Chapter 2, such trends can be found in the countries' policies for the promotion of renewable energy (Table 1.1).

[5] ADB (2013).

Table 1.1 Renewable Energy Targets and Plans of Selected ASEAN Countries

Country	RE Targets in Primary Energy	RE Electricity Targets	Biofuels Targets and Plan
Indonesia	23% of primary energy supply, 2025	17.5%, 2021; 11% Geothermal; 6.5% Hydropower	5% of primary energy supply by 2025
Lao PDR	Increase by 30%, (new renewables) 2025	Keep the share of renewable as near as 100%, 2025 Biofuels, 450 million L/day	10% (662 ktoe), 2025
Malaysia	n/a	17% by 2030 including Biomass 1,750 MW Mini-hydro 490 MW Solar PV 854 MW Municipal waste 390 MW	B5 implementation program (no target)
Philippines	n/a	15,319 MW by 2030 (5,439 MW, 2010)	B20, E20 mandates by 2025
Thailand	25%, 2021	Solar + wind, 3,200 MW; Hydro, 1,608 MW; Ocean and geothermal, 3 MW; Biomass, 4,390 MW by 2021	40 million L/day by 2021
Viet Nam	5%, 2030; 11%, 2050	6%, 2030	5% mandate plan (from 2015)[(a)]

Note: (a) Based on Decision 177/2007/QD-TTg.
ktoe = thousand tonnes of oil equivalent, Lao PDR = Lao People's Democratic Republic, L = litres, n/a = not available, MW = megawatts.
Source: Compiled by the authors from various sources.

Asian countries, however, vary greatly in biofuel feedstock resources and biofuel market size. For example, Indonesia and Malaysia, as the world's largest palm oil producers (from which biodiesel can be produced), have huge potential for biodiesel production. However, bioethanol production in these two countries is relatively small. On the other hand, Thailand has abundant bioethanol production potential and a relatively large domestic market, but the country's potential for biodiesel production is limited (only a limited area in south Thailand has palm plantation). Therefore, a regional integrated market for biofuel trade across countries is expected to optimise the biofuel supply and demand in the region.

Scope and the Structure

The study was conducted through three phases. The first phase focused on the biofuel development status and future biofuel demand and supply potentials in four working group (WG) member countries, namely, Indonesia, Malaysia, the Philippines, and Thailand. The second phase expanded the scope of the study to 16 countries—to include all of the ASEAN countries, and other countries in the region such as Australia, China, India, Japan, New Zealand, and South Korea. Although the scope of the study in the first and second phases was limited to the energy sector, the third phase expanded the analysis of the supply side to include the constraint of food and agriculture, as well as the potential of biofuel trade. In all phases, the study focused on conventional (or first generation) biofuels.

This paper is structured as follows: Chapter 1 reviewed the increasing importance of biofuels in Asia and the significance of this study. In Chapter 2, policies of biofuels and current development status were reviewed. Chapter 3 focused on the estimates of future of demand and supply to analyse the Asian potential of biofuels. The potential of the region's biofuel trade and the prospects are discussed in Chapter 4. The issue of competitiveness and the issue of food vs. fuel were summarised under the findings of this study in Chapter 5, followed by policy implications in Chapter 6.

CHAPTER 2
Biofuel Promotion Policies and Development Status in East Asian Countries

Biofuel Policies and Programs

(1) Existing Policies and Regulations

The policies implemented for biofuels in the East Asian region (ASEAN+6) differ among the countries depending on their purposes. Although they share most of the policy drivers in promoting biofuels, their priorities are different. Table 2.1 presents a summary of the current biofuel-related policies in each country. The Philippines and Indonesia are implementing mandatory policies to introduce both bioethanol and biodiesel. Australia has also implemented the mandatory introduction of biofuel policy at the state level. South Korea has also mandated the introduction of biodiesel by B2. Most of the member countries' biofuel promotion policies, however, are based on the development program rather than on the mandatory scheme. For Japan, promotion is limited to the introduction of 500,000 kilolitres (kL) of ETBE[1]-based biofuel (E3) as a voluntary effort by the private sector. The policies to introduce biofuels in the region have the following features, as discussed below.

<u>Rural Development</u>

Most of the developing countries in this region are promoting biofuels as a part of the rural development policy. The development of biofuels is expected to improve the energy supply system and poverty problem in rural area. Especially in Indonesia, the Philippines, and Thailand, biofuel policies are adopted to increase the income of farmers and to provide energy resources to rural areas through local production. The promotion of biofuels in the

[1] Ethyl tertiary butyl ethel (ETBE) is a chemical compound of ethanol.

Philippines and Indonesia has significant effects because of the transport barriers when accessing the commercial energy source.

Energy Security

In this region, except for Malaysia and Brunei Darussalam, all member countries are net oil importers. The fluctuation of international oil price always becomes an uncertain factor for these countries. Particularly for the Southeast Asian countries, increasing oil prices will squeeze their national budgets because of their subsidies to fossil fuel and electricity. For example, Indonesia has caused a financial crisis in 2005 because of the remarkable increase of international oil prices. Hence, biofuels as a domestic resource are expected to be a substitute of imported oil. The effort to reduce the dependence on imported oil is the most important energy strategy to keep the stability of energy supply in this region.

Industry Strategy

Malaysia and Singapore are promoting biofuels as part of their industrial policies. To enhance the promotion of biofuels as an export industry, the Malaysian government has maintained the related industry regulations. The processes are widespread to upstream palm oil production, refinery, trade regulation, taxation, and fuel standards. On the other hand, Singapore has a strategy to promote biofuels in order to become a hub of the refinery industry in the region by fully utilising the existing infrastructure for oil refinery. The government is promoting a plan to become a trading centre of biofuels in the region.

Environment Policy

Developed countries in this region have promoted biofuel policies as environmental policies to mitigate the impact of global warming and air pollution. Biofuel initiatives of Japan and South Korea are motivated to reduce greenhouse gas emission. In some cities in China and India, biofuels are promoted as a countermeasure against air pollution.

Features of biofuel promotion policies introduced in this region:

- Priorities and motivations in each country are greatly different.

- There are no common regional policies with clear criteria, such as those for trade, environmental protection, or food security.

Table 2.1 Main Drivers for Biofuel Promotion by Country

Country	Main Drivers		Country	Main Drivers
Australia	>CO_2 reduction >Clean energy supply		Malaysia	>Industry development
Brunei Darussalam	No		Myanmar	>Energy security >Agriculture development policy
Cambodia	>Reduce oil import >Explore clean fuels		New Zealand	>CO_2 reduction >Clean energy supply
China	>Reduce oil consumption >Food stock adjustment		Philippines	>Reduce oil import >Energy security >Rural development
India	>Reduce oil import >Explore clean fuels		South Korea	>Energy diversification >Reduce oil import >Clean energy supply
Indonesia	>Reduce oil import >Energy security >Rural development		Singapore	> Industry development
Japan	>CO_2 reduction >Clean energy supply		Thailand	>Reduce oil import >Energy security >Rural development
Lao PDR	>Energy security		Viet Nam	>Reduce oil import >Energy security

Table 2.2 Policy and Target for Biofuel Development by Country

Country	Mandatory	Main Policy, Development Program, and Planning	Target
Australia	Local level: E4, B2	1. The Fuel Quantity Standards Act 2000 2. The Ethanol Production Grants Program (2002–2021) 3. The Energy Grants Scheme (2011–2021) 4. The Ethanol Distribution Program (Finished)	20% of total transport fuels in 2050 (including bio-jetfuel)
Brunei Darussalam	No	No	No
Cambodia	No	No	No
China	No	1. Act for Testing Expansion of Ethanol-Blended Gasoline for Cars (2004), 6 provinces and 27 cities (E10) 2. 500 yuan (6 cents)/liter [(a)] for bioethanol production (2011–2012) 3. RE Development in the 12th Five-Year Plan	Bioethanol: 4 million tonnes (2015) Biodiesel: 1 million tonnes (2015)
India	No	1. National Policy on Biofuels > 9 states and 4 union territories, E5	Biofuel: 20% by 2017
Indonesia	B10 (2013), E3	1. National Energy Policy (2006) 2. Presidential Instruction No. 1/2006 3. Mandatory Regulation DEMR No. 32/2008	5% of national energy mix by 2025
Japan	No	1. Voluntary target of 500,000 kilolitres (kL) of bioethanol by E3 (ETBE)	Total 500,000 kL bioethanol by 2017
Lao PDR	No	1. Renewable Energy Development Strategy (2010)	10% of total transport fuels in 2020 Bioethanol: 106 million litres Biodiesel: 205 million litres
Malaysia	No	1. National Biofuel Policy (2006) 2. B5 promotion Program (Started June 2011, completed July 2014)	B7 after July 2014
Myanmar	No	1. Jatropha tree-planting project, 2006–2008	4 million hectares (ha) by 2015
New Zealand	No	1. Biofuel Act 2008, Obligation B5 and E3~E10 2. Biofuel Sales Obligation (Apr. 2008 ~ Dec. 2012): 3.4% of transport fuels. Excise tax of NZ$ 0.505 cents/liter is exempted. (Abolished). 3. Biodiesel Grants Scheme (Jul. 2009 ~ Jun. 2012): Subsidy NZ$ 0.425 cents/liter (Removed)	No target
Philippines	E10, B2	1. Biofuel Act 2006 (RA 9367) 2. National Biofuel Program	2030: E20/E80, B20
South Korea	B2	1. 2nd Biodiesel Long-term Supply Plan (2010) - (1st plan: 2006)	B5: vehicle B20: bus and truck
Singapore	No	1. Industry strategy on worldwide biofuel terminal and as a hub for biofuel trade	No target

Thailand	No	1. Alternative Energy Development Plan (AEDP: 2013–2021) 2. Incentive to palm oil growing area of 2.5 million *rais* 3. Price subsidy to biofuels and feedstock 4. Development Program on Land Use to Expand the Feedstock (2010–2022)	2021: Bioethanol: 9 million litre/year 2021: Biodiesel: 7.2 million litre/year
Viet Nam	No	1. Prime Minister's Decision No. 177 2. Mandatory from 1 Dec. 2014: E5 (7 provinces and cities) 3. Financial support for biofuel program (Total amount: VND259.2 billion from 2007–2015)	2025: E5 and B5 (1.8 million tonnes total of biofuels)

Note: (a) Convert to US$0.06/liter with the exchange rate of US$1 = 6.8 yuan.
Source: Annex: Biofuel Policies in East Asian Countries.

(2) Development Program

As shown in Table 2.2, all of the countries in this region have introduced biofuel development programs or targets, except Brunei Darussalam and Cambodia. The Philippines and Indonesia have mandated the use of bioethanol and biodiesel at the national level. On the other hand, Australia has obligated to utilise E4 and B2 at the state level and South Korea has mandated the use of B2 across the country. In Thailand, New Zealand, and Malaysia, the governments have introduced various promotion programs on a national scale and Viet Nam has announced the utilisation of E5 after December 2014.

It is clear that the development stages or levels in each country are totally different. The local government is the principal player in China and India for biofuel introduction. The development stage in Viet Nam and Myanmar remains at the level of planning. Brunei Darussalam and Cambodia have not yet announced any policy or program to introduce biofuels.

(3) Target

Among the member countries, the biofuel targets are also quite different. China, Japan, and Thailand have a quantitative target. On the other hand, Malaysia, the Philippines, South Korea, and Viet Nam have set their targets by blending share. Australia, India, Indonesia, and Lao Peoples' Democratic Republic (Lao PDR) have set their targets by the share of biofuels in total fuel consumption.

(4) RD&D

Due to the different levels of development and regional diversification, the levels of introduction and research, development, and demonstration (RD&D) of biofuels are also very different. The existing biofuel production plants are based on the first-generation technology. The first-generation biofuel technologies are already mature in the region and most of them are rich in feedstock supply by domestic production. The RD&D activities in most of the countries in this region are focused on crop productivity improvement. Some of them try to avoid the impact on the existing food supply system and deforestation by promoting non-edible crops such as nipal, jatropha, and pongamia. Expectation for jatropha is high, and the boom of cultivation of jatropha has occurred at a certain period of time.

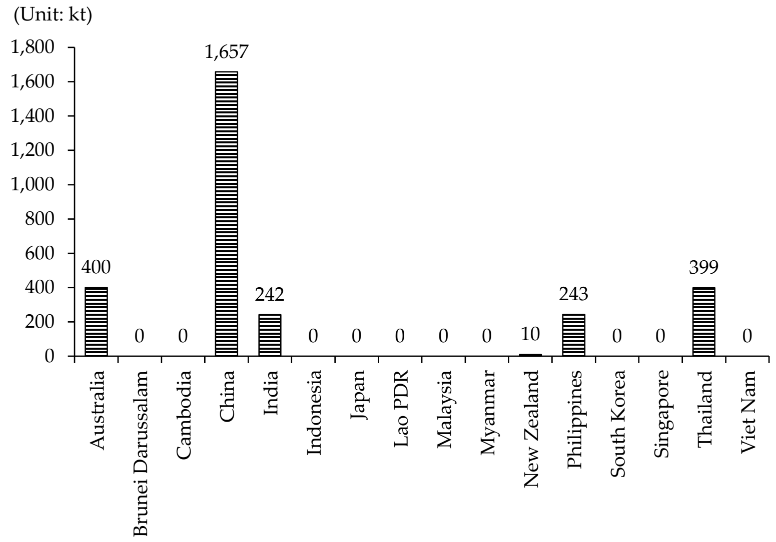
Next-generation biofuel technology development is essential in the sustainable supply system. Japan, South Korea, China, Thailand, and India are leading in commercialisation on cellulosic technology by biomass feedstock to produce bioethanol. Biodiesel production technology using algae as raw material is being widely developed by each country.

2.2. Development Status

(1) Biofuel Consumption by Country

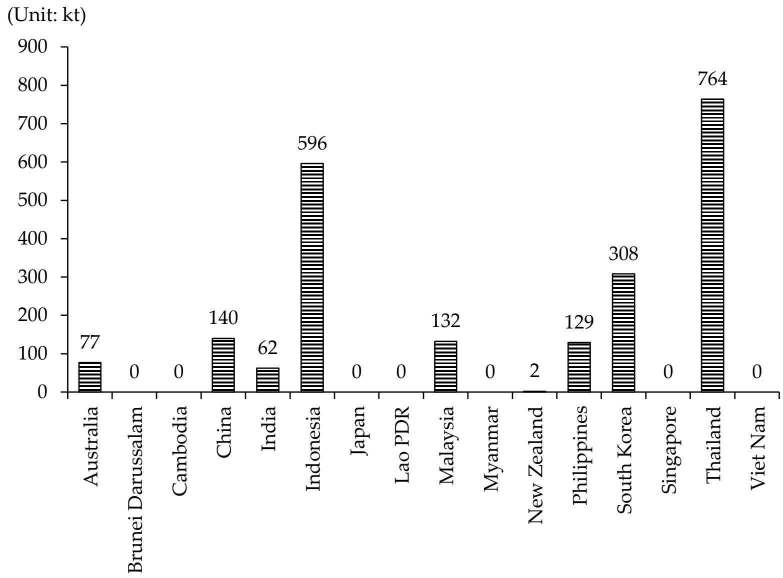
Figure 2.1 and Figure 2.2 show the biofuel consumptions by each country for 2012. In this region, the total consumption of bioethanol is 2.95 million tonnes while that of biodiesel is 2.21 million tonnes.

Figure 2.1 Bioethanol Consumption by Country in 2012



Sources: International Energy Agency (IEA), (2014), World Energy Balances and Statistics 2014. Paris: IEA.

Figure 2.2 Biodiesel Consumption by Country in 2012



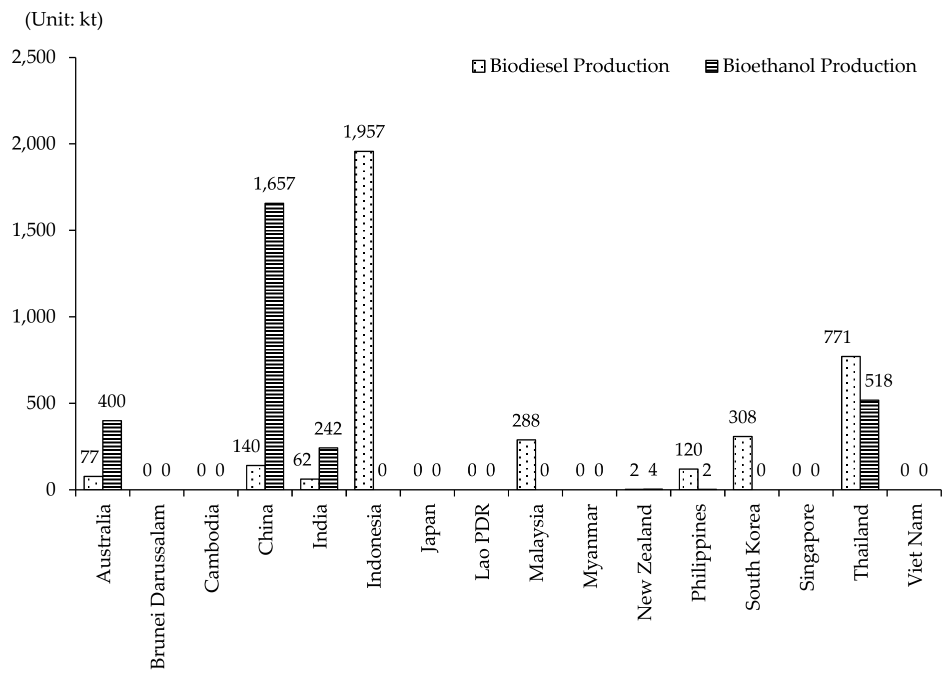
Source: International Energy Agency (IEA), (2014), World Energy Balances and Statistics 2014. Paris: IEA.

China consumes the largest amount of bioethanol in the region. According to the IEA statistic, bioethanol consumption in China was 1.657 million tonnes while biodiesel was 0.14 million tonnes in 2012. Thailand comes second, consuming 0.764 million tonnes of biodiesel and 0.399 million tonnes of bioethanol in the same year.

(2) Biofuel Production and Capacity by Country

The production of bioethanol is approximately 2.823 million tonnes across the region in 2012. Most of the production of bioethanol comes from China (1.657 million tonnes), Thailand (0.518 million tonnes), Australia (0.40 million tonnes). On the other hand, approximately 3.725 million tonnes of biodiesel were produced in the whole region, where Indonesia (1.957 million tonnes) and Thailand (0.771 million tonnes) accounted for the majority of the production.

Figure 2.3 Biofuel Production by Country in 2012



Sources: International Energy Agency (IEA), (2014), World Energy Balances and Statistics 2014. Paris: IEA.

The total production capacity of the existing bioethanol plants in 2012 is 5.6 million kL per year. Biodiesel production capacity is approximately 14.3 million kL at the same year. China has the highest annual production capacity of bioethanol and Thailand comes second. China's annual production of bioethanol is 2.6 million kL in 2012 while Thailand has a production capacity of 1.4 million kL per year, followed by Viet Nam and Australia. However, the specific figures of bioethanol production in the latter two countries are not available. About 80 percent of bioethanol production is exported in the case of Viet Nam.

Table 2.3 Biofuel Production Capacity by Country in 2012

	Number of Plant	Capacity (million litres/year)	Bioethanol Feedstock
Australia [1)]	3	440	Sugarcane (molasses), sorghum, waste starch
Brunei Darussalam	0	0	No feedstock
Cambodia	1	0.16	Cassava
China [2)]	5	2,600	Maize, cassava
India	na	na.	Molasses
Indonesia	8	416	Sugarcane (molasses), cassava
Japan	na	na	Sugar cane (molasses)
Lao PDR	na	na	Cassava
Malaysia	0	0	No feedstock
Myanmar	3	8.3	Sugar cane (molasses)
New Zealand	1	15~20	Whey, industry waste, import
Philippines	5	163	Sugarcane (molasses), import
South Korea	na	na	na
Singapore	0	0	No feedstock
Thailand [3)]	21	1,420	Sugarcane (molasses), cassava
Viet Nam [4)]	6	550	Sugarcane (molasses)
Total	53	5,612	

Note : na = not available.
Source: Annex: Biofuel Policies in East Asian Countries

Table 2.4 Biofuel Production by Country in 2012

	Number of Plant	Capacity (million litres/year)	Biodiesel Feedstock
Australia [1)]	11	360	Tallow, used cooking oil, palm oil
Brunei Darussalam	0	0	No feedstock
Cambodia	0	0	Used cooking oil
China [2)]	na.	na.	Used cooking oil
India	6	480	Used cooking oil, animal fats and tallow, other oils
Indonesia	25	5,600	Palm oil
Japan	na.	na.	Used cooking oil
Lao PDR	0	0	No feedstock
Malaysia	30	3,920	Palm oil
Myanmar	6	0.6	Jatropha, palm oil
New Zealand	7	70	Animal fats and tallow, used cooking oil, rapeseed
Philippines	9	463	Coconut, jatropha
South Korea	na.	na.	Used cooking oil, import
Singapore	6	1,469	Palm oil, used cooking oil, animal fats
Thailand [3)]	15	1,920	Palm oil, used cooking oil
Viet Nam [4)]	0	0	na
Total	115	14,282	

Notes:
1) Data until December 2013, Biofuel Association of Australia (BAA).
2) The number of plants and capacity for bioethanol are not included in the production for food.
3) Until November 2012. Not specific for fuel use.
4) Until February 2013. The total ethanol plant capacity is 12.51 million litres/day until the end of 2013. Of the production, 80 percent is for export.
Source: Annex: Biofuel Policies in East Asian Countries

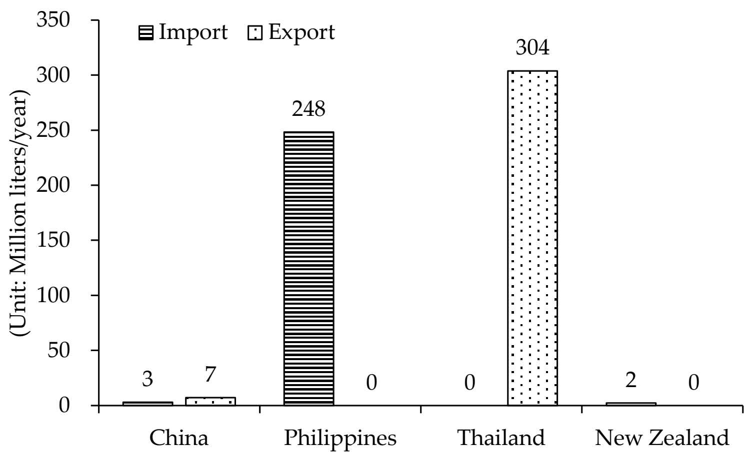
On the other hand, Indonesia (5.6 million kL), Malaysia (3.9 million kL), and Thailand (1.9 million kL) have an overwhelming amount of production capacity for biodiesel. These three countries are the major producers of palm oil in the world; they have an advantage in the production of biodiesel as a raw material from palm oil. The case of Singapore is also noteworthy. Although, in Singapore, agriculture land is not available for use in the production of feedstock, the country tries to import the raw palm oil from Malaysia and Indonesia to produce biodiesel for export purpose. At the time of the study, Singapore has a biodiesel production capacity of 1.47 million kL per year. The Philippines has about 463,000 kL per year of production capacity, where most of the feedstock comes from coconut oil.

(3) Biofuel Trade

Trade of biofuels in the region is not so active. According to the 2012 data, the volume of bioethanol trade is approximately 565,000 kL per year. Thailand is the main exporter in the region with 304,000 kL per year, while the Philippines is the main importer of bioethanol with 248,000 kL per year.

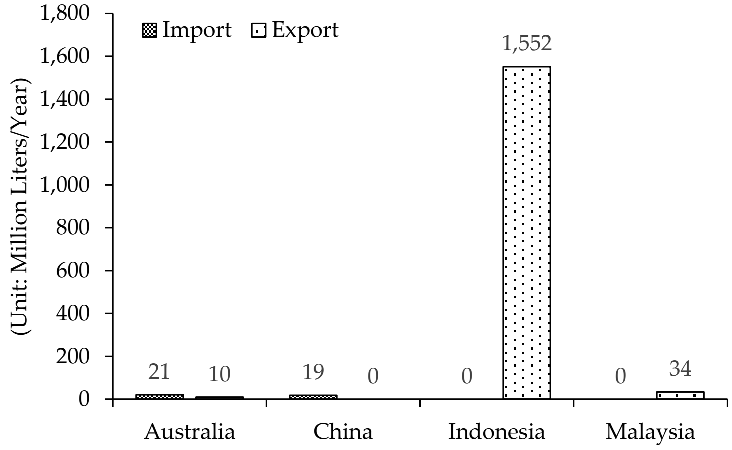
Biodiesel trading volume of ASEAN+6 in 2013 is 1.6 million kL overall. As the leading country of biodiesel export in this region, Indonesia has exported 1.55 million kL in the same year. Malaysia was next with 34,000 kL biodiesel exported in the same period. Most of the biodiesel production from these two countries is for export to the European Union market but only a small amount of export is provided to the member countries in the region.

Figure 2.4 Bioethanol Trade in 2012



Sources: USDA GAIN Report (2012b), (2012e), and (2012f); (2014), World Energy Balances and Statistics 2014. Paris: IEA.

Figure 2.5 Biodiesel Trade in 2012



Sources: USDA GAIN Report (2012a), (2012b), (2012g), and (2012h).

Table 2.5 shows a tax rate applied to the import of biofuels in each country in the region. The main tariff is made up of most favored nation (MFN) tax rate, goods sales tax, and the additional tax rate.

Table 2.5 Biofuels Import Duty and Related Taxes

Import to country	MFN duty rate	Sales tax	Additional duties and taxes
Australia	5% + AU$78.44 per litre	10%	•Import processing charge (AU$40.20)
China	40%	17%	
India	150%	No sales tax	•Landing charges (1% CIF) •CESS (3% (Duty + Countervailing duty)) •Additional Countervailing Duty (4% (CIFD + Landing charges + Countervailing duty + CESS)
Indonesia	30%	10%	•Excise (IDR50,000.00 per litre) •Income tax (7.5% CIFD)
Japan	0% + JP¥38.1 per litre	8%	
Malaysia	0% + RM60.00 per liters	5%	•Excise (RM22.50 per litre, 15%)
New Zealand	0% + NZ$50.284 per litre	15%	•Import entry transaction fee (NZ$46.89)
Philippines	10%	12%	
Singapore	0%	7%	•Excise (SGD88.00 per litre)
South Korea	30%	10%	•Education tax (10% (Special consumption tax, or liquor tax, or interior tax, whichever is applicable)) •Liquor tax (W57.00 per litre)
Thailand	0% + THB80.00 per litre	7%	•Excise (0.1%, THB0.05 per litre) •Interior tax (10% of excise)
Viet Nam	40%	10%	•Special sales tax (65%)

Source: Duty rate is by Duty Calculator. http://www.dutycalculator.com, accessed on May 20, 2014.

(4) Feedstock supply

Feedstock Available

Currently, sugarcane, maize, and cassava are the main raw materials for bioethanol production in this region. ASEAN+6 also produces most of the rice, wheat, and sweet potato in the world. These crops are suitable as a feedstock for bioethanol, but not much amount is being used as a feedstock for fuel production because their usage as food is more important. The production of sugarcane in this region accounts for 36.4 percent of the world's production and 30.5 percent for cassava, especially since cassava is not consumed as a major food in the East Asian region. In this sense, cassava has potential as a feedstock for bioethanol.

As for oil crops, coconut and palm oil are the main feedstocks for biodiesel in this region. Production of palm oil accounts for 86.3 percent while coconut accounts for 79.7 percent of the world production.

Table 2.6 Production by Crop in ASEAN+6 (per 1,000 ha)

	Cassava	Rice (paddy)	Sorghum	Sugarcane	Coconuts	Oil, palm fruit
Australia	0	723	1,935	25,182	0	0
Brunei Darussalam	3	1	0	0	0	0
Cambodia	8,034	8,779	0	469	66	0
China	4,500	201,001	2,051	114,435	239	650
India	8,076	157,900	7,003	342,382	10,280	0
Indonesia	24,010	65,741	0	24,000	17,500	101,700
Japan	0	10,500	0	1,000	0	0
Lao PDR	743	3,066	0	1,222	0	0
Malaysia	33	2,576	0	800	563	94,558
Myanmar	730	29,010	223	9,690	420	0
New Zealand	0	0	0	0	0	0
Philippines	2,210	16,684	0	30,000	15,245	541
South Korea	0	6,304	2	0	0	0
Singapore	0	0	0	0	0	0
Thailand	21,912	34,588	52	95,950	1,055	10,777

Viet Nam	9,898	42,398	0	17,540	1,202	0
ASEAN+6 (Total)	80,149	579,272	11,266	662,670	46,569	208,225
Share of the World Total (%)	30.5	79.9	19.3	36.4	79.7	86.3
World + (Total)	262,753	724,960	58,412	1,819,420	58,419	241,227

Source: FAOSTAT (2014).

Land Use

According to the FAO database, the ASEAN+6 member countries had a total land area of 2.50 billion ha in 2011, where 1.25 billion ha (around 50% of total land area) was defined as agricultural land. The total harvested area from land used for cultivation was 520 million ha. This means that only 41 percent of the agricultural area was utilised in 2011. Most of the remaining agricultural areas were "permanent meadows and pastures" type of land, which was not suitable for agriculture. Looking at each country data, some had a ratio of cultivated area to agriculture area as being relatively low. Although the percentage is not large, the expansion of cultivated area is still possible in some countries.

Table 2.7 Utilisation of Land by Country in 2011 (1,000 ha)

	Country area	Land area	Agricultural area				Forest area	Other land	Inland water	Area harvested (1,000 Ha)	Land Utilization Rate from Agricultural area (%)
				Arable land	Permanent crops	Permanent meadows and pastures					
Australia	774,122	768,230	409,673	47,678	400	361,595	148,376	210,181	5,892	24,869	6.1
Brunei	577	527	11	3	5	3	378	137	50	15	134.1
Cambodia	18,104	17,652	5,655	4,000	155	1,500	9,967	2,030	452	3,974	70.3
China	960,000	932,749	519,148	111,599	14,716	392,834	209,624	203,977	27,251	173,675	33.5
India	328,726	297,319	179,799	157,350	12,300	10,149	68,579	48,941	31,407	198,141	110.2
Indonesia	190,457	181,157	54,500	23,500	20,000	11,000	93,747	32,910	9,300	40,099	73.6
Japan	37,796	36,450	4,561	4,254	307		24,988	6,901	1,346	2,997	65.7
Laos	23,680	23,080	2,378	1,400	100	878	15,673	5,029	600	1,438	60.5
Malaysia	33,080	32,855	7,870	1,800	5,785	285	20,369	4,616	225	6,600	83.9
Myanmar	67,659	65,329	12,558	10,786	1,464	308	31,463	21,308	2,330	17,606	140.2
New Zealand	26,771	26,331	11,371	471	71	10,829	8,261	6,699	440	282	2.5
Philippines	30,000	29,817	12,100	5,400	5,200	1,500	7,720	9,997	183	14,077	116.3
R.Korea	9,990	9,710	1,756	1,492	206	58	6,215	1,739	280	1,642	93.5
Singapore	71	70	1	1	0		2	67	1	1	161.6
Thailand	51,312	51,089	21,060	15,760	4,500	800	18,987	11,042	223	20,811	98.8
Vietnam	33,096	31,007	10,842	6,500	3,700	642	13,941	6,224	2,089	13,813	127.4
Total	2,585,440	2,503,372	1,253,283	391,993	68,909	792,381	678,290	571,799	82,068	520,040	41.5

Source: FAO Statistics Division, http://faostat.fao.org/, 15 May 2014.

CHAPTER 3
Biofuel Market and Supply Potential in East Asian Countries

Methodology of Demand Projection

(1) Methodologies

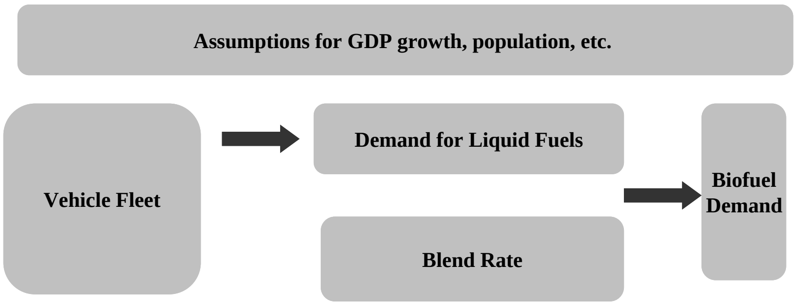
Biofuels could be used in various sectors, including the industrial, power generation, and transport sectors. Within the transport sector, biofuels can be used as vehicle, marine, and aviation fuels. However, since road transport is currently the largest market for biofuels (and for petroleum fuels), 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

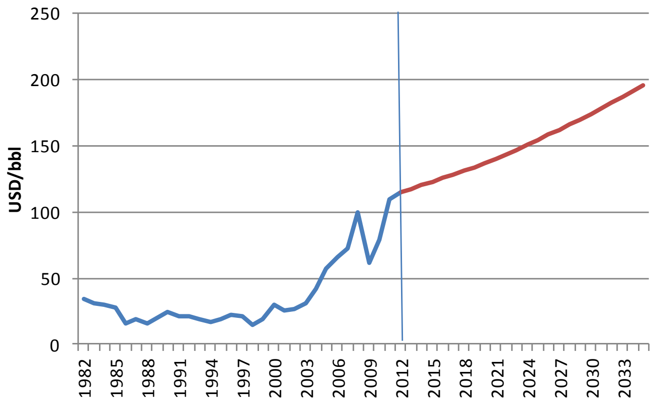
Sources: The World Bank for 2000–2011 data; ERIA and IEEJ for other data.

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.

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

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.

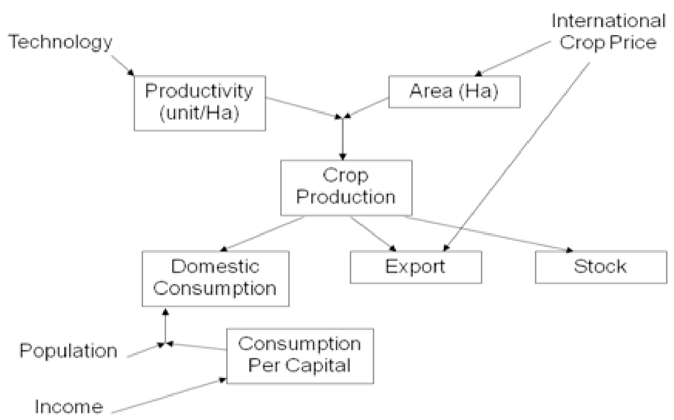
$$EX = (1+a5)*\log EX_{t-1} + b*\log (IP0/IP_{0,\, t-1})$$

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)

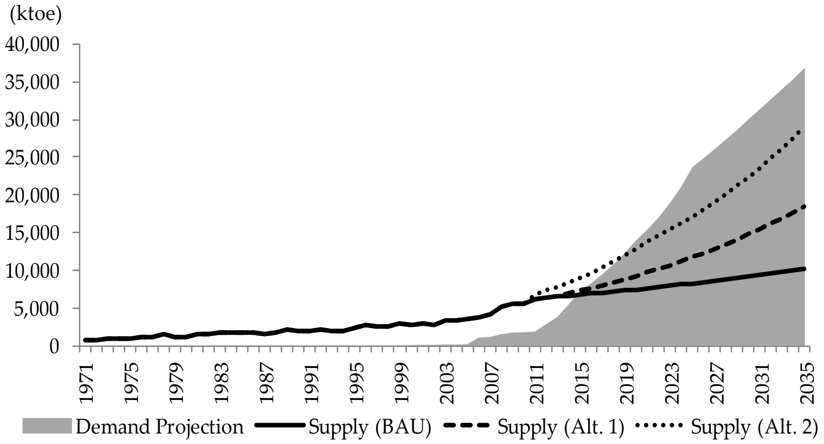
"Alternative 2" is a case where land utilisation and productivity per cultivated area for each of the crop in this region is maximised by 2035. The most advanced productivity of each crop in this region has been assumed as the baseline value, and technology and high productivity variety are available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

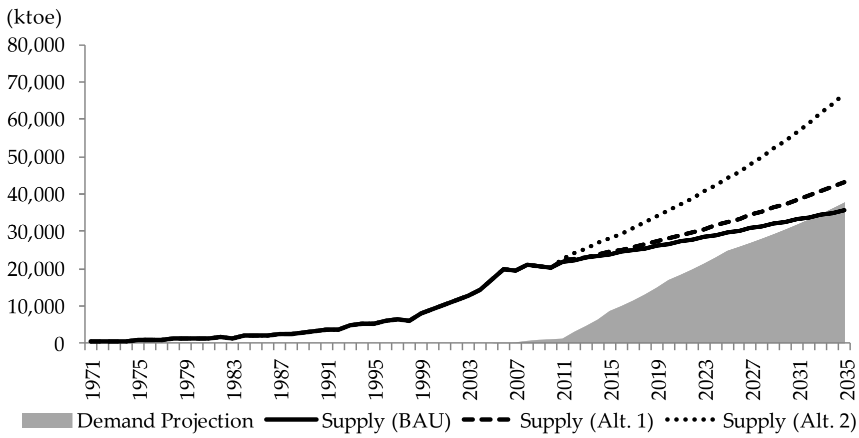
The total aggregated bioethanol supply potential for "Alternative 1" is projected to reach 18,538 ktoe while "Alternative 2" is estimated to be 29,085 ktoe in 2035. Both of these cases cannot meet the demand based on the existing program on bioethanol in this region. Biodiesel supply potential has increased 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.

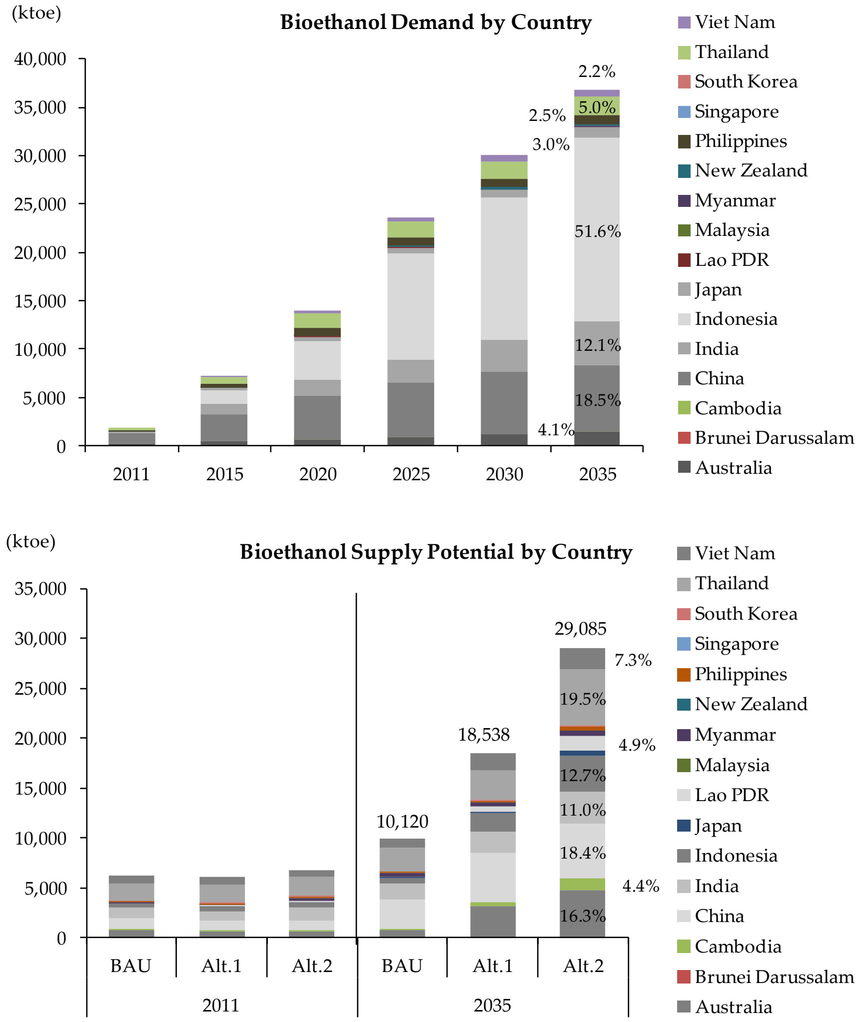
Figure 3.5 Biodiesel Demand and Supply Potential



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

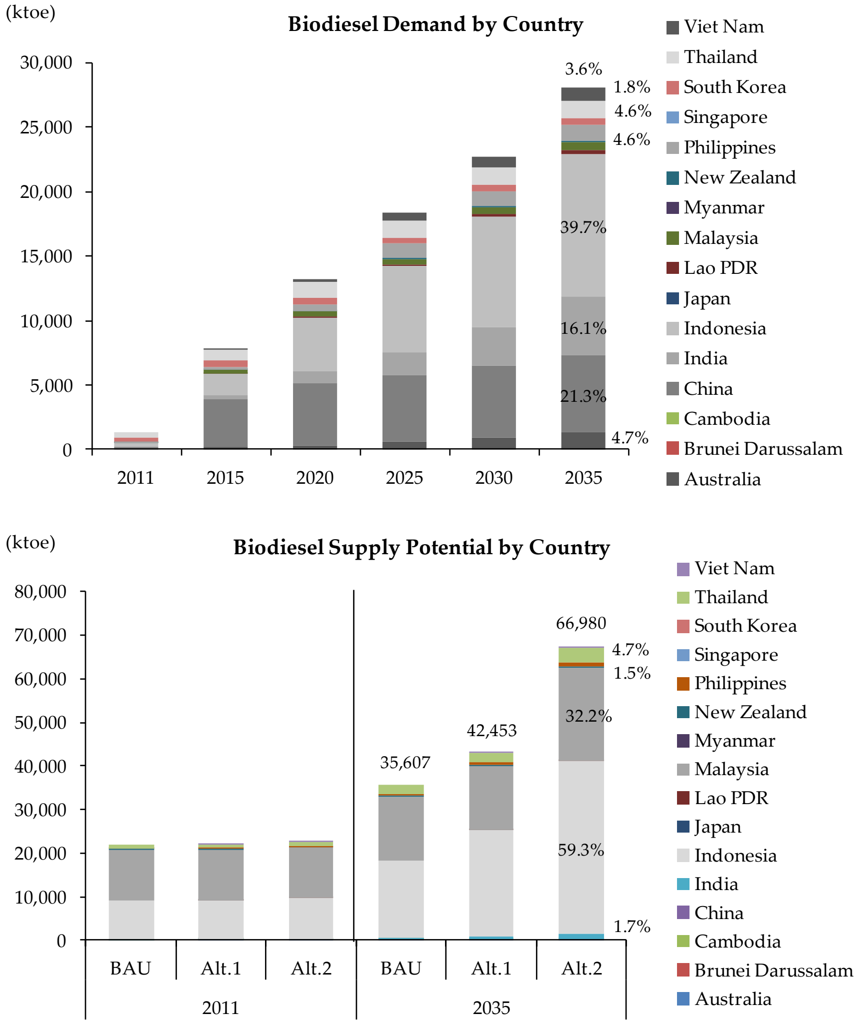
Looking at the demand and supply potential of bioethanol and biodiesel by country, it can be observed that the country with large biofuel demand in the future does not necessarily have sufficient supply potential, and vice versa. For example, Indonesia is expected to have the largest bioethanol demand, 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.

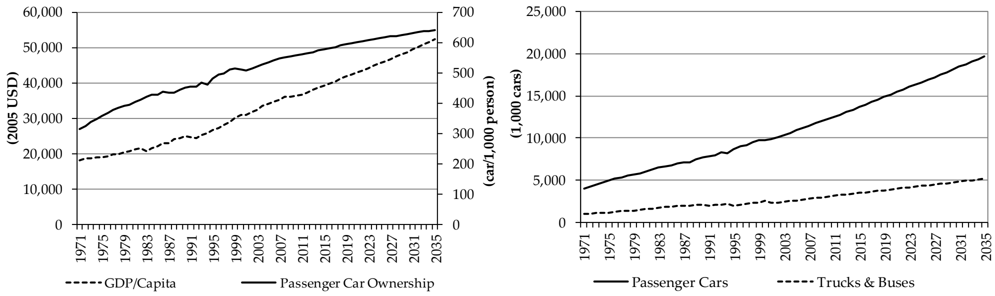
3.3.1. Australia

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.

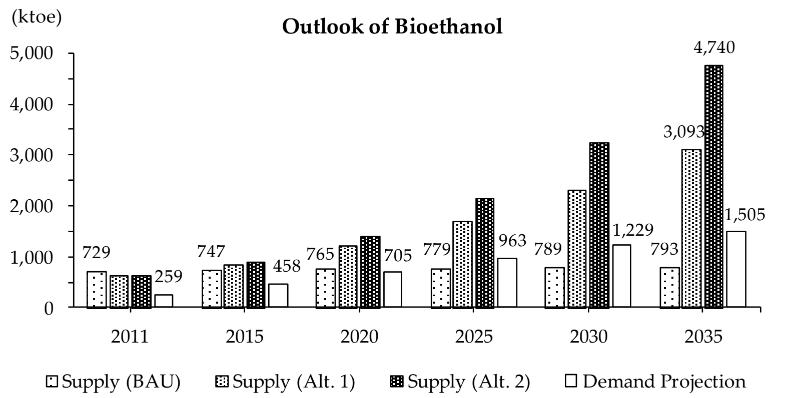
When it comes to biodiesel, animal fat and rapeseed (small quantity) are the main potential feedstock. Supply potential for biodiesel in a BAU scenario is estimated to be 150 ktoe in 2035. Feedstock for biodiesel will increase to 243 ktoe by 2035 because of the increased feed supply as a result of maximised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

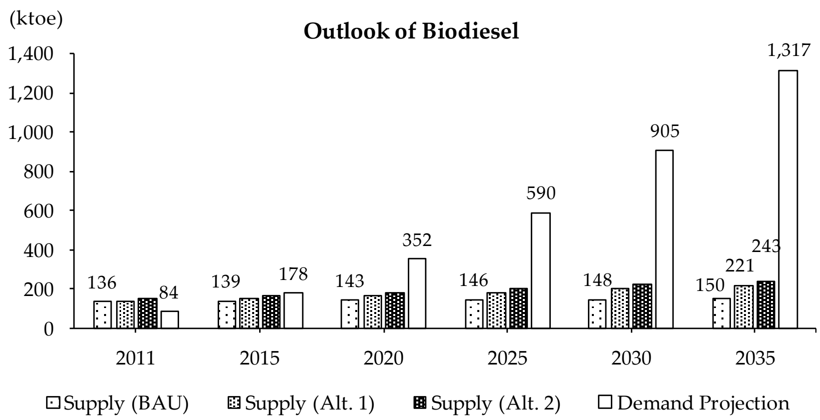
Biofuel Outlook

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





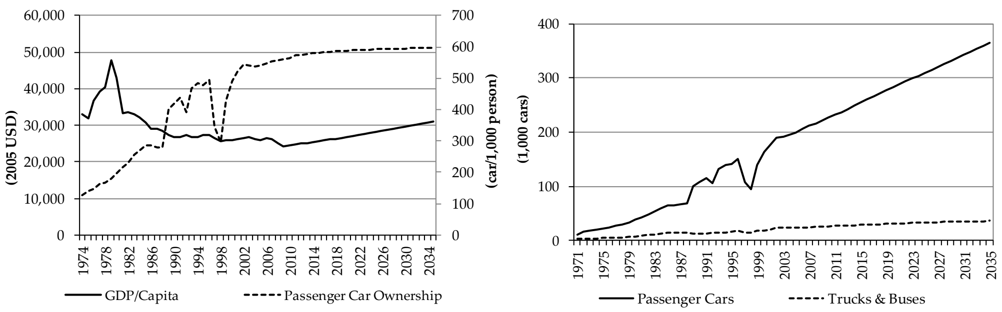
Source: Estimation was done for this study by author/s.

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.

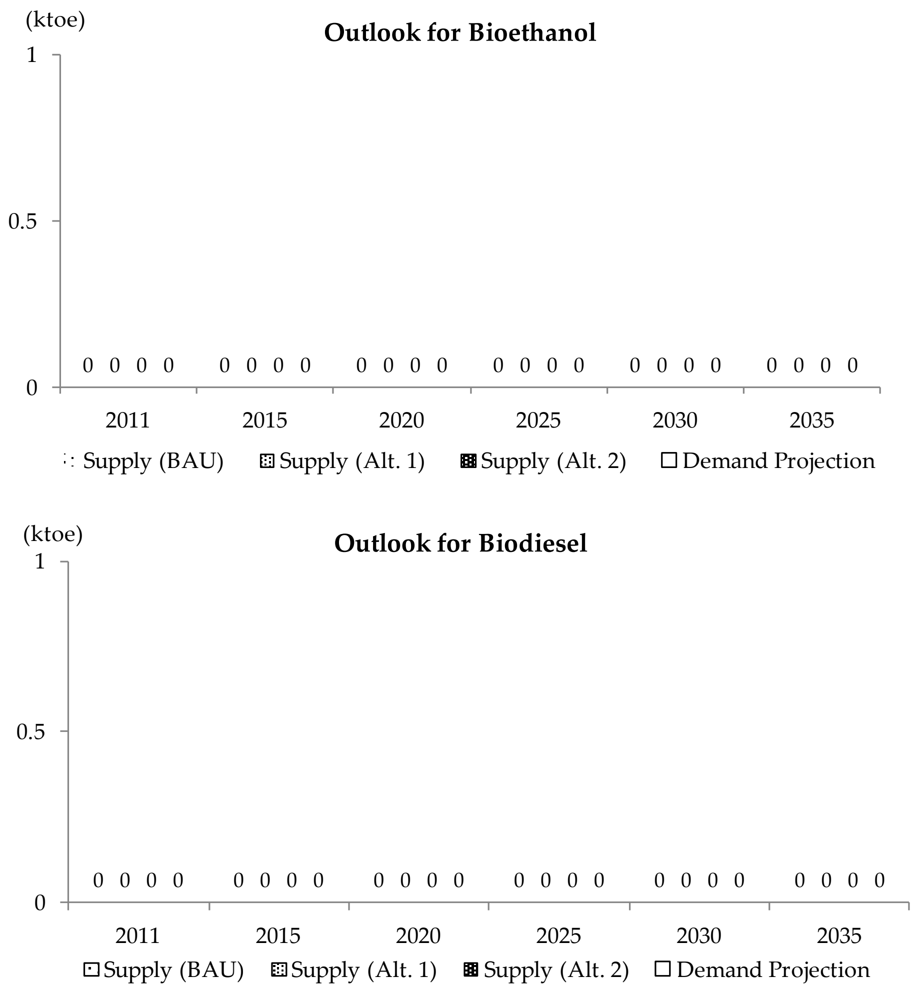
Biofuel Supply Potential

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.

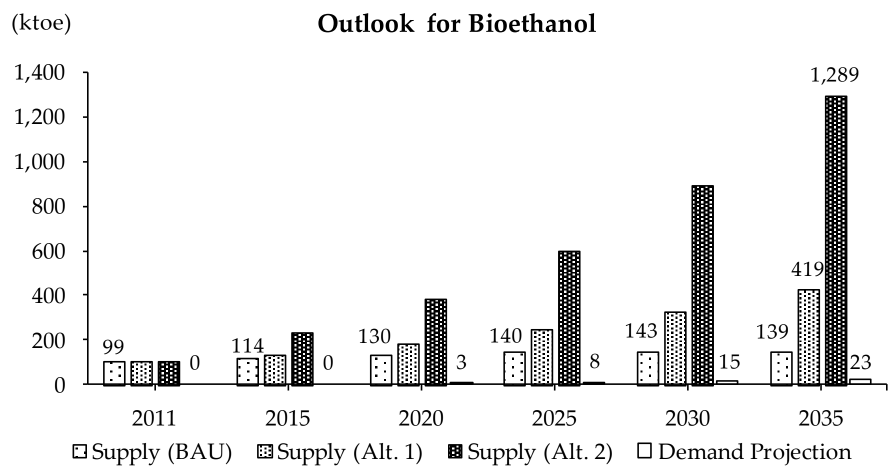
At the time of the study, the major oilseed crop in Cambodia is soybean. Soybean production has just a small of amount of surplus after domestic consumption and export. However, given the rapid growth of population, demand for edible oil is expected to increase accordingly, leaving little potential for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

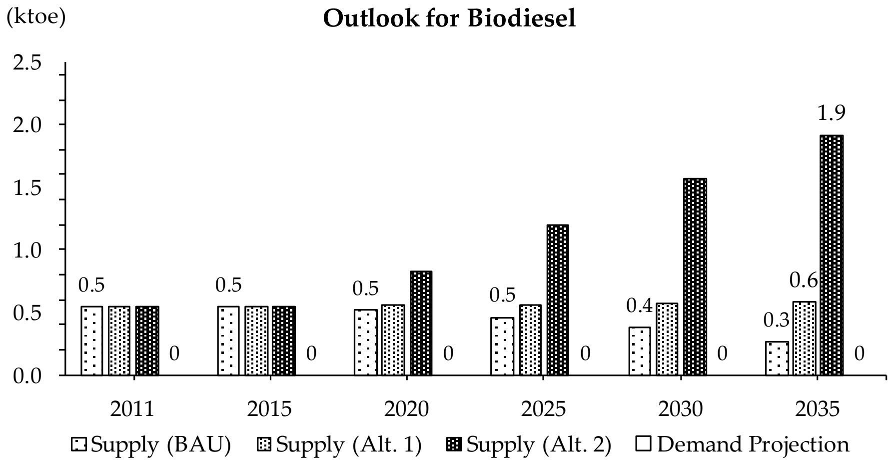
Biofuel Outlook

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.

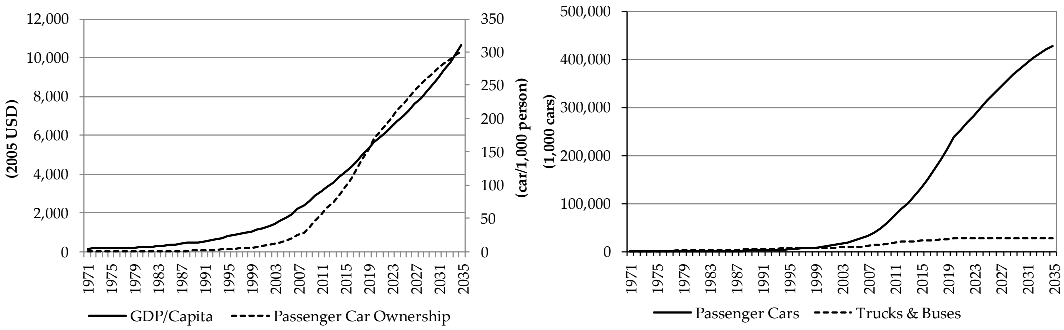
3.3.4. China

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.

<u>Biofuel Supply Potential</u>

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.

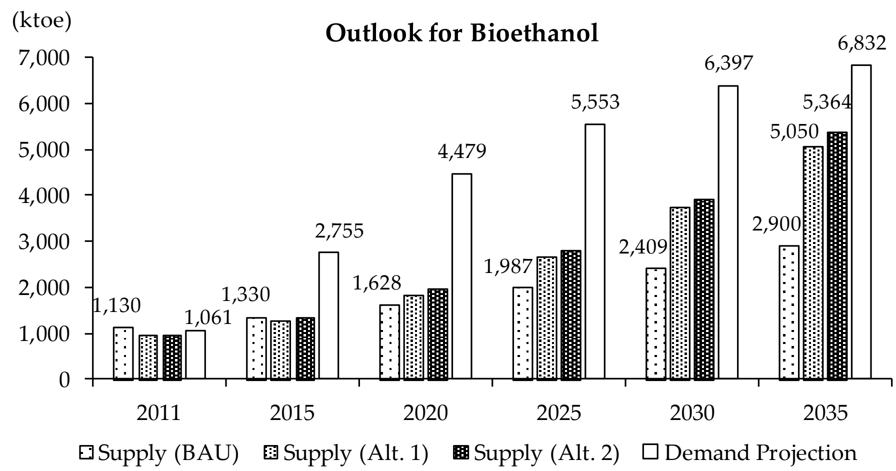
China's rapeseed production is one of the largest in the world. According to the FAO statistics, China produced 13.43 million tonnes of rapeseed in 2011, accounting for 21.5 percent of the world's total. Although China is also one of the largest producers of cooking oil, including soybean oil and cotton 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.

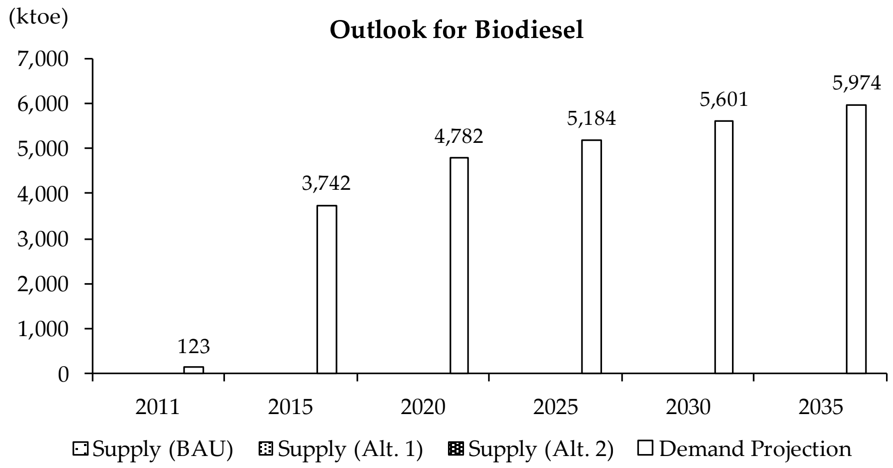
Biofuel Outlook

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.

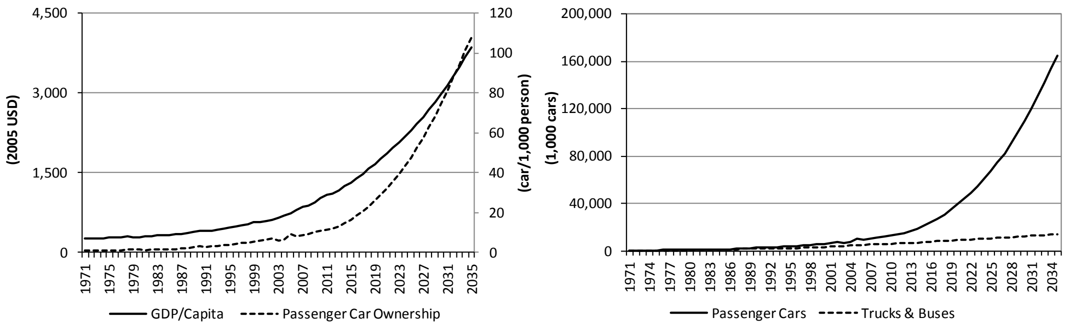
3.3.5. India

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.

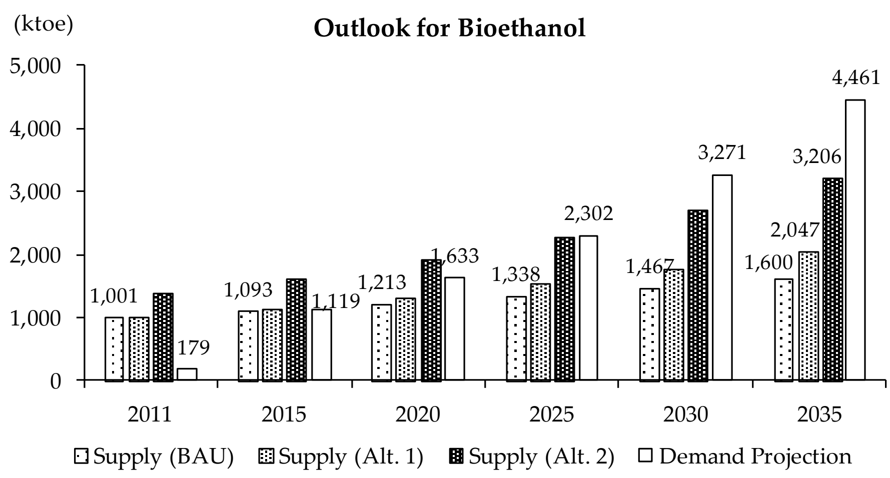
Coconut, rapeseed, and soybean are the major oilseed crops in India. India’s production of rapeseed accounted for 13.1 percent of the world’s total in 2011. However, given the country’s large and growing population, the demand for cooking oil in India will continue to increase in the future. Thus, spare 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.

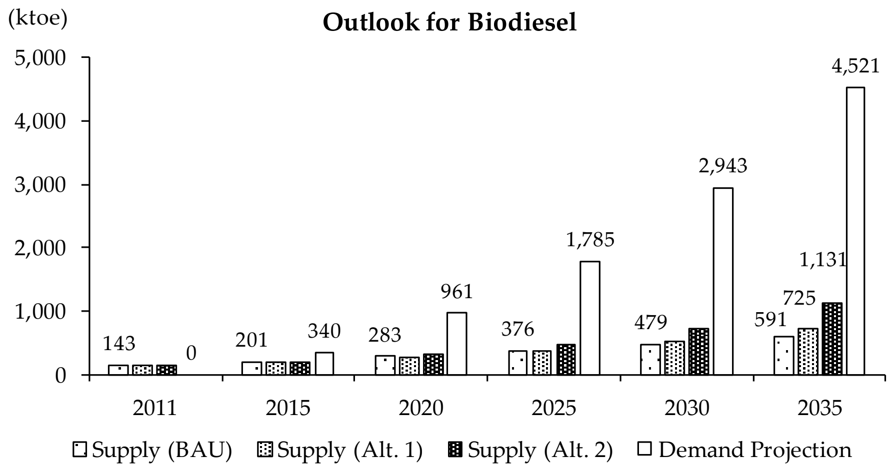
Biofuel Outlook

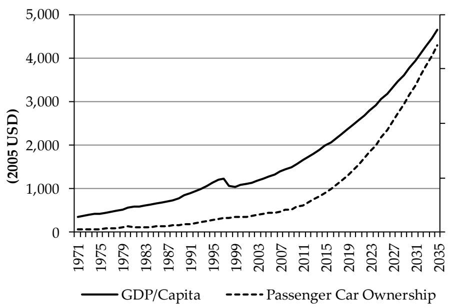
India is a country that has maintained a higher than 90 percent food self-sufficiency. However, the country relies on import for wheat, cooking oil, and animal fat used as cooking oil. The projection results indicate that if the target for biodiesel use were to be fulfilled by domestic supply alone, 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.

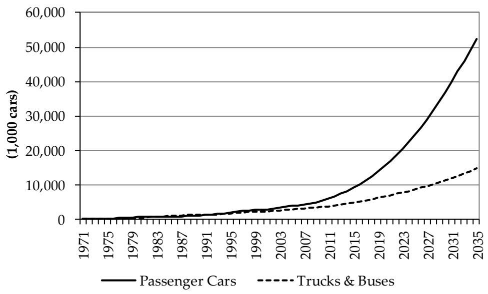
Meanwhile, maize and molasses have a production surplus after domestic consumption. The surplus could be used as a feedstock for bioethanol production. However, results show that around 2025, there is an expected shortage of bioethanol supply to meet the domestic demand (driven by government biofuel 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.

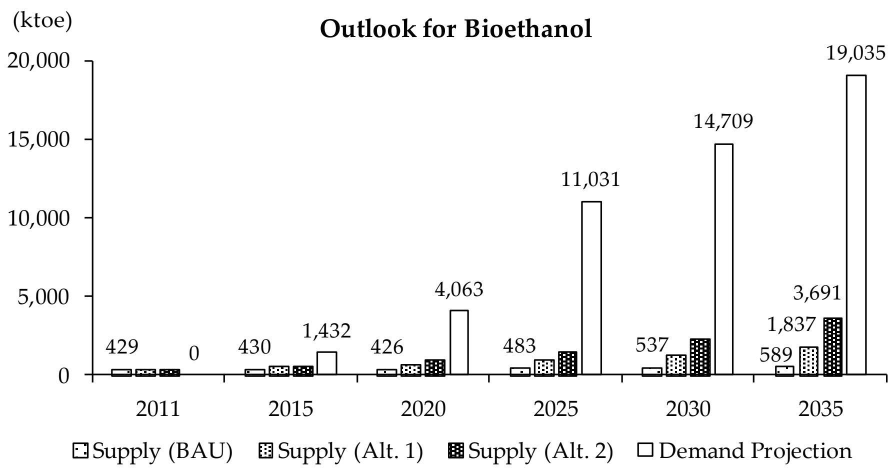
Feedstock of biodiesel is mainly from palm oil. Indonesia is one of the largest palm oil producers in the world. Crude palm oil production in 2011 reached 2,145 million tonnes, accounting for 44.2 percent of the global market. The supply potential (under a BAU scenario) of biodiesel from palm oil is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

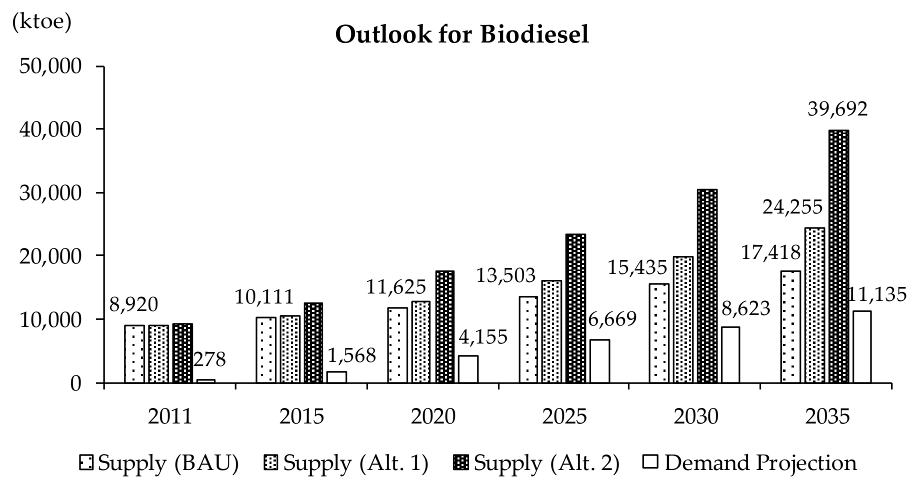
Biofuel Outlook

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.

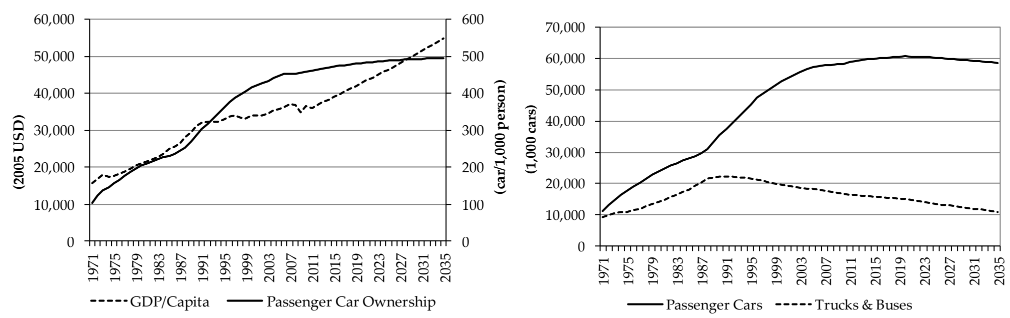
3.3.7. Japan

<u>Biofuel Demand</u>

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.

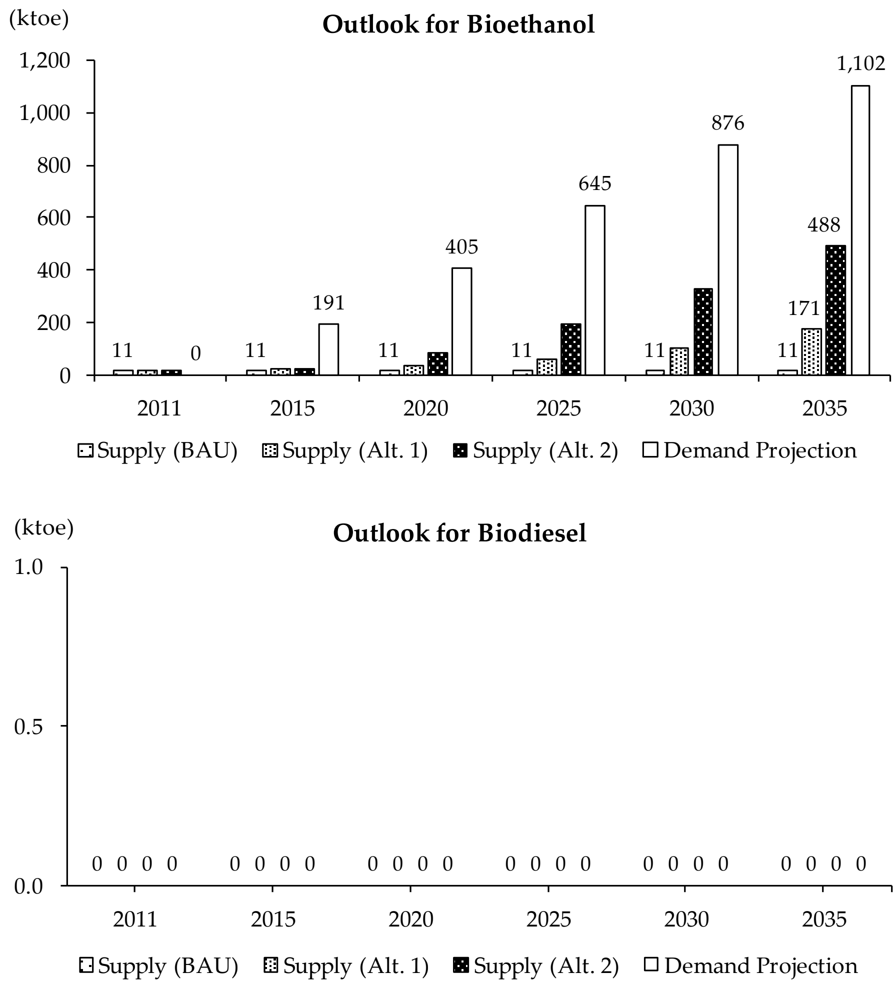
Japan has no oilseed crops for feedstock supply of biodiesel except some scattered small-scale biodiesel production using waste cooking oil in local areas. The practice is not expected to scale up, given the country’s declining population.

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.

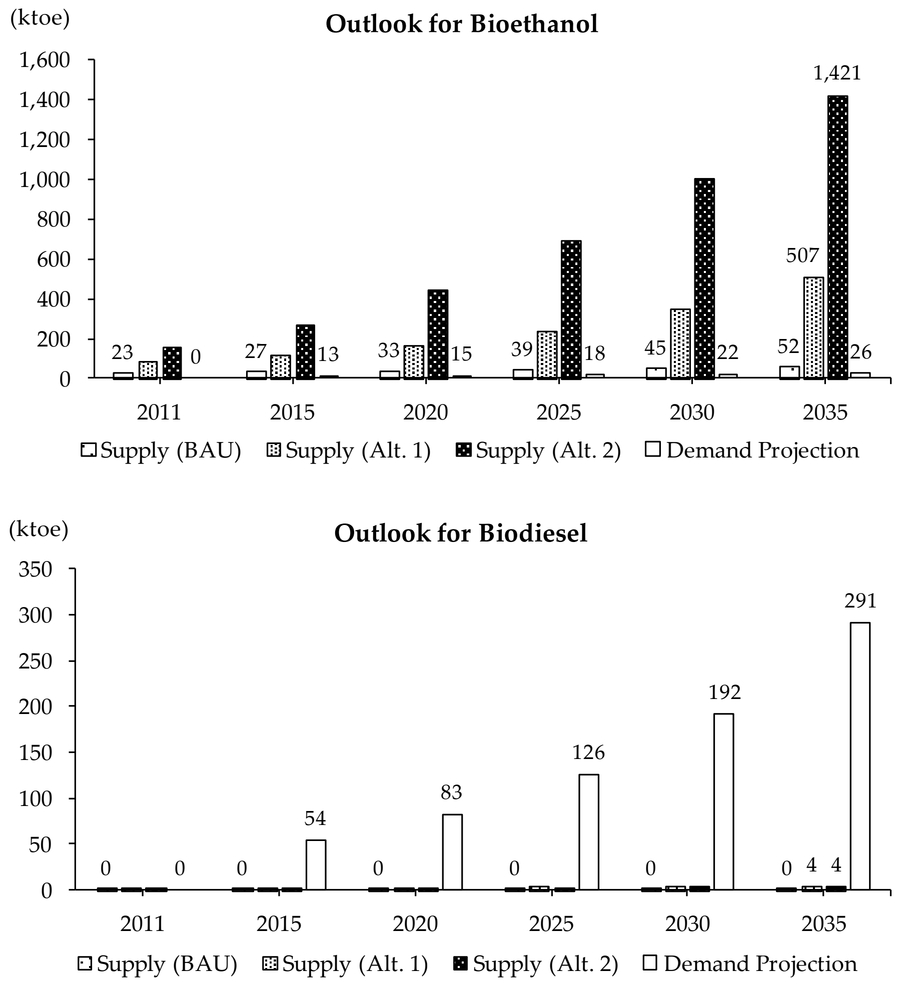
Meanwhile, soybean is the only oilseed crop growing in Lao PDR, and the cultivation area is relatively small. As Lao PDR is a net importer of cooking oil, the country is supposed to have little feedstock for biodiesel production. Even if the scenario is "Alternative 1" or "Alternative 2", there will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

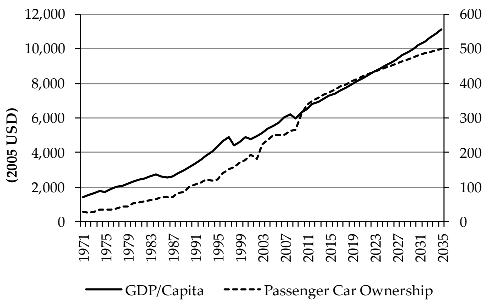
3.3.9. Malaysia

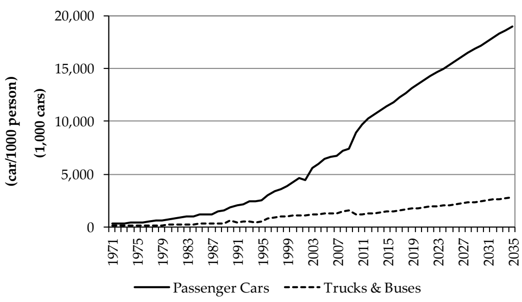
Biofuel Demand

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.

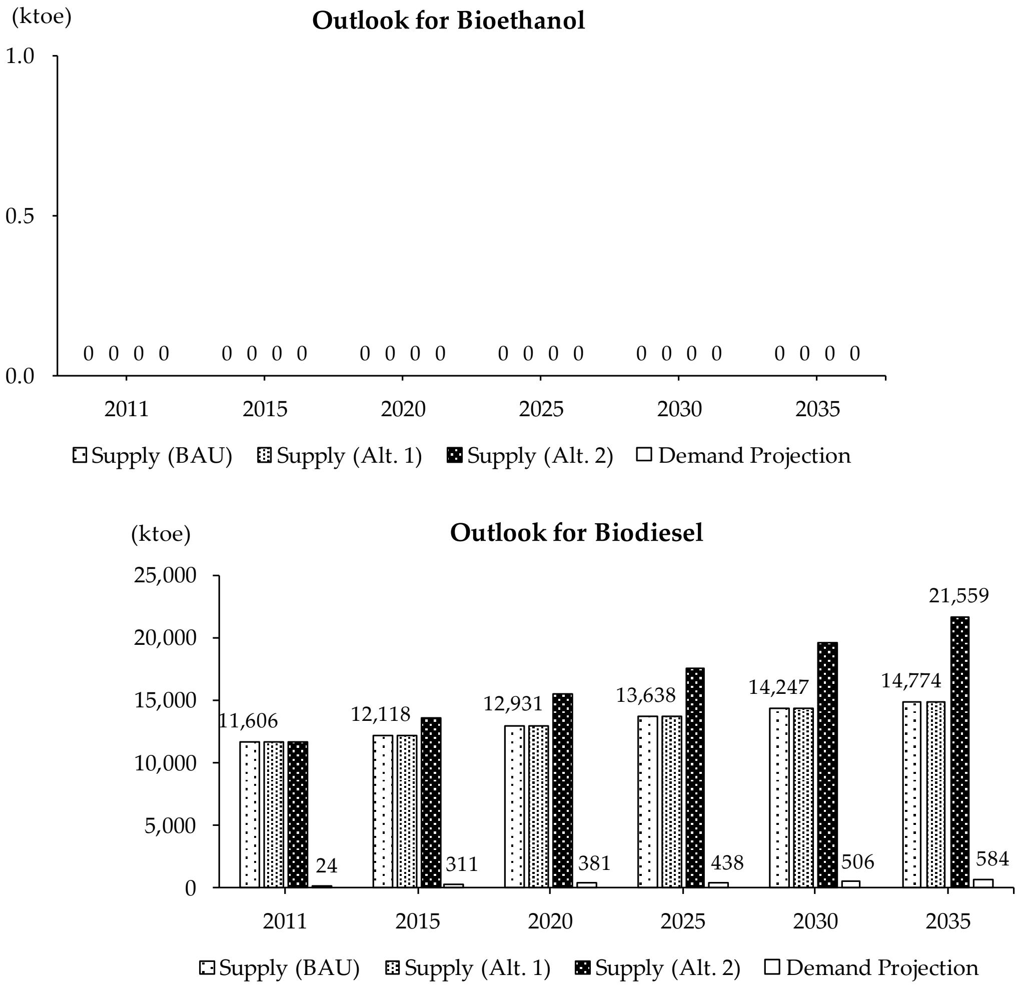
According to FAO data, Malaysia's agricultural land area is 7.87 million ha, where 6.76 million ha is harvested area. Unutilised agricultural land area would be approximately 1.1 million ha. In the BAU case, the actual cultivated oil palm area reached 4.36 million ha in 2012 and is projected to reach 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.

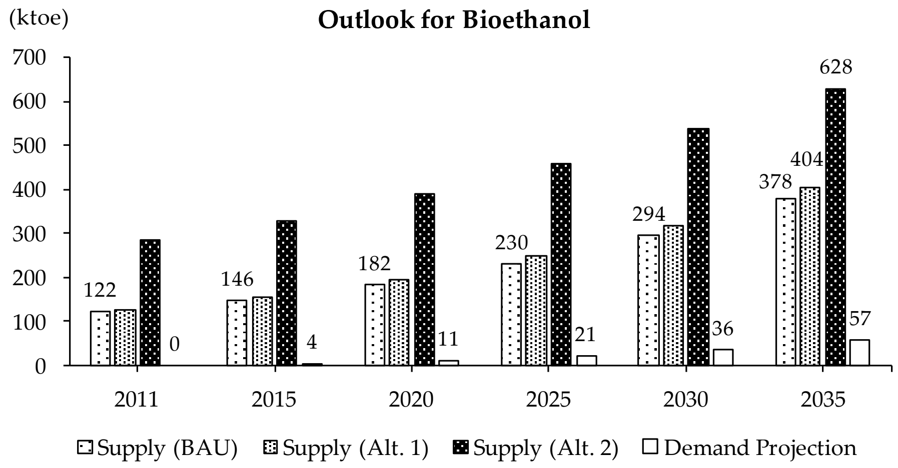
The cultivation area of oilseed crops is relatively small in scale. In this study, it is assumed that there is little feedstock for biodiesel production in Myanmar.

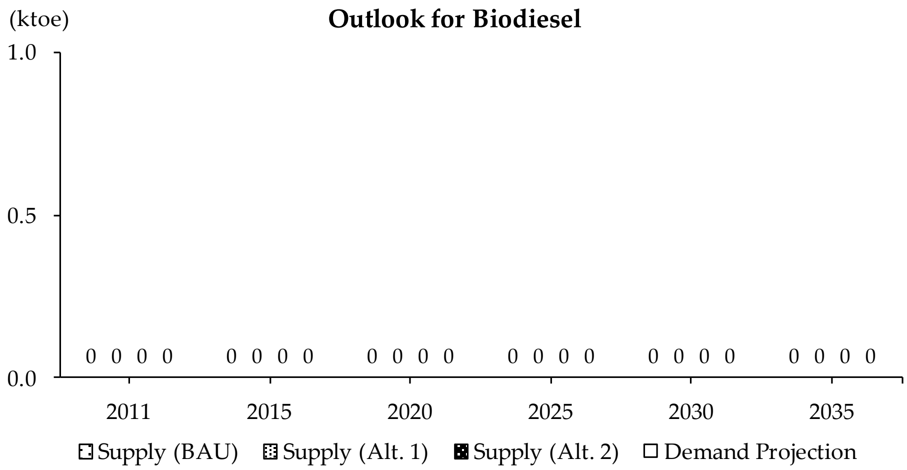
Biofuel Outlook

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.

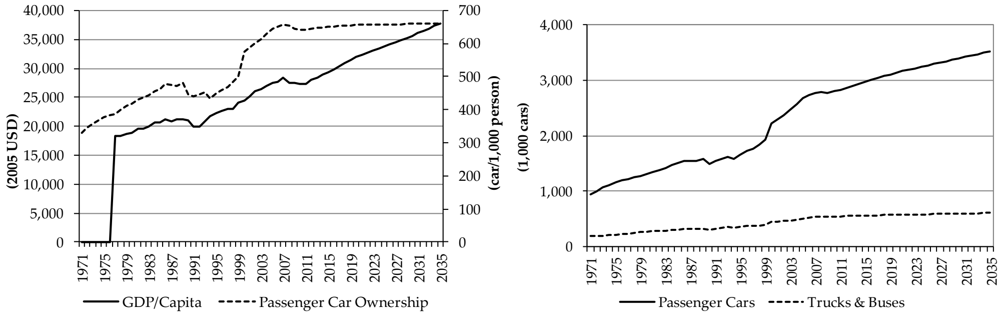
3.3.11. New Zealand

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.

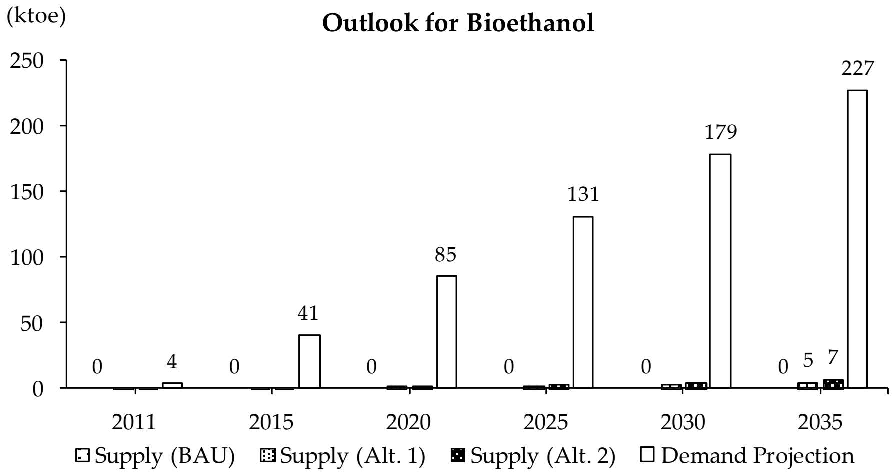
Meanwhile, the country has a potential supply of livestock fat that could be used to produce biodiesel. It is estimated that the supply potential of biodiesel will expand from 174 ktoe in 2011 to 212 ktoe in 2035.

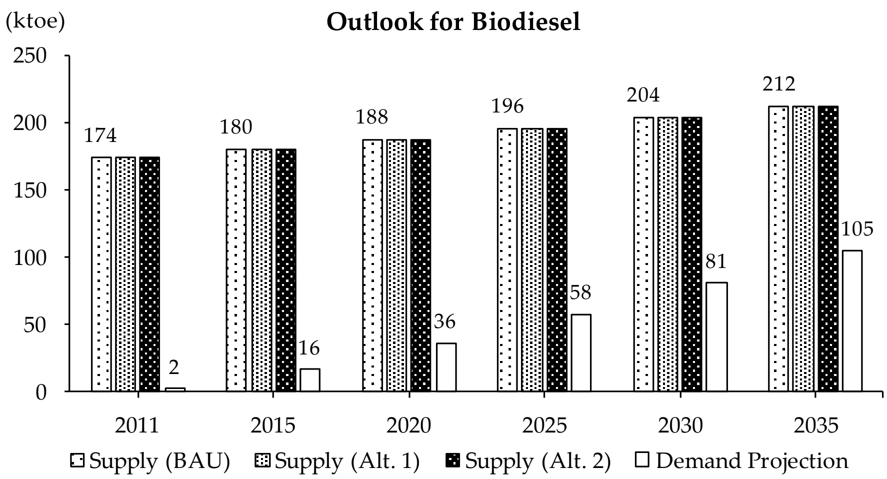
Biofuel Outlook

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

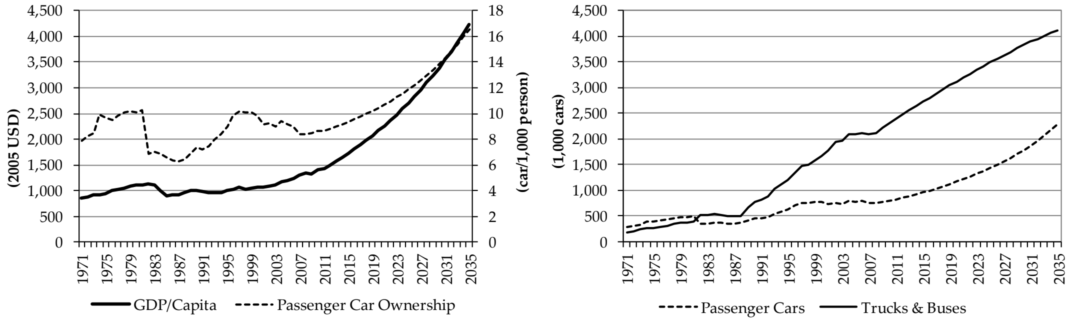
Biofuel Demand

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.

<u>Biofuel Supply Potential</u>

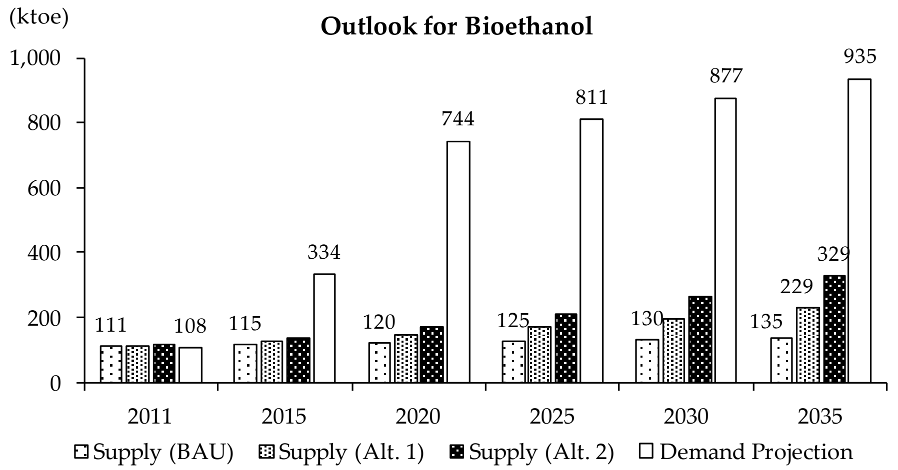
In the Philippines, only sugarcane (molasses) has the potential to be a major feedstock for bioethanol production. However, because it is a net importer of sugar, only molasses is expected to be used to produce bioethanol. Supply potential (in a BAUscenario) of bioethanol is estimated to expand slightly 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.

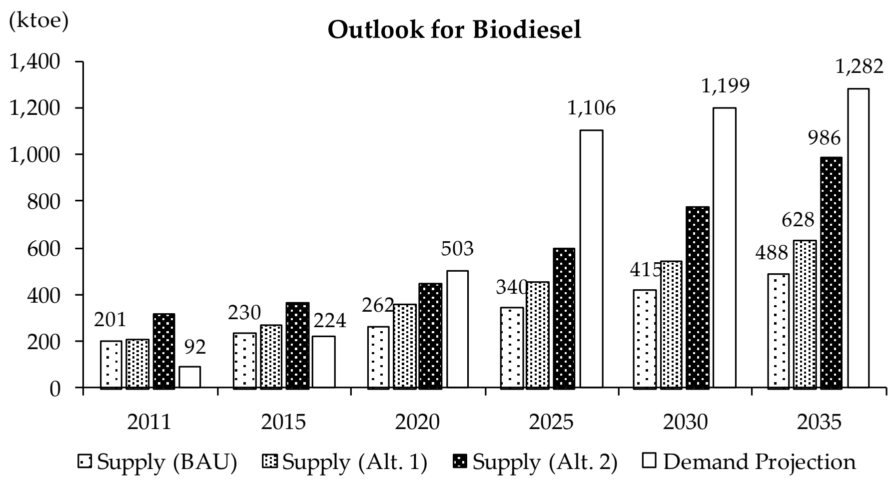
Coconut is the main feedstock for biodiesel production in the Philippines. The country is one of the world's largest coconut producers and is also a major exporter of coconut products. By promoting the use of biodiesel, the income of coconut farmers and that of coconut industries are expected to increase. 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.

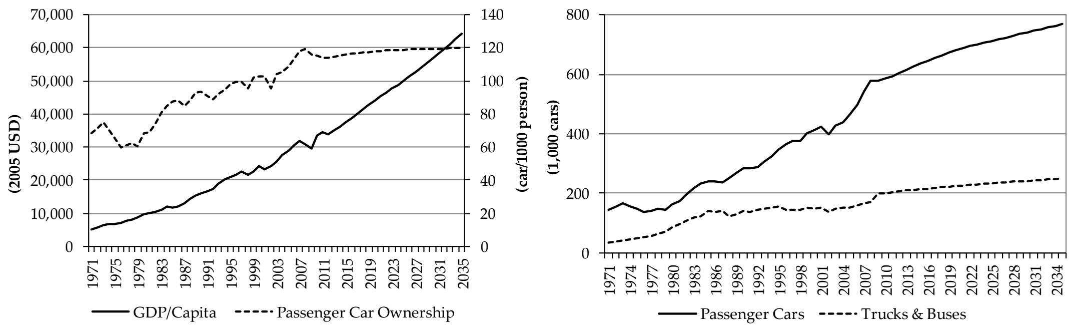
3.3.13. Singapore

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.

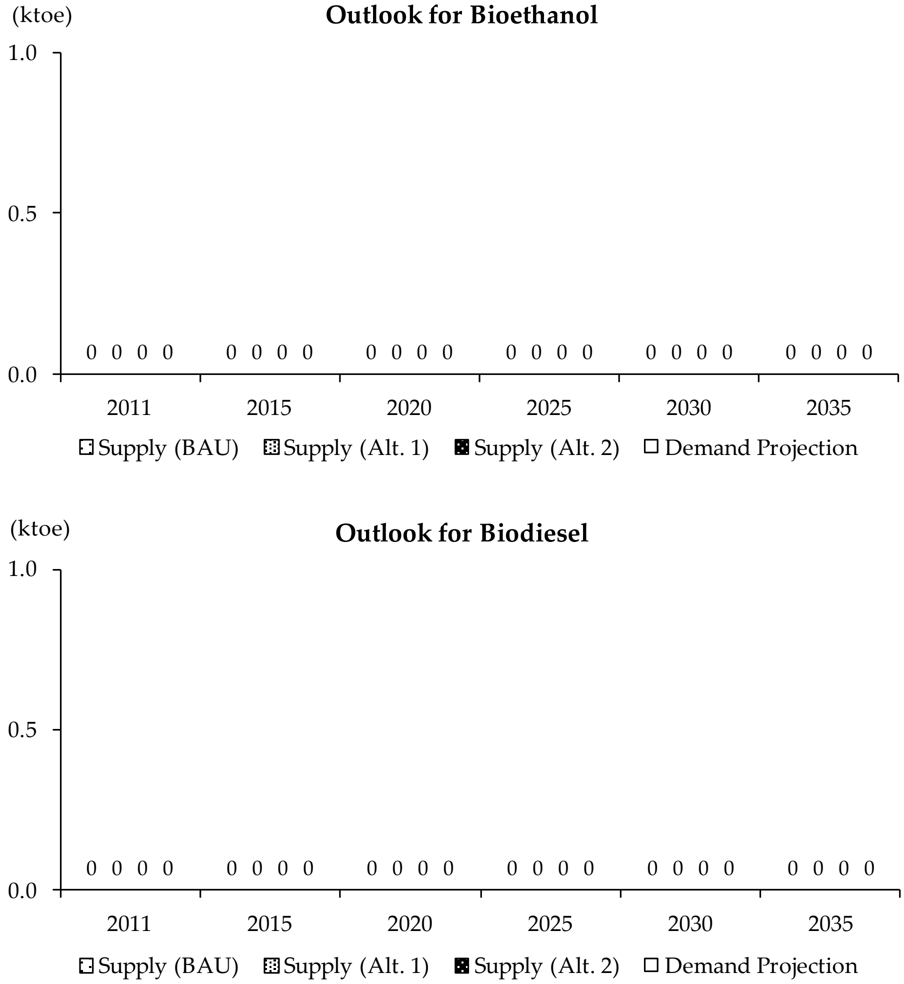
<u>Biofuel Supply Potential</u>

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.

<u>Biofuel Outlook</u>

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.

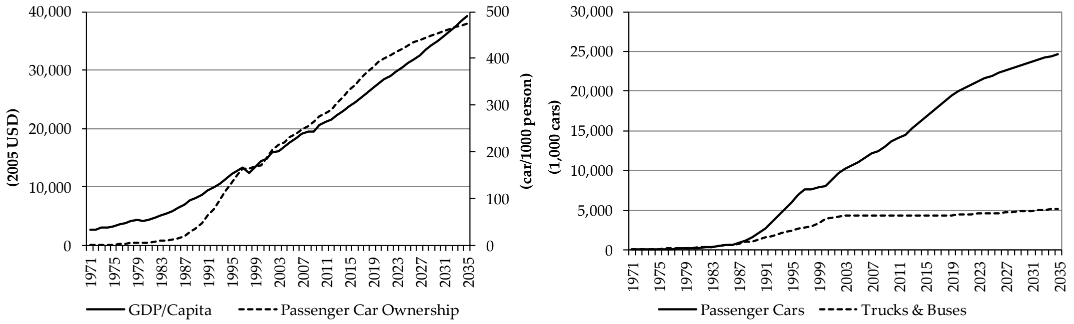
3.3.14. South Korea

<u>Biofuel Demand</u>

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

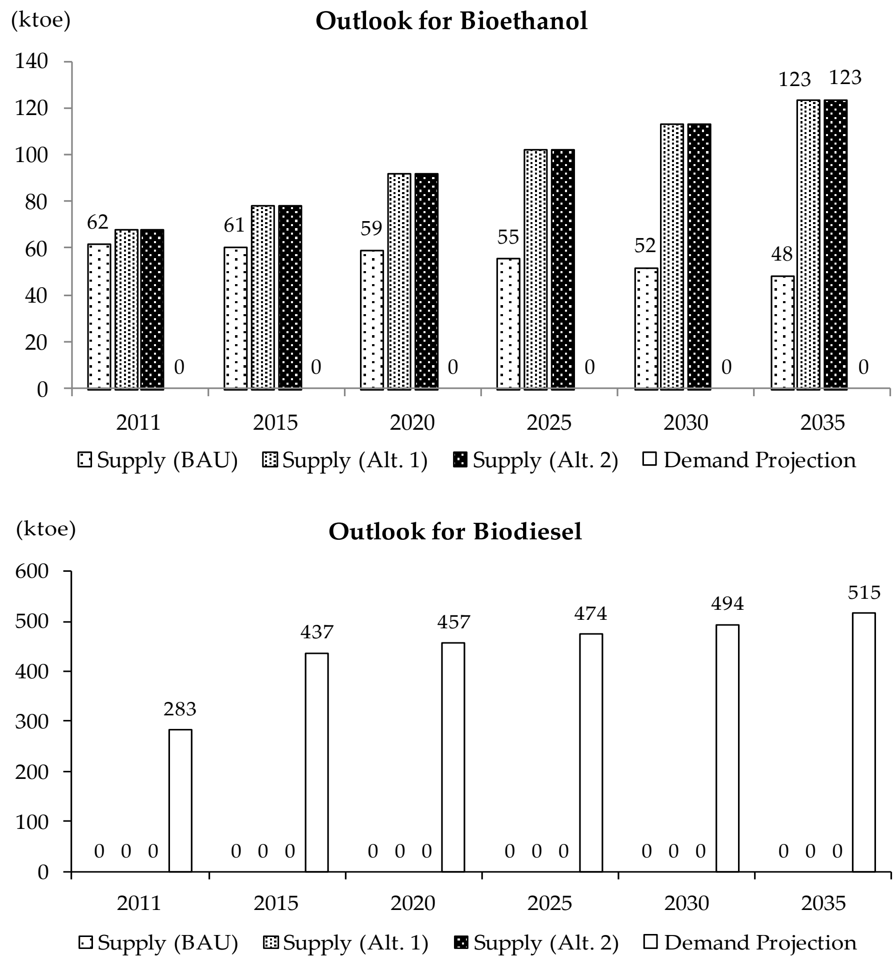
The food self-sufficiency in South Korea is only about 20 percent. The country is a net importer of sugar and maize, which could be used to produce bioethanol. Only rice production have surplus after domestic consumption. However, the excess capacity of rice production is small. In this study, it is 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.

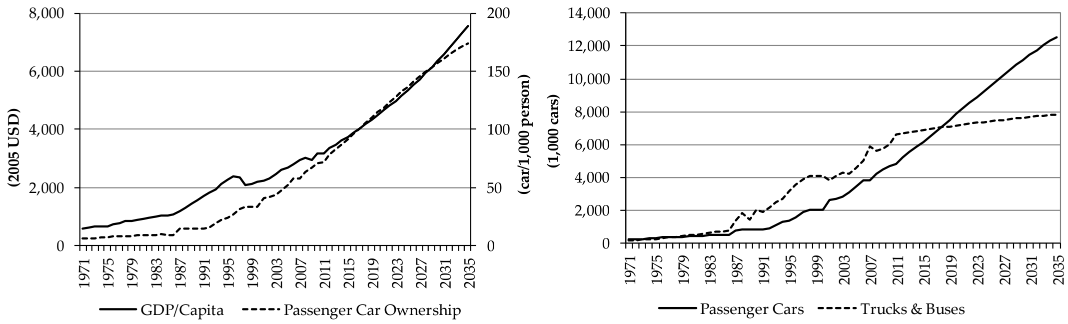
3.3.15. Thailand

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

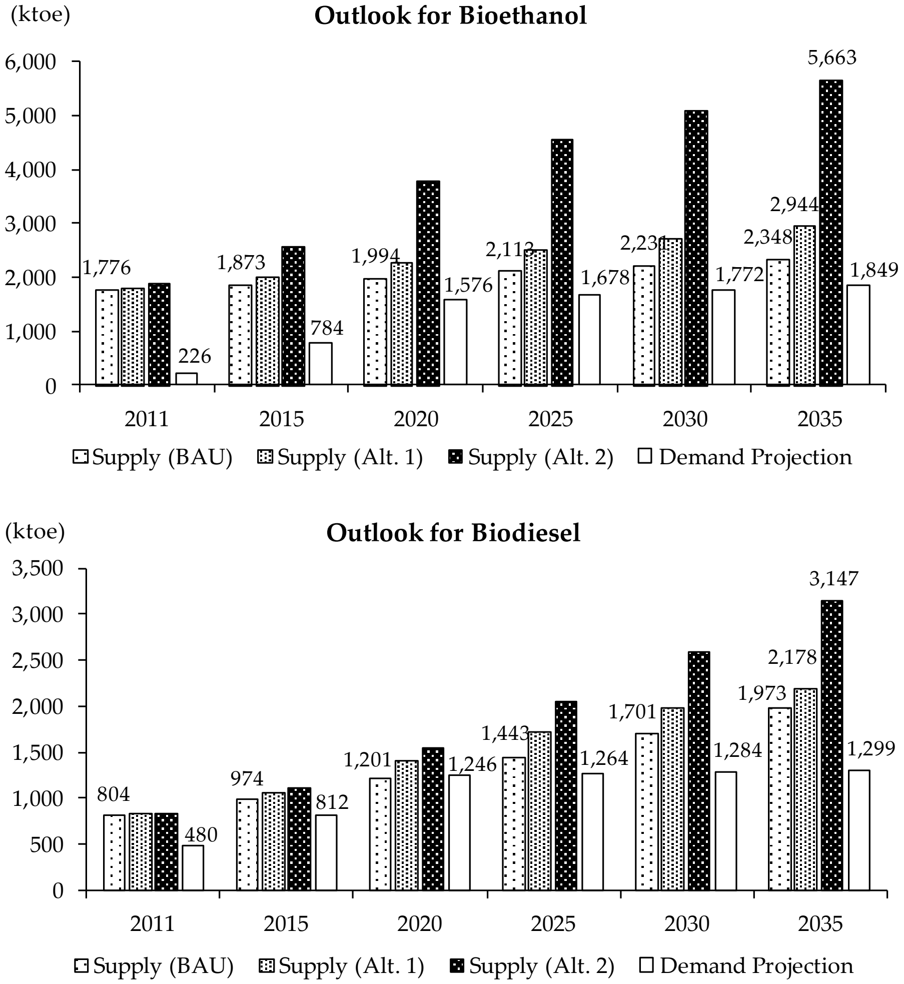
Thailand has a good potential for feedstock resources (mainly sugarcane and molasses) for bioethanol production. The supply potential (in a BAU scenario) of bioethanol is estimated to reach 2,348 ktoe in 2035. According to FAO data, Thailand has approximately 249,000 ha of unused agricultural land. In "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.

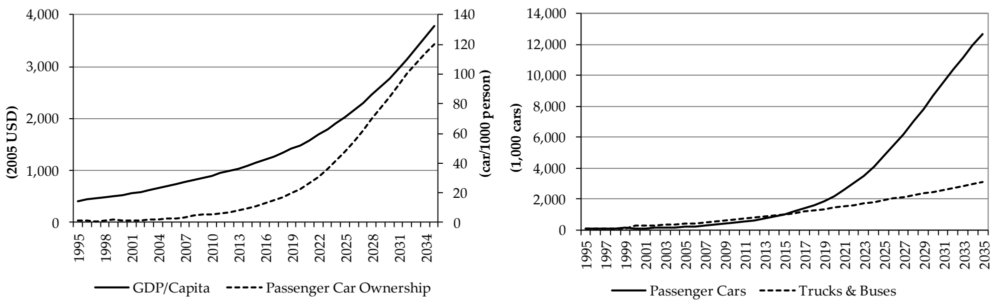
3.3.16. Viet Nam

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.

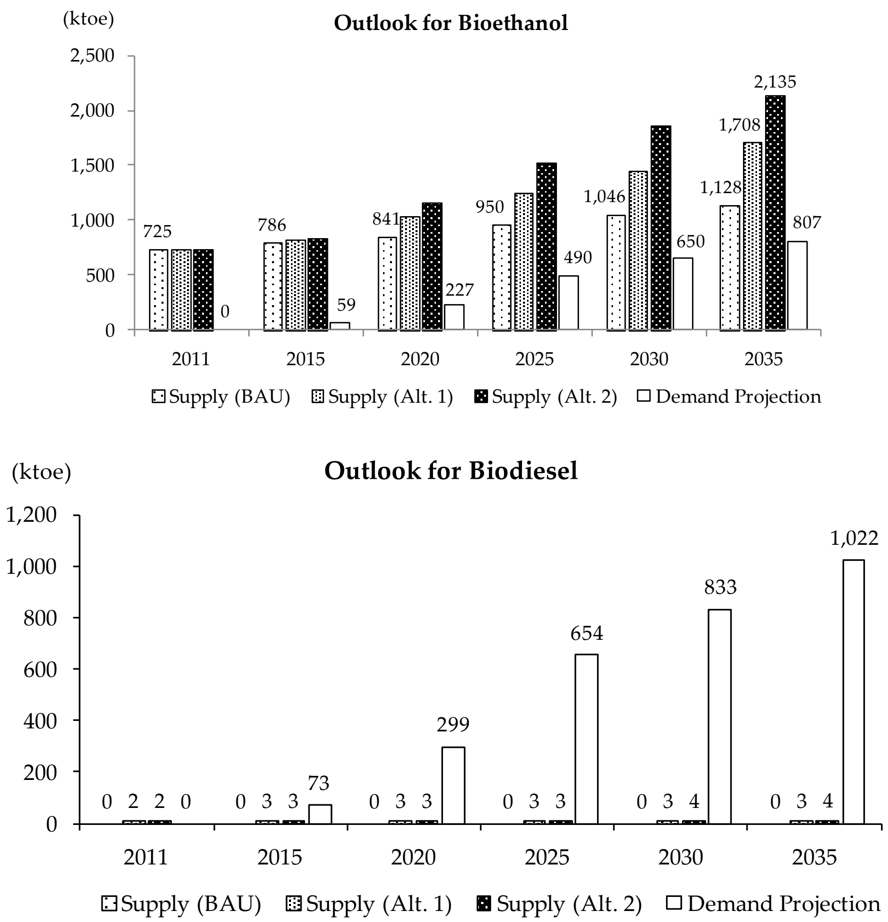
Since Viet Nam is a net importer of cooking oil, it is assumed that the country has little potential on feedstock supply for biodiesel production.

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

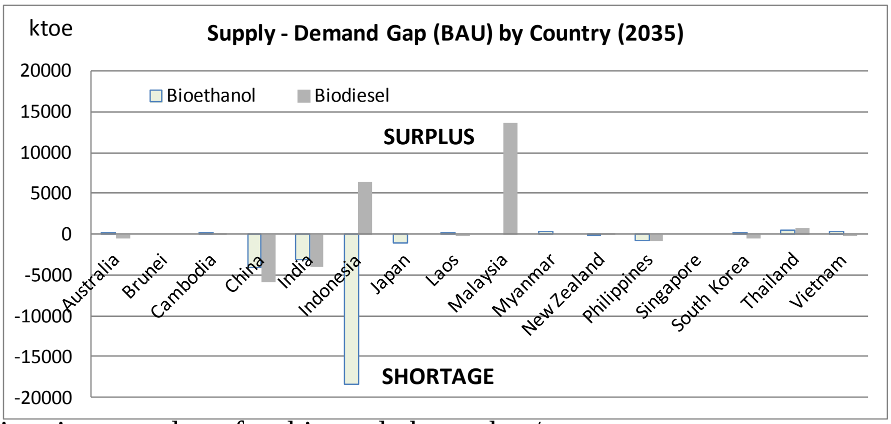


Source: Estimation was done for this study by author/s.

CHAPTER 4
Potential for Trade

Looking at the demand and supply potential of bioethanol and biodiesel by country, it could be observed that countries with large biofuel demand in the future do not necessarily have sufficient potential of supply, and vice versa (Figure 4.1). For example, Indonesia is the country with the largest demand, accounting for more than half of both bioethanol and biodiesel demands, while its supply potential of bioethanol is estimated to be very limited. This results in Indonesia experiencing the largest shortage of bioethanol by 2035. Malaysia, on the other hand, is supposed to be the region's second-largest biodiesel supplier in 2035, with its domestic biodiesel demand projected to be marginal. Consequently, it could have a large surplus of biodiesel in the future. This mismatch of future biofuel demand and supply potential indicates that cross-country biofuel trade is necessary to optimise the region's biofuel utilization. Details on the issues of regional biofuel market integration will be discussed in Chapter 5.

Figure 4.1 Supply–Demand Gap by Country (business-as-usual case)



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

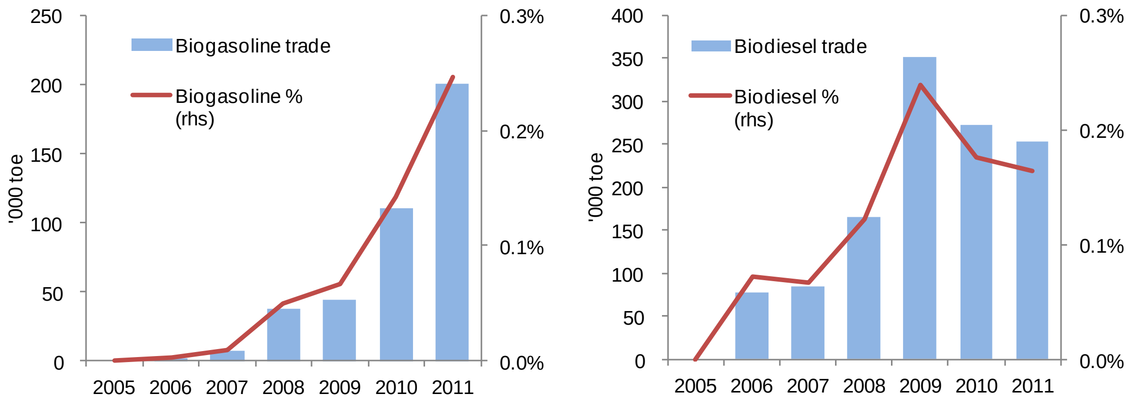
The above results show gaps between demands and supplies among countries as well as in the region. The gaps can be reduced through the integration of the market. This section addresses the benefits integration in terms of the potential expansion of trade. Although the advantage of market integration seems to be clear from the point of regional demand and supply, the reality is much more complex because the prerequisites of market integration must be considered. This includes regional common standards and differences of national interests in biofuels. In this chapter, the complexity is analysed from the perspective of the potential expansion of the biofuel market through integration and the impact of competing objectives upon policies.

First, the current status of biofuel trade in Asia is reviewed from the perspective of international demand and supply for liquid fuels. Next, the magnitude of the benefits from integration is estimated quantitatively. Finally, options to expand the trades are discussed.

Trade of Biofuels in Asia: Current Status

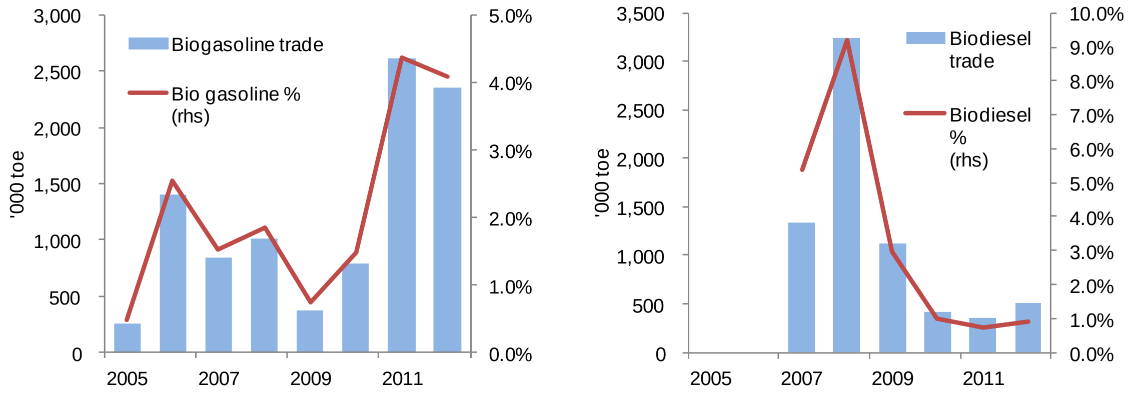
The trade of biofuels in the Asia-Pacific region had not been as active as in other regions, such as in Europe and the Americas. As Figure 4.2 shows, the shares of bio-gasoline (mostly bioethanol, but includes ethyl tertiary butyl ether [ETBE]) and bio-diesel trade over the total traded volume of each product are still at a negligible level, or below 0.3 percent. This percentage is considerably low compared with the US and European shares (Fig. 4.3 and Fig. 4.4).

Figure 4.2 Trades of Bio-Gasoline (Left) and Biodiesel (Right) in Asia



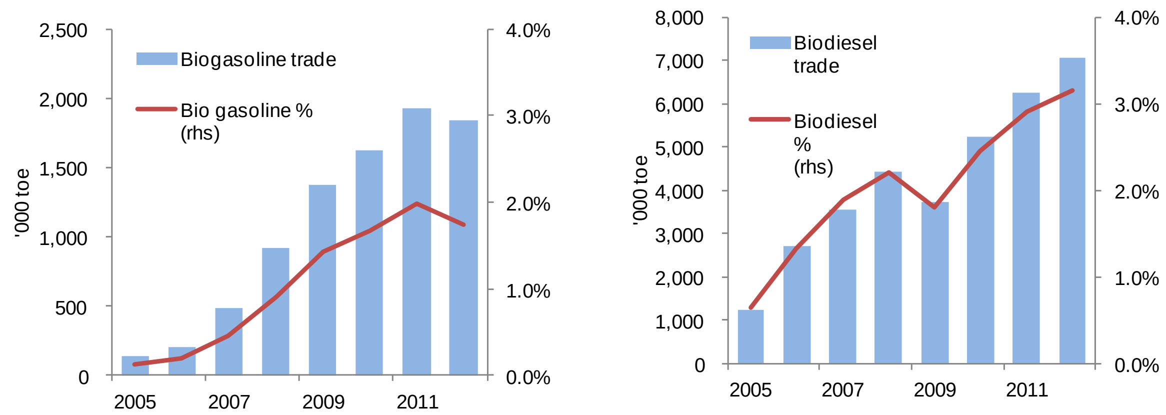
Note: There was no trade before 2005. Trade volume is the sum of export and import.
Source: IEA (2013), Energy Balance of OECD Countries and Energy Balance of non-OECD Countries.

Figure 4.3 Trades of Bio-Gasoline (Left) and Biodiesel (Right) in the US



Note: There was no trade before 2005. Trade volume is the sum of exports and imports.
Source: IEA (2013), Energy Balance of OECD Countries.

Figure 4.4 Trades of Bio-Gasoline (Left) and Biodiesel (Right) in Europe

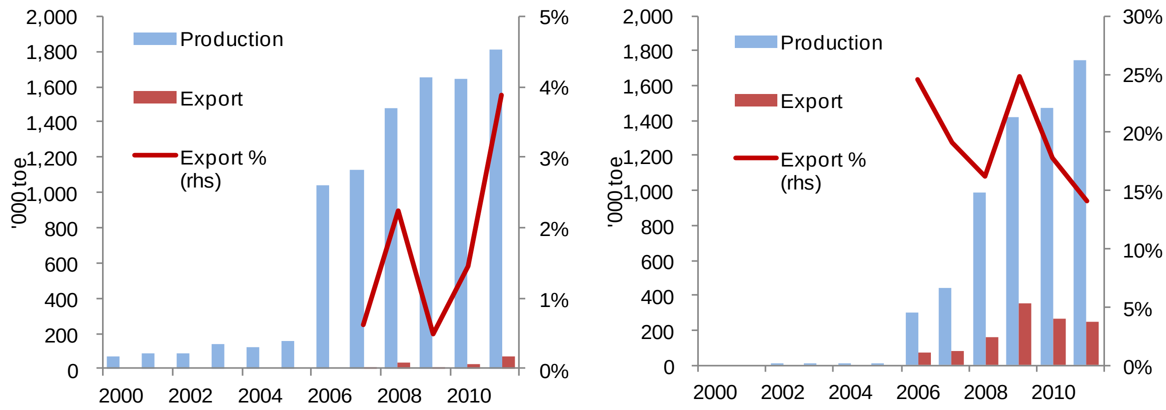


Note: There was no trade before 2005. Trade volume is the sum of export and import.
Source: IEA (2013), Energy Balance of OECD Countries.

The most important factor behind the inactive trade of biofuels is that biofuels trade requires dedicated infrastructure, such as tank, tank truck, pipeline, and tankers. Biofuels trade, therefore, costs much more than ordinary oil product trade, especially for many of the developing countries in Asia. Its specification and terms of trade contract, in addition, are not standardised as in ordinary oil product trade. Its trade tends to be conducted among a limited number of parties and its market is as liquid as the oil product market. At the time of writing this report, the major exporters of biofuels in Asia are Indonesia and Malaysia; in other countries, both production and export capacities have not been well developed.

Another factor is the purpose of biofuels introduction. Biofuels are, in general, produced mainly for domestic use. One of the rationales for producing and utilising costly biofuels is to secure domestic energy supply, replacing imported fuels. This motivation is shared particularly among Asian countries because many of them are net importer of oil. Biofuels are, in this sense, energy produced to be consumed domestically, and trading is not the primary purpose of biofuels production. Figure 4.5 shows that only less than 5 percent of bio-gasoline production in Asia has been exported. Also, it suggests that, although around 20 percent of the total biodiesel production is exported, its volume and share has reached a peak in 2010 and has declined afterward.

Figure 4.5 Export Shares of Bio-gasoline (Left) and Biodiesel (Right) in Asia



Source: IEA, (2013), Energy Balances of OECD Countries 2013 and Energy Balances of non-OECD Countries.

Besides securing domestic energy supply sources, biofuels' contribution to rural and agricultural development is also important. In fact, in Asia, the market for biofuels is linked to both food and energy markets and whether products can be domestically consumed or exported depends not only on the prices of oil products but also on food prices.

There are a number of motivations behind each country's biofuel development efforts. Trade is an area where these different motivations conflict with each other.

Summary

Biofuels trade in Asia has not been as actively conducted as in the US or Europe. This is partly because biofuel production and consumption is still negligible in the total oil product supply, and because the primary purpose of biofuels introduction in many Asian countries is to enhance self-sufficiency in energy supply. Hence, importing or exporting biofuels is not actively pursued. No drastic change is expected in future biofuels trade. This is because the abovementioned factors will remain the same in the foreseeable future. Biofuels supply potential, where a conflict with food consumption is also taken into account, is also estimated to be relatively limited, as discussed in Chapter 3.

Thus, it becomes a policy challenge to promote a more active trade of biofuels, as a clear biofuel policy formulated by each Asian country will be important in providing a clear policy direction to encourage investment in biofuels to enhance supply capacity, and to provide the infrastructure needed to activate trade. The standardisation of biofuels quality specification will also help to reduce obstacles to the smooth exporting and importing of biofuels.

Potential of the Biofuel Market for Trade

1) Potential of the Biofuel Market for Trade

The above analysis showed that the current trades of biofuels in Asia are still limited. In this section, the potential expansion of the biofuel markets is estimated.

Without trade, the market equilibrium is below both demand and supply. Without trade, the maximum potential of the market of each country becomes smaller than demand and supply. These constraints in the market potentials of bioethanol and biodiesel are calculated as such in the area "Potebtial with Trade" of the graph shown in Figure 4.6 and Figure 4.7 The benefit is the difference between the integrated potential through trade and the constrained potential by border.

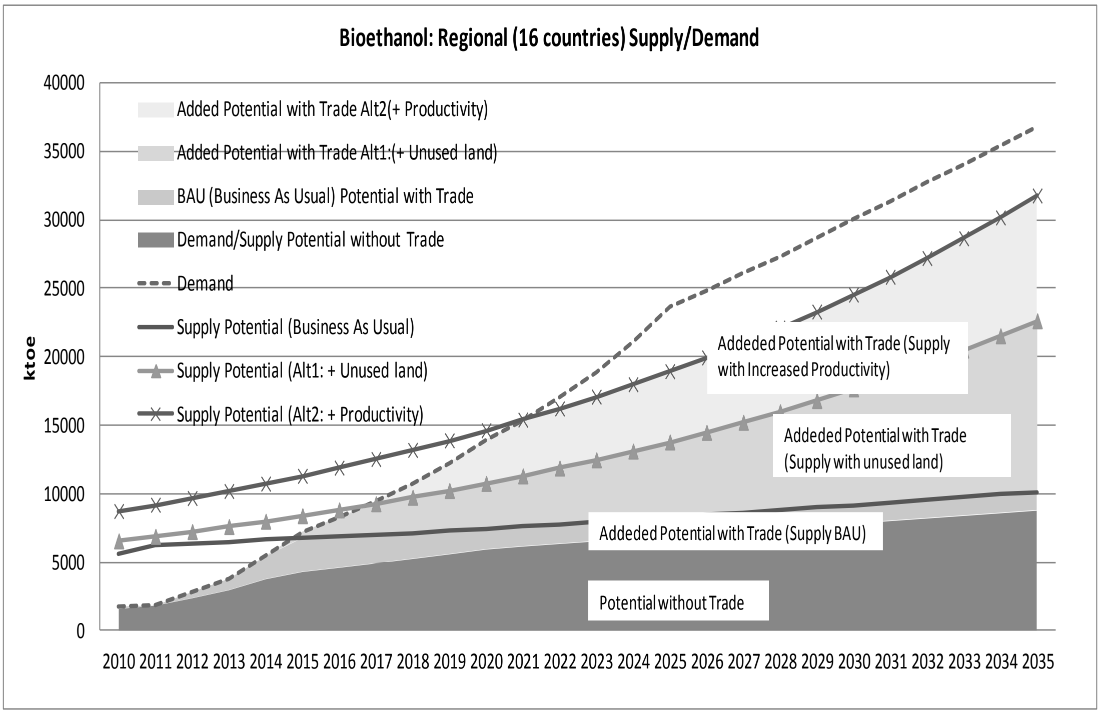
The formula for estimating the gap between markets—with and without borders (without supply constraint)—is as follows:

Sum of the market constrained by the national border
= Σ Min (country demand, country supply)
Market of the sum of the 16 countries
= Min (Σ country demand, Σ country supply)

Figures 4.6 and 4.7 show the increased potential of market integration for the region of the Asia in 16 countries. Trade will be very important to fully realise the regional market potential. In the case of bioethanol without trade, the potential could not reach 10,000 ktoe by 2035. Supply limitation becomes serious with a scenario of business-as-usual (BAU) and shortage will come by 2015 as this case is below the level of the needs of trade. Assuming trade is available, utilisation of unused land ("Alternative 1") could ease the shortage substantially with an added supply of 25,000 ktoe by 2035, although the shortage will come by 2017.Additional supply potential with increased productivity ("Alternative 2") could further contribute to the market potential, with additional 10,000 ktoe by 2035. Still, shortage could come in early 2020s and the shortage could remain as large as 5,000 ktoe until 2035 or later.

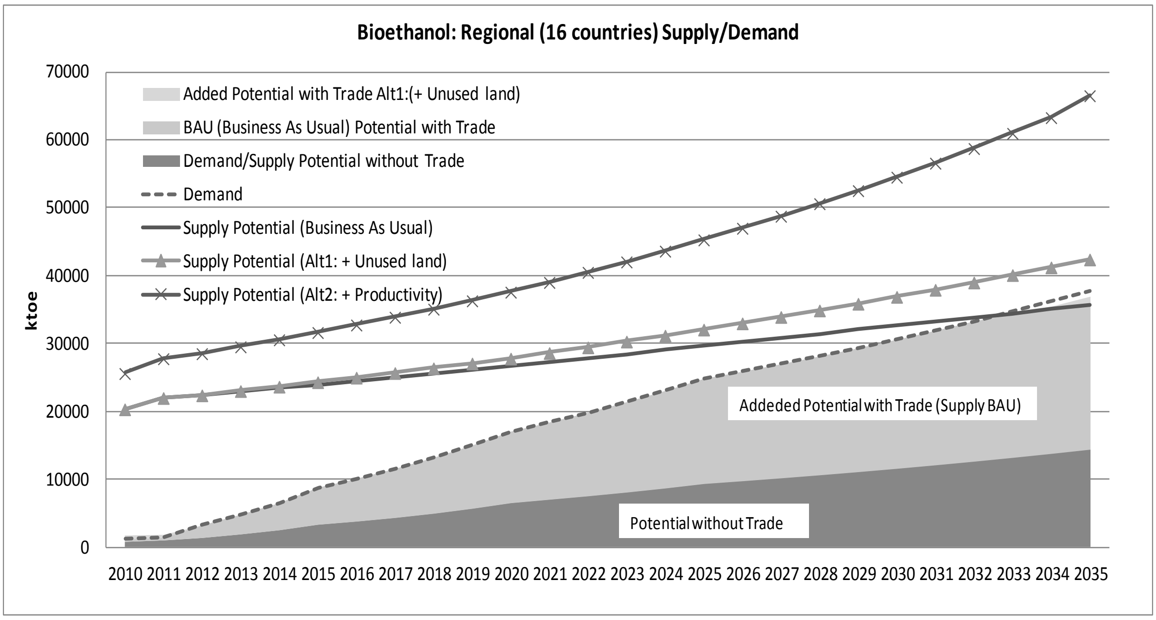
In case of biodiesel without trade, the potential will be below 15,000 ktoe by 2035.
The trade could add the potential of about 20,000 by 2035 in a business-as-usual (BAU) scenario. Shortage could come as early as 2030s without the utilisation of unused land ("Alternative 1").

Figure 4.6 Potentials of Bioethanol Market (in ktoe)



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

Figure 4.7 Potentials of Biodiesel Market (in ktoe)



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

2) Policies for market integration

The factors of trade barriers are mentioned in the previous section. Among many factors, this study highlights the importance of each country’s national interest. Even if common standards for biofuels are established in the region, the integration of the market still depends on the intention of each individual country (whether the country wants to open the market or not). In the case of biofuels, a government's intention of having a market integration with foreign countries is shaped by the drivers and objectives of biofuel promotion in that country. In Asia, the objectives for the utilisation of biofuels include (1) energy security, (2) trade balance, (3) economic development, (4) rural development, (5) agricultural development (job and income for farmers), and (6) climate change mitigation.[1]

The priorities of the drivers and objectives to promote biofuel production and consumption may vary from country to country depending on the individual country's endowment of energy resources and social and economic development circumstances. For oil-importing countries like the Philippines and Thailand, energy security, trade balance, and economy are the critical drivers behind the government's support for biofuel utilisation. For energy-producing countries like Indonesia and Malaysia, the objectives of developing the rural areas and the domestic agricultural industries become critically important.

The integration of the markets, therefore, has to meet the various interests of different countries. For example, one critical element is the economic value of biofuels. If biofuels cannot compete with other fuels, such as gasoline and mineral diesel, trades across national borders would be difficult. Moreover, the integration of the market can have a negative impact on one objective and a positive impact on another and the degree of the impacts may differ by country depending on the extent of the market integration. Like in the Philippines, biofuels are perceived as alternatives to oil products and the Philippines' *Biofuel Act of 2006* was intended to promote local production to reduce import of oil in the future. On the other hand, the less populated Malaysia has huge potential for biodiesel export but its domestic demand is limited, while the government of Malaysia is promoting both export and domestic consumption.

What is, therefore, the optimal level of market integration to fulfill the interests of different countries to the maximum? This is, in fact, the subject of the framework on regional trade resulting from negotiations among countries.

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[1] Adrian and Elspeth (2009).

The method of market integration is export and import. Most countries can achieve the objectives mentioned above through export. However, the export potential is limited to only a few countries. Therefore, this imbalance will make market integration very difficult even if there are regional benefits. The issue lies in the conflict of national and regional interests.

How can we bridge the gap between national and regional benefit? The key is on the collective benefit. One example was shown in the agenda of the Second East Asia Summit of 2007 hosted by the Philippines. The summit was a response to the increasing crude oil price. One of the purposes of the summit was to see the feasibility of replacing imported oil and oil products with regional biomass and biofuels. The message is clear that the key is the price. If biofuels could be produced at lower cost than those of oil products from the Middle East, the oil-importing countries will have a strong incentive to import biofuels although this may not directly contribute to industry development or job creation.

In the light of the collective interests of ASEAN countries and their historical responses to energy prices, the most practical action for cooperation is to reduce the cost of biofuel production. The above analysis showed the huge potential of market creation by regional market integration and the need for a cooperative effort in improving productivity.

In summary, the role of trade is very important in expanding the market of biofuels. As noted in the introduction, liquid fuels could be the major energy source in Asia. Here, the collective benefits of expanding biofuels use are not only regional energy security, but also the mitigation of global warming.[2] The stake of collective benefits from the trade is large. However, the current development of biofuel trades is still limited, compared with the potential. The prospects of limited trade could continue. There are two primary reasons, which can be shared in developing Asia. One reason is that biofuels are expected to contribute to the rural and agricultural development through domestic production. In fact, in Asia, the market of biofuels is linked to both food and energy markets and the products can be domestically consumed or exported, depending on not only the prices of oil products but also on food

[2] 2 Degree Scenario or so called 2DS scenario in the transport sector in the *World Energy Outlook* (IEA, 2013c).

prices. Another is the concern for energy security, especially for oil-importing countries. Therefore, national biofuel policies of many Asian countries are oriented to promote the domestic production of food–biofuel compatible feedstocks for both markets of energy and agriculture, which make it challenging to be fully open in the future.

The limitation in trade could bring different future prospects of shortage or surplus of biofuels by country, depending on the profile of the policies and agricultural characteristics of each country. The ambitious demand by the ASEAN, especially by Indonesia, implies that some ASEAN countries (most likely to include Indonesia) may face a shortage earlier, whereas some countries (most likely to include Malaysia) can sustain the surplus longer than the cases of fully integrated market assumption.

CHAPTER 5
Competitiveness and Food Security

Competitiveness

The increasing oil prices since the early 2000s have accelerated efforts for energy security through the utilisation of renewable energies. At the early stage before 2004, the general concern was to promote renewable energies. From 2003 to 2004, various renewable energies promotion initiatives were introduced, including the 10 percent target of ASEAN (2003), the Renewable Portfolio Standard (RPS) targets of Thailand, and the Renewable Energy Bill of the Philippines.

As crude oil prices continued to rise, the competitiveness of biofuels as alternatives to oil could improve. Policy measures emerged in 2005 with the "Call for Biofuel in Thailand" in 2005, jatropha cultivation order in Myanmar in 2006, presidential instruction for national biofuel team in Indonesia in 2006, and the *Biofuel Act of 2006* in the Philippines in 2006. These Asian responses to the rising crude oil prices were accumulated in the Second East Asia Summit in Cebu, Philippines in January 2007. The cost of energy security is at stake. The message was clear that they were searching for alternative competitive fuels. Especially for oil-importing countries such as India, China, Thailand, and the Philippines, the concern was not only energy security, but also the loss of foreign reserve through increased payment for energy importation.[1]

The crude oil price level at the Second East Asia Summit is the same as the current crude oil price level of around US$100/bbl. According to a study of

[1] Yamaguchi and Yanagi (2010).

the IEA,[2] this price level makes most of the conventional biofuels in Asia competitive to oil products. However, this study found that there are cases that the higher energy prices in the domestic market do not necessarily increase the supply of domestic biofuels. One case is the higher selling prices in international markets, which could be for food or energy. Another case is the higher prices in domestic food market. The result is shortages of domestic biofuels, notably in Indonesia and Malaysia, with no stringent implementation of biofuel mandates. If the case is the higher prices in the domestic food market, it should have contributed to the security of food.

In the international perspective, the prices of energy and food in developing Asian countries are generally low compared with those in developed countries. The increase of demand for feedstocks in the export market could benefit domestic farmers, but not domestic energy consumers. A stringent mandate of biofuels should be designed in consideration of the interactions and relative competitiveness of domestic and international energy and food markets.

Food vs. Fuel

Most of biodiesel in Asia is from palm oil (Indonesia and Malaysia) and coconut oil (Philippines). Most of bioethanol is from sugarcane (India, Thailand, and the Philippines) and cassava (Thailand). These feedstocks are originally used for food, including those for humans and for livestocks. The problem is that the increased price of biofuel will increase the supply of biofuel, decreasing the land available to supply these foods. The anticipated outcome is the shortage of foods and price increases of foods. A critic from a famous scientist “boom in bioethanol is a competition between the 800 million people in the world who own automobiles and the 3 billion people who live on less than $2 a day”[3] is a serious challenge to the cause of poverty reduction through the promotion of biofuel.

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[2] IEA (2013b).

[3] Brown (2006).

Therefore, it is generally believed that the global food crisis of 2007/08 is partly due to the production of biofuels. The experience in Asia also highlighted serious concern for the rise of food prices and shortages in imports. Although later studies, including those by the World Bank, concluded that the contribution of biofuels' production to the rise of food prices had not been as large as originally thought,[4] the concern is put into a priority in this study.

In Asia, nonetheless, the emergence of biofuel as a product of agriculture has had a strong impact on agriculture for its potential for increased value added of the agricultural sector. This is because most of the Asian countries are agrarian and have strong agricultural base for export. Even if it increased the prices of food as agricultural products, it becomes an economic benefit of the agriculture sector.

In fact, one of the findings in this study is that conventional biofuels from edible agricultural products have become very important as alternatives to oil products and their promotion becomes a national priority in energy and agricultural policies in many countries in Asia including ASEAN countries that suffered from food price increases, such as Indonesia, the Philippines, and Malaysia.

The reality is that commercially available technologies are limited to those of conventional first-generation biofuels in Asia, therefore, without clear prospects of next-generation biofuels, the supply will continue to depend on conventional technologies. Conventional technologies use agricultural land for energy crops. In terms of "food vs. fuel" arguments, the two options[5] for feedstocks are (1) edible feedstocks like sugarcane, cassava, and palm oil[6]; or (2) non-edible alternatives like jatropha.

Although there are opinions in favour of non-edible alternatives, this study found the non-edible option to be not realistic at this time. Rather, the first option of edible feedstocks for biofuels is supported, as far as supply can

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[4] The World Bank (2010).

[5] The other option, which is outside the scope of this study, is that biofuels should not be used (see Pimentel et al. [2010])..

[6] The view here is that food and biofuels are not competing, but should be compensating each other (see Johnson and Virgin [2010]).

meet the demand until next-generation technologies become commercially available. There are two major advantages. One is food security. The expansion of food-compatible energy crops can be a safety net against food shortage. Second is the compatibility of the market. The market of feedstocks for both foods and energy expands beyond one "food only" market or "energy only", therefore, farmers could be more secure compared with the "biofuel only" market, which can be more volatile than the market of food.

CHAPTER 6
Policy Implication

Main Arguments

Based on the reviews, liquid fuels could be the major energy source in Asia in the coming decades. The collective benefits of expanding biofuels use are not only regional energy security, but also the mitigation of global warming. The expansion of biofuels utilisation in Asia could benefit not only individual countries but also the region as a whole. The challenges are to find and expand the Asian potential of biofuels.

The future potential depends on the demand and supply outlook. A major finding on demand side is the exceptionally large demand by Indonesia. Assuming Indonesia's demand will not change, one of the most important findings is that the shortage of bioethanol is coming soon, if no progress is made in increasing productivity and in effectively using unutilised lands. Another important message from the findings is that biofuels in Asia should not be separated from agriculture as it is already integrated in the market. The success of biofuel utilisation in Brazil and Thailand indicates that there are ways in sustainably developing food-compatible biofuels. In Asia, foods compatible to biofuels will continue to be the primary sources, however, the supply potential of agriculture-oriented conventional biofuels in the region of 16 countries may fail to catch up with the fast growth of demand before 2020s.

The core strategy suggested in this study is to improve the enabling environment—improve productivity and enhance regional cooperation for trade and energy security. Also, the development of next-generation biofuels as a mid- to long-term solutions should also be pursued in line with the development of energy–agriculture integration for the security of both sectors.

Policy Implications

1) Supply side

- Provide incentives to increase productivity and enhance the utilisation of unused agricultural lands, as an energy–agriculture joint policy initiative. The policy could benefit both sectors of energy and agriculture.
- Improve the conversion efficiency from solid to liquid biomass.

2) Demand side

- Promote regional energy security through biofuels trade.
- Promote local best practices of "sustainable" consumption/utilisation of biofuels for energy access.
- Promote domestic/local use of biofuels, including waste oil products from food industries.

3) Enabling Market

- Use domestic biofuels mandate to activate the local market, improve productivity, and promote the use of unused agricultural lands.
- Share biofuel standard for inter-regional trade.

4) Sustainability/Food Security

- Secure food allocation (production allocation or preferably through distribution).
- Enable domestic/local use of biofuels as a buffer for food security.
- Develop a sustainable development map of biomass utilisation in the future energy mix with vision of the role of biofuels.

5) Importance of collaborative study and development of next generation biofuels

- Commercialise next-generation biofuels within the next decade.

6) Different implications by type of the country

- For energy importing countries like the Philippines and Thailand, policies for productivity increase with efficient use of land (utilisation of unused land) should be enhanced through a joint effort of both the energy and agriculture sectors. For Indonesia, since the future demand is exceptionally large, greater efforts will be required.
- Exporting countries with abundant supply sources like Malaysia should pursue a more stringent implementation of the policies, like the B5 mandate.
- A regional framework such as ASEAN could contribute to the research of next-generation biofuels for the sake of common interests in the region.

References

Adrian, Z. and T. Elspeth (2009), 'The development of biofuel in Asia', *Applied Energy*, 86 (2009).pp.511-520.

Asia Biomass Office (2013), 'Current State of Renewable Energies in Brunei Darussalam', November. Available at: http://www.asiabiomass.jp/english/topics/1311_05.html (accessed March 31, 2014).

Asian Development Bank (ADB) (2009), *Status and Potential for the Development of Biofuels in Viet Nam*. Manila: ADB.

Asian Development Bank (ADB) (2011), *India: Study on Cross-Sectoral Implications of Biofuel Production and Use*. Manila: ADB.

Asian Development Bank (ADB) (2012), *Biofuels in the Greater Mekong Subregion: Energy Sufficiency, Food Security, and Environmental Management*. Manila: ADB. Available at: http://www.adb.org/publications/biofuels-greater-mekong-subregion (accessed April 10, 2012).

Asian Development Bank (ADB) (2013), *Energy Outlook for Asia and the Pacific*.Manila: ADB.

Asia-Pacific Economic Cooperation (2008a), *APEC Biofuels*:*The Philippines' Biofuels Activities*. Available at: http://www.biofuels.apec.org/me_philippines.html (accessed on March 27, 2014)

Asia-Pacific Economic Cooperation (2008b), *APEC Biofuels*: *Singapore Biofuels Activities*. Available at: http://www.biofuels.apec.org/me_singapore.html (accessed on March 27, 2014)

Asia-Pacific Economic Cooperation (2008c), *APEC Biofuels: Brunei Darussalam Biofuels Activities.* Available at: http://www.egnret.ewg.apec.org/Archive/me_brunei.html (accessed on March 27, 2014)

Asia-Pacific Energy Research Centre (2013), *APEC Energy Overview 2013*. Tokyo: APERC.

Badan Pusat Statistik (BPS) Indonesia (2013), *Statistik Indonesia 2013*. Jakarta: BPS.

Biofuel Association of Australia (BAA) (2013a), 'Ethanol production facilities in Australia'. Available at: http://www.biofuelsassociation.com.au/ethanol-production-facilities-in-australia (accessed on March 27, 2014)

Biofuel Association of Australia (BAA) (2013b), 'Biodiesel production facilities in Australia'. Available at: http://www.biofuelsassociation.com.au/biodiesel-production-facilities-in-australia (accessed on March 27, 2014)

Brown, Lester (2006), 'LESTERBROWN', Earth Policy Institute. Available at: http://www.earth-policy.org/images/uploads/transcripts/Update55_Transcript.pdf, p.4 (accessed on March 20, 2014)

Daiwa Institute of Research Holdings Ltd, (2012), 'Current Status and Issues of Biofuels Production in LAO PDR', *Emerging Markets Newsletter*, No.22/2012.

Dargay, J., D. Gately and M. Sommer (2007), *Vehicle Ownership and Income Growth, Worldwide: 1960-2030*. Available at: http://www.xesc.cat/pashmina/attachments/Imp_Vehicles_per_capita_2030.pdf (accessed on May 14, 2014)

Department of Resource, Energy, and Tourism, Government of Australia (2012), *Energy White Paper 2012*. Available at: http://www.ret.gov.au/energy/Documents/ewp/2012/Energy_%20White_Paper_2012.pdf (accessed February 13, 2013).

Eco Business (2010), 'Biofuels get hotter as green choice in Singapore'. Available at: http://www.eco-business.com/news/biofuel-gets-hotter-green-choice-singapore/ (accessed March 31, 2014).

Eco Business (2011a), 'Year of reckoning for Singapore biofuel investments'. Available at: http://www.eco-business.com/news/year-reckoning-singapore-biofuel-investments/ (accessed March 31, 2014).

Eco Business (2011b), 'Biofuels Development: Singapore Powering Ahead'. Available at: http://www.eco-business.com/news/biofuels-development-singapore-powering-ahead-but-gaps-remain/ (accessed March 31, 2014).

Eco Business (2012), 'Singapore firm reveals new GM biofuel corp'. Available at: http://www.eco-business.com/news/singapore-firm-reveals-new-gm-biofuel-crop/ (accessed March 31, 2014).

FAOSTAT (2014), *The Statistics Division of the FAO*, 1971-2011. http://faostat3.fao.org/home/E, "Download Data" (accessed on March 27, 2014).

Food and Agricultural Policy Research Institute–Iowa State University (FAPRI-ISU) (2012), *World Agriculture Outlook 2012*. Iowa: FAPRI-ISU.

Government of Malaysia, (2006), *National Biofuel Policy*. Jakarta.

Guzman, R. B. de (2012), 'National Biofuels Program'. Presented at the 1st Meeting of the ERIA Working Group for Asian Potential on Biofuel in Jakarta, November 2012.

Guzman, R. B. de (2013), 'Update on the Implementation of the Philippine National Biofuels Program'. Presented at the 2nd Meeting of the ERIA Working Group for Asian Potential on Biofuel, Tokyo, May 2013.

International Energy Agency (IEA), (2004), Sustainable Mobility Project (SMP) Transport Model. Available at: http://oldwww.wbcsd.org/plugins/DocSearch/details.asp?type=DocDet&ObjectId=MTE0Njc (accessed on January 31, 2014)

International Energy Agency (IEA) (2011), *Technology Roadmap Biofuels for Transport*. Paris: IEA.

International Energy Agency (IEA) (2013a), *World Energy Balances and Statistics 2013.* Paris: IEA.

International Energy Agency (IEA) (2013b), *Production Costs of Alternative Transportation Fuels.* Paris: IEA.

International Energy Agency (IEA) (2013c), *World Energy Outlook 2013.* Paris: IEA.

International Energy Agency (IEA) (2014), *World Energy Balances and Statistics 2014.* Paris: IEA.

'Indonesia Finance Today (2011), 'Realisasi Produksi Biodiesel Baru 30,8% dari Target'. Available at: http://www.indonesiafinancetoday.com/read/18817/Realisasi-Produksi-Biodiesel-Baru-308-dari-Target (accessed on January 31,2014)

Japan Bio-Energy Development Corporation, 'What's new.' Available at: http://www.jbedc.com/en/index.shtml (accessed April 7, 2014).

Japan Electric Power Information Center, Inc. (2010), *Electric Power Industry in Overseas Countries 2010,* Vol. 2., Tokyo: JEPIC

Japan Petroleum Energy Center (2011a), 'Energy Policies and Industry of Singapore, A Resourceless Country (*in Japanese*)*'*. Available at: http://www.pecj.or.jp/japanese/minireport/pdf/H21_2011/2011-014.pdf (accessed April 22, 2013).

Japan Petroleum Energy Center (2011b), 'Report from the Fourth Japan-China-Korea Petroleum Technology Conference (*in Japanese*).'

Available at: http://www.pecj.or.jp/japanese/images/top/1109_info.pdf (accessed April 22, 2013).

Johnson, F. X. and I. Virgin (2010), 'Future Trends in Biomass Resources for Food and Fuel' in *Food vs. Fuel*. London & New York: Zed Books.

Lao Institute for Renewable Energy (2011), *Renewable Energy Development Strategy in Lao PDR*. Available at: http://www.lao-ire.org/data/documents/data_research/general/LIRE-Renewable_Energy_Development_Strategy_in_Lao_PDR.pdf (accessed April 12, 2012).

Lao Institute for Renewable Energy (2009), *Biofuel Assessment Study in Lao PDR – Inception Report*. Vientiane: LIRE.

Ministry of Economic Development, Government of New Zealand (2012), *New Zealand's Energy Outlook 2011.* Wellington.

Ministry of Economic Development, Government of New Zealand (2012), 'New Zealand Energy Data File 2012'. Wellington.

Ministry of New and Renewable Energy, Government of India (2009), *National Policy on Biofuels.* New Delhi.

Ministry of Trade and Industry, Government of Singapore (2007), *Energy for Growth.* Available at: http://www.mti.gov.sg/ResearchRoom/Documents/app.mti.gov.sg/data/pages/885/doc/NEPR%202007.pdf (accessed January 31, 2013).

Ministry of Industry and Trade, Government of Viet Nam (2007), *DECISION No. 177/2007/QD-TTg OF NOVEMBER 20, 2007, APPROVING THE SCHEME ON DEVELOPMENT OF BIOFUELUP TO 2015, WITH A VISION TO 2025.* Hanoi.

Morgera, E., K. Kulovesi and A. Gobena (2009), *FAO Legislative 102 case studies on bioenergy policy and law: Options for sustainability*. FAO Legal Office. Rome: FAO.

Myanmar Business Network (*2012), '*Biofuel Plant for Myanmar'. Available at: http://www.myanmar-business.org/2012/12/biofuel-plant-for-myanmar.html (accessed January 24, 2013).

Myanmar Times (2013), "The rise, fall and rebirth of biofuels in Myanmar", 26 August.

National Environment Agency of Singapore 'Air Quality and Targets', Available at: http://app2.nea.gov.sg/anti-pollution-radiation-protection/air-pollution-control#aqt (accessed January 31, 2013).

Nam News Network (2012), 'Vietnam Targets for Biofuel Project'. Available at: http://www.namnewsnetwork.org/v3/read.php?id=MjEzNjQz (accessed April 10, 2013).

National Team for Biofuel Development, Indonesia (2006), *National Team Report of Biofuels Development*. Government of Indonesia.

Policy Research Institute, Ministry of Agriculture, Forestry and Fishing of Japan (PRIMAFF) (2013), *World Food Outlook by 2022–Food Demand and Supply Projection Result for World. Tokyo:* PRIMAFF.

Petro Vietnam Oil (2013), 'List of Biofuels Plants'. Available at: https://www.pvoil.com.vn/en-US/pvoil/plants-products/303 (accessed April 10, 2013).

Pimentel, D. et al. (2010), 'Why We Should Not Be Using Biofuels', in *Food vs. Fuel*. London & New York: Zed Books.

Raju, S. et al. (2012), 'Biofuels in India: Potential, Policy and Emerging Paradigms'. National Centre for Agricultural Economics and Policy Research *Policy Paper 27*. New Delhi.

Ray, S. et al. (2011), *Ethanol Blending Policy in India: Demand and Supply Issues,* Indian Council for Research on International Economic Relations (ICRIER) *Policy Studies No. 9,* p. 7.

Rector, Mya Mya Oo (2011), 'Biomass Energy Researches being Undertaken by the Ministry of Science and Technology'. Presented at the 11th Asia Biomass Seminar in Nay Pyi Taw, Myanmar.

Schott, C. (2009), *Socio-economic dynamics of biofuel development in Asia Pacific*. Jakarta: Friedrich Ebert Stiftung (FES) Indonesia Office.

Shi, X. and S. Goto (2013), 'Harmonizing biodiesel fuel standards in East Asia: Motivations, progress and challenges', *Applied Energy* (105).

Sithideth (2011), 'Energy Policy in Lao PDR'. Presented at the Institute of Energy Economics of Japan (IEEJ) in May 2011 in Tokyo, Japan.

The World Bank. 2010. *Placing the 2006/08 Commodity Price Boom into Perspective.* Washington DC: WB.

Timnas BBN (2006), *Blueprint of Biofuels Development for Accelerating Poverty Alleviation and Unemployment Reduction*. Jakarta.

USDA Global Agriculture Information Network (GAIN) Report (2010), *New Zealand BiofuelsVoluntary Report*. Washington, D.C: USDA GAIN.

USDA Global Agriculture Information Network (GAIN) Report (2010), *Republic of Korea Biofuels Production*. Washington, D.C.: USDA GAIN.

USDA Global Agriculture Information Network (GAIN) Report (2012a), *Australia Biofuels Annual 2012*. Washington, D.C.: USDA GAIN.

USDA Global Agriculture Information Network (GAIN) Report (2012b), (*China- People's Republic of) Biofuels Annual*. Washington, D.C: USDA GAIN.

USDA Global Agriculture Information Network (GAIN) Report (2012c), *India Biofuels Annual 2012*. Washington DC: USDA GAIN.

USDA Global Agriculture Information Network (GAIN) Report (2012d). *Japan Focuses on Next Generation Biofuels*. Washington, D.C.: USDA GAIN.

USDA Global Agriculture Information Network (GAIN) Report (2012e). *Philippine Biofuel Industry Situation and Outlook 2012*. Washington, D.C.: USDA GAIN.

USDA Global Agriculture Information Network (GAIN) Report (2012f). *Thailand Biofuels Annual 2012*. Washington, D.C.: USDA GAIN.

USDA Global Agriculture Information Network (GAIN) Report (2012g). Indonesia Biofuel Annual 2012. Washington, D.C.: USDA GAIN.

USDA Global Agriculture Information Network (GAIN) Report (2012h). Malaysia Biofuel Annual 2012. Washington, D.C.: USDA GAIN.

USDA Global Agriculture Information Network (GAIN) Report (2013a) *India Biofuels Annual 2013*. Washington, D.C.: USDA GAIN.

USDA Global Agriculture Information Network (GAIN) Report (2013b). *Philippine Biofuels Situation and Outlook 2013*. Washington, D.C.: USDA GAIN.

VietnamNet. 2012. 'Vietnam vows to use green fuels to keep air fresh'. Available at: http://english.vietnamnet.vn/fms/environment/53707/vietnam-vows-to-use-green-fuels-to-keep-air-fresh.html (accessed April 10, 2013).

World Trade Organization (WTO) (2007), *Trade Policy Review: Thailand.* WT/TPR/S/191. Geneva: WTO.

World Trade Organization (WTO) (2011a). *Trade Policy Review: Thailand.* WT/TPR/S/255. Geneva: WTO.

World Trade Organization (WTO) (2011b), *Trade Policy Review: Thailand.* WT/TPR/S/255. Geneva: WTO.

Yamaguchi, K. and M. Yanagi. 2010. 'Alternative energy options of Asia in crises', In *Poverty and Sustainable Development in Asia*. Manila: Asian Development Bank.

Annex : Biofuel Policies in East Asian Countries

Australia

Policies and Programs to Promote the Utilisation of Biofuels

(1) Policy Overview

With the publishing of the “Clean Energy Future Plan” in July 2011, Australian Prime Minister Gillard made a commitment to reduce carbon dioxide (CO_2) emissions by at least 5 percent (compared with the 2000 level) by 2020 and to raise the CO_2 emissions reduction goal for 2050 from 60 percent to 80 percent.

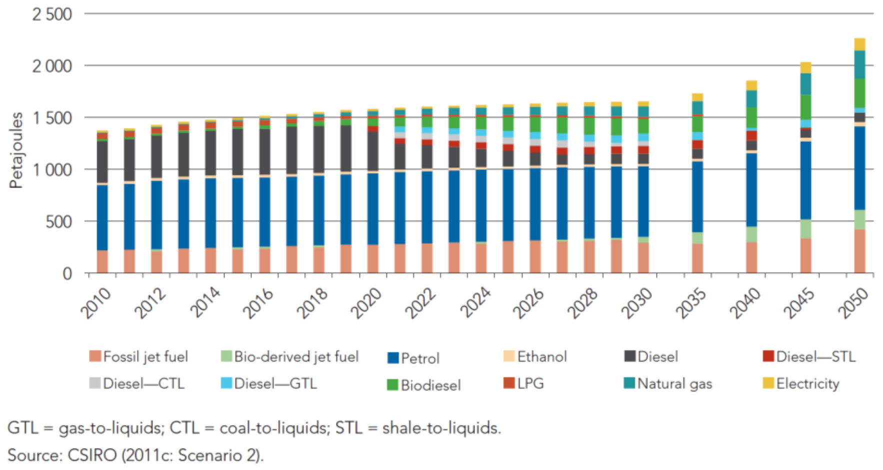
Clean energy supply is also mentioned in the “Australia’s Energy Transformation 2012” (hereinafter, referred to as the “White Paper”) published in Nov. 2012. Biofuels, along with other clean fuels and emerging vehicle technologies, are anticipated to play an important role in transforming the country’s transport sector through 2050.

(2) Target

The Australian government set a target of producing biofuels of 350 megalitres (ML) in 2008. Preferential tax treatment and fuel quality standards are offered to help achieve the target.

The White Paper refers to clean energy supply, but does not indicate specific targets in biofuels. In the “Transport Fuel Model until 2050” mentioned in the White Paper, biofuels are projected to account for around 20 percent (including bio-jet fuel) of total transport fuels in 2050.

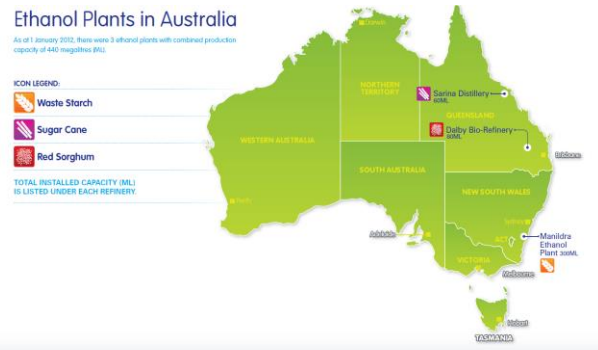
Figure A.1.1 Transport Fuel Mix Projection to 2050, by Fuel Type (PJ)



Source: Australian Government (2012), Energy White Paper 2012.

As of December 2013, there were three ethanol manufacturers with a combined production capacity of 440 ML and an additional capacity of 173 ML expected by 2016. Of the biodiesel plants, only four out of 11 plants with a combined installed capacity of 360 ML are in operation, producing 115 ML of biodiesel from tallow and used cooking oil. New biodiesel plants with a total capacity of 288 ML are planned to be constructed. The following figures and tables show the locations and the lists of biofuel manufacturing plants.

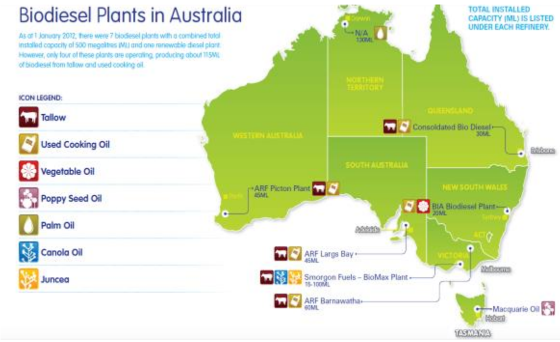
Figure A.1.2 Location and List of Ethanol Plants in Australia



ETHANOL PLANT	LOCATION	OWNER (* BAA MEMBER)	TOTAL INSTALLED CAPACITY (ML) (AT 01.12.13)	FEEDSTOCK	STATUS (AT 01.12.13)
Dalby Bio-Refinery	Dalby, QLD	United Petrolium	80	Red Sorghum	In production
Manildra Ethanol Plant	Nowra, NSW	Manildra Group*	300	Waste Starch	In production, plant expansion continuing
Sarina Distillery	Sarina, QLD	Wilmar BioEthanol (Australia) Pty Ltd*	60	Molasses (by product from sugar processing)	In production
TOTAL CAPACITY (ML)			440		

Source: Biofuel Association of Australia (BAA) (2013a).

Figure A.1.3 Location and List of Biodiesel Plants in Australia



BIODIESEL PLANT	LOCATION	OWNER (* BAA MEMBER)	TOTAL INSTALLED CAPACITY (ML) (AT 01.12.13)	FEEDSTOCK	STATUS (AT 01.12.13)
ARfuels Barnawartha	Barnawartha, VIC	Australian Renewable Fuels*	60	Tallow, Used cooking oil	In production
ARfuels Largs Bay	Largs Bay, SA	Australian Renewable Fuels*	45	Tallow, Used cooking oil	In production
ARfules Picton	Picton, WA	Australian Renewable Fuels*	45	Tallow, Used cooking oil	In production
ASHOIL	Tom Price, WA	Ashburton Aboriginal Corportion*	Unknown	Used cooking oil	In production
Biodiesel Industries	Rutherford, NSW	Biodiesel Industries Australia Pty Ltd*	20	Used cooking oil, Vegetable oil	In production
Ecofuels Australia	Echuca, VIC	Ecofuels Australia Pty Ltd	1.5	Canola oil	In production
EcoTech BioDiesel	Narangba, QLD	Gull Group*	30	Tallow, Used cooking oil	In production
Macquarie Oil	Cressy, TAS	Macquarie Oil Co	15	Poppy Seed Oil & Waste Vegetable Oil	In production
Neutral Fuels	Dandenong, VIC	Neutral Fuels (Melbourne) Pty Ltd	Unknown	Used cooking oil	In production
Smorgon Fuels – BioMax Plant	Laverton, VIC	Smorgon Fuels Pty Ltd	N/A (Prior to closure 15-100)	Tallow, Canola Oil and Juncea Oil	Closed
Territory Biofuels	Darwin, NT	Territory Biofuels Ltd	140	Refined, Bleached & Deodorised (RBD) Palm Oil, Tallow, Used Cooking Oil	Restart in 2014
TOTAL CAPACITY (ML)			360		

Source: Biofuel Association of Australia (BAA) (2013b)

Table A.1.1 shows the historical trend of biofuel production and consumption in Australia. Although bioethanol production and consumption experienced a steady increase until 2011, it has become flat in recent years. Biodiesel also shows a quite moderate growth in its production and consumption.

Table A.1.1 Historical Trend of Biofuel Production in Australia

							(million liters)	
Year End July		2007	2008	2009	2010	2011	2012	2013
Bioethanol	Prodiction	84	149	203	380	440	440	440
	Consumption	84	149	203	380	440	440	440
Biodiesel	Prodiction	54	50	85	130	250	350	400
	Consumption	61	54	96	139	275	371	420

（出所）USDA GAIN Report, Australia Biofuels Annual 7/3/2013

(3) Development Program

(3.1) *The Fuel Quality Standards Act 2000*

On petroleum product standards in Australia, the “Fuel Quality Standards Act 2000” provides the content of biofuels in automobile fuels as follows:

- Gasoline: The ethanol content of gasoline is 10 percent or less.

- Diesel: The biodiesel content of diesel is 5 percent or less.

(3.2) *The Ethanol Production Grants Program* (September 2002–June 2021)

This program was introduced in September 2002 to subsidise ethanol producers by granting an amount equivalent to the excise duty, which is A$0.38143 per litre of ethanol. The program is ongoing and scheduled for review after 30 June 2021.

(3.3) *The Energy Grants (Cleaner Fuels) Scheme* (December 2011–June 2021)

This program subsidises biodiesel producers and importers by granting them an amount equivalent to the excise tax (or customs duty), which is A$0.38143 per litre of biodiesel. The scheme will continue until at least June 30, 2021.

(3.4) *The Ethanol Distribution Program* (Completed)

To increase the number of retailers (service stations) selling 10 percent ethanol blended gasoline (E10), the following subsidies were introduced:

- To compensate the cost of installing E10 sales equipment, up to A$10,000 were provided to each retailer that installed such equipment (October 2006–March 2008).

- Up to A$10,000 were provided to each retailer that achieved the E10 sales goal within 12 months after the installation of E10 sales equipment.

(3.5) *Second-Generation Biofuels Research and Development (Gen 2) Program*

This is a competitive grants program that supports research, development, and demonstration of new biofuel technologies and feedstocks that address sustainable development of the biofuels industry in Australia.

Application for participation in the Gen 2 Program was closed in January 2009 and the scheme expired in June 2012 (For details, see (4) RD&D Information on Biofuels in Australia).

The abovementioned measures (3.2), (3.3) allow biofuels to be retailed at lower prices than regular petroleum products. Also, the abovementioned measure (3.4) has obviously helped increase the sales of bio-gasoline since 2006.

（3.6）*Fund by Australian Renewable Energy Agency (ARENA)*

The ARENA provides a total of A$3.2 billion as part of the Clean Energy Future Package with the aim of enhancing competitiveness of domestic renewable energy technology and facilitating the use of renewable energy. ARENA also subsidises a project through Advanced Biofuels Investment, which intends to promote commercialisation of biofuel technology.

(4) Information on Biofuels Research, Development and Demonstration (RD&D)

(4.1) *Second-Generation Biofuels Research and Development (Gen 2) Program*

A funding of A$12.617 million was allocated to six projects over three years from 2009/10 to 2011/12.

(i) The University of Melbourne (A$1.24 million): This project involves research on biofuel from micro algae, including efficient separation, processing, and utilisation of algal biomass.

(ii) Algal Fuels Consortium (A$2.724 million): The consortium was formed to develop a pilot-scale second-generation biorefinery for sustainable micro algal biofuels and value-added products.

(iii) Curtin University of Technology (A$2.5 million): The project is looking into the sustainable production of high-quality, second-generation transport biofuels from mallee biomass by pyrolysis and utilising the biorefinery concept.

(iv) Bureau of Sugar Experiment Stations (BSES) Limited (A$1.326 million): BSES is developing an optimised and sustainable sugarcane biomass input system for the production of second-generation biofuels, located at Indooroopilly, Queensland.

(v) Microbiogen Pty Ltd (A$2.539 million): The project aims to produce commercial volumes of ethanol from bagasse using patented yeast strains. The project is located at Lane Cove, New South Wales.

(vi) Licella Pty Ltd (A$2.288 million): Licella will examine the commercial demonstration of converting lignocellulosics to a stable bio-crude.

(4.2) *The Australian Biofuels Research Institute (ABRI)*

ABRI was established to promote the commercialisation of next-generation advanced biofuels in Australia. ABRI is administered by the Australian Renewable Energy Agency (ARENA). The government has committed A$20 million to ABRI. Of this funding, A$5 million has been allocated as a foundation grant for an algal biofuels project at James Cook University at Townsville, Queensland. The balance of A$15 million will be used to fund additional grants, awarded on a competitive basis, under the Advanced Biofuels Investment Readiness Program.

（4.3）*Latest development on algae fuel*

(i) In July 2013, Algae.Tec Ltd. signed a deal with Australia’s largest power company, Macquarie Generation, owned by the New South Wales Government to locate an algae carbon capture and biofuels production facility alongside the Bayswater coal-fired power station in Hunter Valley, and feed waste carbon dioxide (CO_2) into the enclosed algae growth system. The algae will feed on waste CO_2 emitted by the power plant and the resulting algal oil is converted to biodiesel and hydrogenated to grade A jet fuel.[1]

[1] Algae.Tec Ltd. “Algae.Tec signs carbon capture biofuels deal with Australia’s largest coal-fired power company”. Press release dated July 2, 2013.

(ii) In July 2013, Dr. Evan Stephens of the University of Queensland and the team at the Institute for Molecular Bioscience, in collaboration with Germany's Bielefeld University and Karlsruhe Institute of Technology, identified fast-growing and hardy microscopic algae that could prove the key to cheaper and more efficient alternative fuel production. Dr. Stephens and the team identified hundreds of native species of microscopic algae from freshwater and saltwater environments around Australia and tested them against thousands of environmental conditions in the laboratory, creating a shortlist of top performers.[2]

(5) Future Challenges

(5.1) Supply disruptions

The devastating Queensland floods in December 2010 and January 2011 disrupted ethanol production at two of the three ethanol plants into the first half of 2011. Given this uncertainty, it remains a concern for many industry participants.

(5.2) No mandates for alternative transport fuels

The Australian government does not support mandates for alternative transport fuels; however, some state governments have legislated or proposed biofuels mandates.

（5.3）Profitability of biofuel plants

To secure the profitability of biofuel plants, it is necessary to facilitate investment and R&D on new biofuels, such as microalgae and pongamia, and to extend the time period of a current subsidy program that is offered to promote the production of biodiesel and bio-jet fuels.

Trend of Biofuels Trade in Australia

Table A.1.2 shows the historical trend of import and export volumes of biofuels in Australia. Bioethanol is currently not imported. In 2012, 10 ML of biodiesel was exported of which China and South Korea accounted for 50

[2] The University of Queensland, Institute for Molecular Bioscience.

percent and 36 percent, respectively. Biodiesel export in 2013 is expected to increase due to the depreciation of the Australian currency.

Table A.1.2 Transition of Import and Export Volumes of Biofuels in Australia

							(million liters)	
Year End July		2007	2008	2009	2010	2011	2012	2013
Bioethanol	Imports	0	0	0	0	0	0	0
	Exports	0	0	0	0	0	0	0
Biodiesel	Imports	7	4	11	9	25	21	20
	Exports	0	0	0	0	0	10	20

（出所）USDA GAIN Report, Australia Biofuels Annual 7/3/2013

In Australia, 1) customs duty, 2) excise tax, and 3) goods and services tax are imposed on petroleum products.

1) Customs Duty: Tax imposed on the petroleum products imported into Australia—A$0.38143/litre.

2) Excise Tax: Tax imposed on the petroleum products manufactured in Australia—A$0.38143/litre.

3) Goods and Services Tax (GST): 10 percent across the board

Biodiesel is exempted from customs duty under the Energy Grants (Cleaner Fuels) Scheme. However, imported bioethanol is more expensive than domestically produced bioethanol because there is no customs duty exemption system for imported bioethanol.

Brunei Darussalam

Brunei Darussalam is endowed with oil and natural gas, which are rich enough to meet the primary energy demand of the country. For this reason, the country did not have to consider the use of renewable energies and there is no official activity on biofuel utilisation. However, Brunei Darussalam is committed to implement strategies relating to energy security, diversification of supply, and energy efficiency and conservation as an active member of the Association of Southeast Asian Nations (ASEAN).[3] This is reflected in the Energy White Paper presented by the Energy Department in 2011, which set

[3] Asia-Pacific Energy Research Centre (2013).

out a goal of adopting 10 percent electricity from renewable energies in 2035 in order to diversify its energy sources and strengthen energy security.[4]

Although Brunei Darussalam has not implemented an energy policy to promote biofuel utilisation, it does not mean that the country has never shown interest in biofuels development. In 2011, the government indicated an expectation of inviting foreign direct investments through public–private partnership in biofuel facilities that would aim for the European market where the European Union mandated the reduction of carbon dioxide emissions by 80 percent by 2050.[5] Going back to the late 2000s, there were a few biofuel projects discussed with other countries but it is not clear how much progress these projects have made. For example, in April 2007, the Brunei Economic Development Board and a Malaysian company, HDZ Biodiesel Corporation Sdn Bhd, signed a memorandum of understanding to establish a biodiesel project in Brunei Darussalam. Also, the Brunei National Petroleum Company and the Philippine National Oil Company–Alternative Fuels Corporation were in a discussion about a joint biodiesel project in the Philippines using jatropha as feedstock.[6] Therefore, biofuel project development may be seen in Brunei Darussalam in the future.

Cambodia

Policies and Programs to Promote the Utilisation of Biofuels

(1) Policy Overview

The Cambodian government has not established any policies or initiatives for the development of biofuels, so far. Although it has started a series of discussions to promote the development of biofuels, final results have not been announced yet.

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[4] "Current State of Renewable Energies in Brunei Darussalam," Asia Biomass Office (November 2013).

[5] "Gov't wants FDI in biofuel projects", *The Brunei Times*, November 26, 2011.

[6] APEC Energy Working Group, Expert Group on New and Renewable Energy Technologies. http://www.egnret.ewg.apec.org/Archive/me_brunei.html

Cambodia is a net oil importer and the demand for oil imports is projected to increase fast in the future. Developing and expanding the biofuel industry could help the country to curtail its rapidly increasing oil imports.

According to some reports released by the Asian Development Bank Institute (ADBI) and the Japan Development Institute (JDI), the bio energy policy in Cambodia is expected to follow the precedent in Thailand.[7] The JDI report suggests that both bioethanol and biodiesel plans for Cambodia can be developed using the same raw materials used in Thailand. As in the case of Thailand, palm oil and sugarcane can be used to produce bioethanol while palm oil and cassava can be used for biodiesel production in Cambodia.

(2) Target

There is no clear target that has been released by the Cambodian government.

(3) Development Program

In Cambodia, technology is available to extract oil from seeds and convert jatropha oil to biodiesel for use in diesel engines. The technology for producing bioethanol is not available, although it is well developed in other Southeast Asian countries, such as Thailand. The energy content of jatropha oil is similar to that of diesel oil and jatropha oil can be substituted directly in most diesel engines.

In 1994, the Mong Reththy Group and its South Korean venture partner, Borim Universal, launched a large-scale project to plant 11,000 hectares (ha) of oil palms near Sihanoukville. The project was the first commercially motivated attempt to develop a vegetable oil plantation in Cambodia.

After that, a South Korean bio energy company, the MH Bio-Energy, opened its cassava ethanol plant in Kandal region. This plant is currently the only ethanol plant in Cambodia.

In addition, Idemitsu Kosan signed a memorandum of understanding with the Cambodian government to promote biofuels production in the country in December 2012. Idemitsu Kosan has also been promoting its biofuel business in Viet Nam, where the company has begun producing biomass on a pilot basis.

[7] The Thailand Cabinet adopted guidelines for promoting the production and utilisation of ethanol as a motor fuel in 2000.

(4) Information on Biofuel RD&D in Cambodia

There is no information available on biofuel RD&D in Cambodia.

(5) Way Forward

The current development of biofuel is based on pilot projects and there is no clear government policy on biofuels.

Food security in Cambodia is a critical issue. Jatropha, which cannot be used as food, is considered suitable for cultivation in Cambodia. However, the economic viability of producing biodiesel from jatropha still needs to be established.

Trend of Biofuels Trade in Cambodia

There is no official statistics that has been released as yet, but there is a presumption of possible production capacity in Cambodia.

Table A.3.1 Biofuel Production Capacity in Cambodia

1. Biofuels in Cambodia	2. Possible Production Capacity	3. Consumption
Biodiesel	193.2 million litres	No data available
Bioethanol	93.9 million litres	No data available

Source: Schott (2009).

China

Policies and Programs to Promote the Utilisation of Biofuels

(1) Policy Overview

The Chinese government adopted the "National Economy and Social Development—12th Five-Year Plan Outline (2011–2015)" at the 4th Congress of China's 11th Period National People's Congress in March 2011. One of the targets set in the 12th Five-Year Plan was to increase the share of clean energy in total primary energy supply to 11.4 percent by 2015.

Chapter 5 of the 12th Five-Year Plan cites the acceleration of up-to-date agricultural development and firm maintenance of distinctive agriculture modernisation policies. Chapter 5 lays out a policy to accelerate the changeover of agricultural development patterns and to enhance overall agricultural production capabilities, risk aversion capabilities, and market competitiveness.

(2) Target

According to the "12th Five-Year Plan on Renewable Energy Development" published by the National Energy Administration of China, the government plans to raise the share of renewable energy in total energy consumption to 9.5 percent by 2015, where the target for biofuels is 3.5 million tonnes of annual bioethanol consumption, and 1.5 million tonnes of annual biodiesel consumption by 2015.

Table A.4.1 Renewable Energy Development Project in China's 12th Five-Year Plan

	Capacity		Annual Production		Ton Coal Equivalent
	Value	Unit	Value	Unit	million ton
A. Power Generation	394	GW	1203	TWh	390
1. Hydro	260		910		295.8
2. Wind	100		190		61.8
3. Solar	21		25		8.1
4. Biomass	13		78		24.3
Agricultural and Forestrial residues	8		48		15
Biogas	2		12		3.7
Municipal Solid Waste	3		18		5.6
B. Biogas			22	billion m^3	17.5
1. Residential	50	million households	21.5		17
2. Industrial organic waste water treatment facility	1000	Unit	0.5		0.5
C. Heating and Cooling					60.5
1. Solar thermal water heater	400	million km^2			45.5
2. Solar thermal cooker	2	million units			
3. Geothermal					15
Space heating and cooling	580	million km^2			
Water heating	1.2	million households			
D. Fuels					10
1. Solid biomass	10	million ton			5
2. Bioethanol	4	million ton			3.5
3. Biodiesel	1	million ton			1.5
Total					478

Source: National Energy Administration of China (2012), 12th Five-Year Plan for Renewable Energy Development.

(3) Development Program

China's bioethanol fuel introductory project began with the "Ethanol-Blended Gasoline Development Program" under the 10th Five-Year Plan starting in 2001. In March 2002, the "Bill for Testing the Use of Ethanol-Blended Gasoline for Cars" and the "Administrative Instructions for Testing the Use of Ethanol-Blended Gasoline for Cars" were announced to implement a one-year test project to develop legislation; set up a competent government department; and establish raw material procurement, production, transport, and sales systems.

In February 2004, the "Act for Testing the Expansion of Ethanol-Blended Gasoline for Cars" and the "Administrative Instructions for Testing the Expansion of Ethanol-Blended Gasoline for Cars" were announced to launch expanded introduction of bioethanol fuels. Within the expansion program, four bioethanol-producing companies were designated and the region where biofuels were to be introduced was expanded to five provinces and 27 cities. By the end of 2005, bioethanol consumption reached 1.02 million tonnes, and about 20 percent of national gasoline consumption was E10.

At the Petroleum Alternative Energy Research Committee formed by the National Development and Reform Commission, China (NDRC) and National Energy Administration in December 2005, it was discussed that future plans to expand the introduction of ethanol fuel should be implemented under the precondition that the nation's food supply and land use were not threatened.

China is the third-largest bioethanol producer in the world following the United States and Brazil. There are five ethanol plants in China: four of these plants use corn and wheat as raw materials, and one uses cassava. In 2011, these four plants (82% of the feedstock supply was corn, and 18% was wheat) produced 2.1 million kilolitres (kL) of ethanol. The plant that uses cassava produced 152,000 kL of ethanol. All other plants, except this one, were said to be running close to their full production capacity. The government, however, has no intention of approving further land use for facility expansion. The blend rate of ethanol was 8–12 percent, with any changes depending on the market price of oil.

China's production volume of fuel ethanol was estimated at 2.43 million kL in 2012—an 8 percent increase from the 2011 level. There is no change to the government's policy that biofuels should be developed on the precondition that the nation's food provisions and land use are not threatened. The government and business operators have been researching on the use of sweet sorghums as an alternative source, which is an annual gramineous plant and cultivated as feed for livestock; however, sweet sorghum has not yet been grown on a large scale.

Some government agencies and state-owned enterprises have been planting jatropha, but there is no government plan announcement of launching large-scale jatropha plantation. As of 2011, two places in Hainan province have implemented biodiesel pilot programs with a blend rate of 2–4 percent. Both the provincial government and an oil company are still in the stage of considering when to introduce a mandate blend of biodiesel in all the cities in Hainan province.

Due to soaring food prices after 2008, the Chinese government has been forced to tighten the management of the grain handling department, including the production of ethanol. As a result, financial support for the production of grain-based ethanol was reduced and the subsidy for ethanol production was dropped to US$0.06 per litre in 2012. By 2015, the Ministry of Finance of China intends to abolish the refund of the value-added tax and impose a 5-percent consumption tax on the production of grain-based ethanol.

Table A.4.2 Government Subsidy for Production of Fuel Ethanol in China (in US$ cents/litre)

2005	2006	2007	2008	2009	2010	2011	2012
21.3	18.9	15.9	20.4	19.2	16.0	16.0	6.0

Note: US$1 = 6.8 yuan
Source: USDA GAIN Report (2010 and 2013). *Peoples Republic of China Biofuels Annual Report*.

The Chinese government has exempted the 5 percent consumption tax imposed on the production of biodiesel, based on the judgment that the use of used cooking oil contributes to the introduction of renewable energy. Biodiesel producers are requesting the government to make this measure permanent.

Since 2008, the Chinese government has implemented mandatory blending of ethanol in the six provinces of Heilongjiang, Jilin, Liaoning, Henan, Anhui, and Guangxi; and in 27 cities in the provinces of Hubei, Hebei, Shandong, and Jiangsu. These districts and cities were chosen because they were close to the grain production areas, and PetroChina and Sinopec were mandated to blend 10 percent ethanol into gasoline. The production of fuel ethanol is premised on use-based mandatory blend or consumption projection by the government. Since this is based on the government's management system, private companies are prohibited to import ethanol when the market price is high.

In the short term, the following issues were considered as requiring immediate solution: (1) investigation and reevaluation of the crop acreage and designing of an energy crop production plan, (2) implementation of a test project for the large-scale production of biofuels from energy crops other than agricultural products that are consumed as basic foods, (3) development of legislations related to biofuels and establishment of a distribution system, and (4) technological development and establishment of an industrial structure.

(4) Information on Biofuel RD&D in China

As part of their energy cooperation program in 2011, the United States and China launched a joint research on sustainable aviation biofuel oil. Jatropha was chosen as an optional feedstock and a test flight was conducted in Beijing in November 2011. The Chinese government had instructed PetroChina to produce jatropha in the southwest region, but the timing of commercial production was not clear.

China has focused on some non-grain sweet sorghums that grow on infertile land and do not compete with food crops. The first commercial ethanol plant, with a capacity of 113,600 kL, is being constructed in Inner Mongolia and will be completed in 2015. However, it is not clear how much the government will subsidise this scheme, and the provincial government has not made clear when to impose the mandatory blend.

(5) Way Forward

Aircraft jet fuel annual consumption in China is currently 20 million tonnes and is projected to reach 40 million tonnes in 2020. In May 2012, the Civil Aviation Administration of China (CAAC) announced a plan to substitute 12 million tonnes (30%) of jet fuel with biofuels by 2020.

Development was initiated on biofuel production using algae. In September 2010, the Boeing Company and the Qingdao Institute of BioEnergy and Bioprocess Technology established a joint institute for promoting research on algae-based aircraft biofuel. The institute would look into its practical use within five years and its commercialisation within 10 years.

Trend of Biofuels Trade in China

Tentatively, China imposes a 5 percent import duty on imports of denatured alcohol. The duty rate has been greatly lowered from 30 percent in 2009, seemingly aiming to promote import of by-products and raw materials. Imported denatured alcohol is used only by the chemical industry and the government allocates the imported products to specific provinces and cities. An import tariff on non-denatured alcohol has been maintained at 40 percent. Both non-denatured alcohol and denatured alcohol are subject to 17 percent value-added tax and 5 percent consumption tax.

Table A.4.3 Import and Export Volume of Ethanol in China (in kilolitres)

	2007	2008	2009	2010	2011	2012
Import	678	402	158	3,612	5,305	15,308
Export	129,974	108,111	107,895	156,020	43,333	44,962

Source: USDA GAIN Report (2013). *Peoples Republic of China Biofuels Annual Report*.

In 2012, the import duty was reduced to zero for imports from the ASEAN countries, Chile, and Pakistan with whom the Free Trade Agreement (FTA) was concluded. In any case, the imported products are much more expensive than the domestic ones and the import volume is limited.

Table A.4.4 Supply and Demand of Bioethanol in China (in 1,000 kilolitres)

		2006	2007	2008	2009	2010	2011	2012
Production		1,647	1,736	2,002	2,179	2,128	2,255	2,509
Export		0	19	8	16	12	8	7
Import		0	0	0	0	3	5	3
Consumption		1,647	1,736	2,002	2,179	2,128	2,255	2,509
Number of Plants		4	4	4	5	5	5	5
Capacity		1,824	1,824	2,065	2,243	2,500	2,500	2,600
Main Feedstock (1000 ton)								
	Corn	3,200	3,420	3,700	4,000	4,000	4,400	5,000
	Wheat	1,050	1,050	1,050	1,050	1,050	1,050	1,050
	Cassava	0	0	364	467	392	336	336

Source: USDA GAIN (2013), *Peoples Republic of China Biofuels Annual Report*.

Table A.4.5 Supply and Demand of Biodiesel in China (in 1,000 kilolitres)

		2006	2007	2008	2009	2010	2011	2012
Production		273	352	534	591	568	852	909
Export		0	0	0	0	0	0	0
Import		0	0	0	0	0	0	19
Consumption		273	352	534	591	568	852	909
Number of Plants		65	96	84	62	45	49	52
Capacity		1,761	3,124	3,351	2,670	2,556	3,181	3,408
Main Feedstock (1000 ton)								
	Used Cooking Oil	267	344	522	578	556	833	889

Source: USDA GAIN Report (2013), *Peoples Republic of China Biofuels Annual Report*.

India

Policies and Programs to Promote the Utilisation of Biofuels

(1) Policy Overview

It has been more than a decade since a biofuel policy was introduced in India's policy agenda. India implemented a biofuels program primarily to reduce oil import dependence and explore clean fuels. Driven by robust economic growth, India's oil demand has rapidly increased, which has consequently boosted its oil import dependence.[8] As India needs to strengthen energy security, it is important for the country to identify indigenous energy sources to meet domestic energy demand and reduce oil imports.

[8] Based on the IEA's Energy Balances of Non-OECD countries in 2012, the demand for crude oil in India grew at an annual rate of 6.4 percent between 2001 and 2010.

Being the world's third-largest emitter of CO_2, India has implemented policies, such as automotive fuel economy policy and biofuel policy, which are expected to contribute to the reduction of greenhouse gas emissions. In 2003, India introduced the Auto Fuel Policy where under this policy, Bharat Stage IV (Euro IV equivalent) norms for fuels and vehicles were in effect starting April 1, 2010 in 13 cities of India while Bharat Stage III (Euro III equivalent) was applied to the rest of the country.[9]

National Biofuel Mission

In 2003, under the Planning Commission of the Government of India, the National Biofuel Mission was launched to ensure energy security with minimum damage to environment. The Ethanol Blended Petrol Program and Biodiesel Blending Program were the main parts of the Mission and the objectives of these programs were to initiate the blending of biofuels with transport fuels on a commercial scale.[10]

Before the National Biofuel Mission started, an ethanol pilot program, which proposed to blend 5 percent ethanol (E5), was initiated in 2001 and this turned out to be successful. With the start of the Ethanol Blended Petrol Program, an E5 blending target became mandatory for nine states and four Union Territories on January 1, 2003.[11] However, ethanol supplies significantly dropped due to severe droughts in 2003 and 2004, which thereby forced India to import ethanol from Brazil to meet the E5 blending target. To deal with this situation, India amended the E5 mandate so that E5 blending would only be required when ethanol supplies were sufficiently available and when the domestic ethanol price was comparable to the import parity price of petrol. Following the 11th Five-Year Plan (2007–2012), which included a recommendation for increasing the ethanol blending mandate to 10 percent, the Cabinet Committee on Economic Affairs implemented E5 blends nationwide in September 2007.

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[9] The 13 cities include Delhi, Mumbai, Kolkata, Chennai, Hyderabad, Bangalore, Lucknow, Camper, Agra, Surat, Ahmedabad, Pune, and Sholapur.

[10] Raju et al. (2012).

[11] ADB (2011). The nine states were Andhra Pradesh, Goa, Gujarat, Haryana, Karnataka, Maharashtra, Punjab, Tamil Nadu, and Uttar Pradesh. The four Union Territories included Chandigarh, Damman and Diu, Dadra and Nagar Haveli, and Pondicherry.

For biodiesel, India started a biodiesel program in 2003 with a mandatory target of 20 percent biodiesel blending by 2011–2012, identifying *Jatropha curcas* as the most suitable tree-borne oilseed for biodiesel production. To support the program, the Ministry of Petroleum and Natural Gas enacted a National Biodiesel Purchase Policy and set a price of Rs25 per litre, which took effect on November 1, 2006 and was raised to Rs26.50 per litre in October 2008.[12]

National Policy on Biofuel

In December 2009, India adopted the "National Policy on Biofuels" with a target of 20 percent blending of biofuels by 2017. This policy lays out a strategy and approach to biofuel development and proposes a framework of technological, financial, and institutional interventions and enabling mechanisms. Food security is critical for India due to the increasing demand for food associated with its vast population and stagnant agricultural productivity. Hence, this national policy specifies that the program is to be carried out based on nonfood feedstocks raised on degraded or wastelands that are not suited to agriculture to avoid conflict with food security.[13] In addition, this biofuel policy promotes plantations of trees bearing non-edible oilseeds on government- or community-owned wasteland, degraded or fallow land, and in forest and non-forest areas, which will prevent conflict with food production.

While the Ministry of New and Renewable Energy is responsible for implementing and coordinating the policy on biofuels, several other ministries are also involved in biofuel development and promotion, such as the Ministry of Environment and Forests, Ministry of Petroleum and Natural Gas, and Ministry of Rural Development, among others. Given the different roles of these ministries, the biofuel policy proposes to set up a National Biofuel Coordination Committee to provide overall coordination, policy guidance and review, and monitoring of the programs. It also suggests establishing a Biofuel Steering Committee to provide effective guidance and to oversee the implementation of this policy on a continuing basis.

In February 2011, the Ministry of New and Renewable Energy issued a Strategic Plan for the New and Renewable Energy Sector for the period

[12] Ibid.
[13] Raju, *et al*. (2012).

2011–2017. In the medium term, second-generation biofuels are expected to have potential for production.

In November 2012, the Cabinet Committee on Economic Affairs announced that the ethanol policy would be revised so that the market could decide the procurement price and ethanol imports would be allowed if supply falls short of enabling the 5 percent ethanol blending into gasoline. This would mean that starting December 1, 2012, the oil marketing companies and ethanol suppliers are able to set the ethanol price, and the oil marketing companies and chemical companies are free to import ethanol in case of any shortfall in domestic supply.

(2) Target

As mentioned earlier, the biofuel policy sets an indicative target of 20 percent blending of biofuels, both for ethanol and biodiesel by 2017. At the time of this study, there was no mandatory blending target for biodiesel. The target is planned to be phased in over time—5 percent blending by 2012, 10 percent by 2017, and 20 percent after 2017. The noticeable feature of India's biofuel policy is that the country focuses on nonfood products as biofuel feedstocks.

Ethanol Production

In India, ethanol is produced from sugar molasses for blending with gasoline. Approximately 90 percent of molasses is used as feedstock for alcohol production. Sugar production is the second largest agricultural industry next to cotton in the country and molasses is a by-product of sugar production. About 70–80 percent of sugarcane produced in India is used for sugar production and the remaining is for alternative sweeteners and seeds. About 85–100 kg of sugar (8.5%–10%) and 40 kg (4%) of molasses can be produced from one tonne of sugarcane. Sugarcane is subject to periodic and alternate cycles of surplus and shortages with a typical 6–8 year cycle; 3–4 years of higher production are followed by 2–3 years of lower production.[14] Table 5.1 shows that the level of sugarcane production in 2009–2010 did not reach the same level of production as that in 2000–2001, and the yields were stagnant for the last decade.

[14] Ibid.

Table A.5.1 Area under Production, Production and Yield of Sugarcane in India

Year	Area (million hectares)	Production (million tonnes)	Yield (tonnes/hectare)
2000-01	4.32	296.00	68.6
2001-02	4.41	297.21	67.4
2002-03	4.52	287.38	63.6
2003-04	3.94	233.90	59.4
2004-05	3.66	237.09	64.8
2005-06	4.20	281.17	65.6
2006-07	5.15	355.52	69.0
2007-08	5.06	348.19	68.9
2008-09	4.40	273.93	62.3
2009-10	4.20	277.75	66.1

Sources: (Before 2005–2006) Ray et al. (2011), p. 7. (After 2006–2007) Raju et al. (2012), p. 34.

India faces difficulty in maintaining or increasing the blending level of ethanol with gasoline. First, the cyclical nature of sugarcane production creates uncertainty of ethanol availability for gasoline. Since sugarcane production changes periodically, availability of molasses along with that of sugar production also varies. This indicates that ethanol production may experience substantial ups and downs at interval of several years. Thus, it is difficult to secure a constant and stable amount of ethanol (Table 1.5-1).

Second, instability in ethanol prices caused by the high degree of unstable ethanol production causes uncertainty for both oil marketing companies and ethanol distillers. The fact that sugarcane market is exposed to periodic surplus and deficits in sugarcane production has a strong impact on prices of sugar molasses. During low availability of sugar molasses, its price goes up resulting in higher cost of ethanol production. Hence, ethanol production may be disrupted due to the high cost of ethanol, while ethanol prices are fixed by the government, thereby making it difficult to earn profits. Furthermore, since ethanol distillers seem to receive a favourable price and assured demand from the beverage and chemical industries, they tend to find a better business opportunity in these industries over the oil marketing companies. Approximately 70~80 percent of ethanol supplied is consumed by chemical industries and potable liquor and the rest goes to transport fuels and others. Ethanol to be blended with gasoline is a minor part of the consumption.

Third, increased production capacity may be required to meet the higher blending target in the future. The production capacity increased to 2 billion litres in 2012 from 1.5 billion litres in recent years (Table 1.5-2). Current ethanol production capacity is estimated to be sufficient to meet the ethanol demand for the 5 percent blending with gasoline. However, this capacity level would not be adequate to implement the 10 percent and 20 percent blending targets in the future unless new capacity is added. Nevertheless, the actual blending level has been around 2 percent against the mandatory target of 5 percent.

Fourth, other than sugar molasses, nonfood crops that could make the ethanol production commercially feasible have not been secured fully yet in India. It is unlikely that the total quantity of molasses for ethanol is used as transport fuel due to its more favourable choices found in potable and industrial alcohol. Since molasses alone does not provide a viable option for achieving the target of 20 percent blending, alternative nonfood crops is necessary for ethanol production. For instance, there is potential for sweet sorghum and tropical sugar beet as biofuel feedstock. However, the production of tropical sugar beet and sweet sorghum are not commercially established like sugarcane and their cost competitiveness is not completely understood so far. Besides, since these crops use arable land, there is a possibility of competing with food crops for land and water resources. Therefore, these two nonfood crops are expected to play only a supplementary role in the ethanol industry until it is proven that yields can be adequate to meet commercial production level.[15]

[15] ADB (2011).

Table A.5.2 Ethanol Used as Fuel and Other Industrial Chemicals in India

unit: million liters

Calendar Year	2007	2008	2009	2010	2011	2012	2013	2014
Beginning Stocks	747	1,396	1,672	1,241	1,065	757	908	582
Production	2,398	2,150	1,073	1,522	1,681	2,154	2,064	1,906
Imports	15	70	280	92	39	34	35	40
Exports	14	4	4	14	29	22	20	30
Consumption	1,750	1,940	1,780	1,780	1,995	2,015	2,405	2,110
Fuel Consumption	200	280	100	50	365	305	650	500
Ending Stock	1,396	1,672	1,241	1,061	757	908	582	388
Production Capacity(Conventional Fuel)								
No.of Biorefineries	115	115	115	115	115	115	115	115
Nameplate Capacity	1,500	1,500	1,500	1,500	1,500	2,000	2,000	2,000
Capacity Use (%)	160	143	72	101	112	108	103	95
Feedstock Use(1,000MT)								
Molasses(000'tons)	9,992	8,958	4,469	6,342	7,004	8,975	8,602	7,940
Market Penetration								
Fuel Ethanol	200	280	100	50	365	305	650	500
Gasoline	13,056	15,829	18,022	19,954	21,080	22,132	22,510	23,703
Blend Rate (%)	1.5	1.8	0.6	0.3	1.7	1.4	2.9	2.1

Source: USDA GAIN Report (2013), p. 13.

Biodiesel Production

In India, feedstocks of biodiesel are non-edible oilseed crops, like jatropha and pongamia, and edible oil waste and animal fats. Approximately 1.2 million tonnes of tree-borne, non-edible seed oils are produced yearly in India. Among 400 non-edible oilseeds found in India, jatropha was specifically chosen as the major feedstock because of its high oil content (40% by weight) and low gestation period (2–3 years) compared with other oilseeds. Furthermore, jatropha is drought-tolerant and can be grown in less fertile and marginal lands with minimal care. Unlike other countries, India does not use vegetable oil derived from rapeseed, soybean, or oil palm for biodiesel production since it relies on imports of these vegetable oils to a large extent to meet domestic demand.

In spite of the government's focus on jatropha, progress of its plantations has been slow in India. It was promoted initially as India's Planning Commission had set an ambitious target of covering 11.2–13.4 million ha of land under jatropha cultivation by the end of the 11th Five-Year Plan (2007–2012).

However, at the time of this study, jatropha occupies merely 0.5 million ha of wastelands across the country.[16]

Consequently, biodiesel production from non-edible oilseeds is considered still at infancy on a commercial scale. Biodiesel production is estimated at 130 million litres in 2014 (Table A.5.3). Only six biorefineries in India produce biodiesel from multiple feedstock and most biodiesel companies seem to work at low capacity.

Table A.5.3 Biodiesel Production from Multiple Feedstocks in India

unit: million liters

Calendar Year	2009	2010	2011	2012	2013	2014
Beginning Stocks	0	45	38	42	45	45
Production	75	90	102	115	120	130
Imports	0	0	0	0	0	0
Exports	0	0	0	0	0	0
Consumption	30	52	60	70	75	80
Ending Stock	45	38	42	45	45	50
Production Capacity						
No.of Biorefineries	5	5	5	5	6	6
Nameplate Capacity	450	450	450	460	465	480
Capacity Use (%)	17	20	23	25	26	27
Feedstock Use(1,000MT)						
Used Cooking Oil	23	36	48	53	56	58
Animal Fats and Tallows	3	4	5	5	6	6
Other Oils	19	33	42	47	50	52
Market Penetration						
Biodiesel, on-road use	30	52	60	70	75	80
Diesel, on-road use	63,388	65,999	68,718	71,550	74,497	77,567
Blend Rate (%)	0.0	0.1	0.1	0.1	0.1	0.1
Diesel, total use	105,646	109,999	115,431	119,249	124,162	129,278

Source: USDA GAIN (2013), p 15.

There are obstacles that slow down the progress of the production and investments in biodiesel. Given the current environment, it seems that there is no incentive for the farmers to turn their fertile lands for jatropha cultivation. First of all, the current biodiesel production is not viable in economic terms. The biodiesel price set at Rs26.50 per litre remains lower than the cost of biodiesel production, which is estimated at Rs35–Rs40 per litre. The impeding factors of India’s undeveloped biodiesel market, such as inadequate supply of jatropha seeds and inefficient marketing channels, also contribute to the higher production costs.

[16] Raju, *et al*. (2012).

The second impediment is associated with the ownership issues of wastelands that are encouraged to be used for the cultivation of biofuel crops. When local communities are involved, the use of wastelands for plantations of biofuel crops may not be easy unless land ownership is given to them. In addition, the utilisation of the privately owned wastelands would not be possible unless farmers are able to receive assured returns based on financial viability of the biodiesel plantations. There was also confusion regarding the extent of wastelands since various agencies used different definitions for wastelands.

Third, the very little progress in developing jatropha plantations deters biodiesel production on a commercial scale. The planned large-scale jatropha plantations have not been successfully implemented by state governments partially due to lack of coordination and linkage to research programs. Consequently, most of the newly raised seedlings are still from those of low-yielding cultivars. Good quality planting materials (jatropha seeds) have not yet been identified.

Diesel demand is projected to grow by 35 percent or 87.4 million tonnes during the 12th Five-Year Plan (2012–2016). This indicates that meeting a 5 percent blending target will require an additional 4.1 million ha planted with jatropha.[17] Apparently, India needs to increase biodiesel production by increasing jatropha plantations in order to meet the blending target.

(3) Development Program

The National Policy on Biofuels identifies several measures to promote biofuel production. Financial measures, such as subsidies and preferential financing, are proposed.

Minimum Support Price

Minimum Support Price (MSP) for the non-edible oilseeds is suggested to be established with a provision for its periodical revision so that a fair price would be ensured to the biodiesel oilseed growers. Careful consideration would be given to the implementation of MSP after consultation with stakeholders, including central and state governments and the Biofuel

[17] USDA GAIN Report (2013).

Steering Committee, followed by a decision of the National Biofuels Coordination Committee.

Minimum Purchase Price

In determining a biodiesel purchase price, the biofuel policy recommends that the entire value chain—from oilseeds production to distribution and marketing of biofuels—be taken into consideration. The Minimum Purchase Price (MPP) for the purchase of ethanol by the oil marketing companies (OMCs) would be based on the actual cost of production and import price of ethanol. In April 2010, the Empowered Group of Ministers decided to increase the ethanol price to Rs27 per litre, an increase from Rs21.50 per litre, which was fixed in 2007 as the MPP. Since fiscal year (FY)2012–2013, however, the procurement price of ethanol is being decided by the OMCs and suppliers of ethanol. The MPP for biodiesel should be linked to the prevailing retail diesel price. After the Biofuel Steering Committee determines the MPP for both ethanol and biodiesel, the National Biofuel Coordination Committee will decide on it. The biodiesel price has remained at the level of Rs26.50 per litre since October 2008 although it is perceived to be below the production cost.

Financial and Fiscal Incentives

While a concessional excise tax of 16 percent is imposed on bioethanol, biodiesel is exempted from excise duty. No other central taxes and duties are proposed to be levied on bioethanol and biodiesel.

The Government of India offers subsidised loans through sugarcane development funds to sugar mills for establishing an ethanol production unit. The loans would cover up to 40 percent of the project cost.[18] The biofuel policy proposes to set up a National Biofuel Fund if financial incentives are deemed necessary. Subsidies and grants may be considered upon merit for new and second-generation feedstocks, advanced technologies and conversion processes, and production units based on new and second-generation feedstocks. The policy does not specify what feedstock to be considered under this category.

[18] Ibid.

For research, development, and demonstration (RD&D) projects, the policy refers to grants, which would be provided to academic institutions, research organisations, specialised centres and industry.

(4) Information on Biofuel RD&D in India

RD&D is supported to cover all aspects, from feedstock production to biofuels processing for various end-use applications. A major objective of the biofuel policy is to undertake R&D on biofuel crops. It aims to put high priority on indigenous R&D and technology development based on local feedstocks and needs. Specifically, the policy identifies focus areas, such as (1) production and development of quality planting materials and high-sugar-containing varieties of sugarcane, sweet sorghum, sugar beet, and cassava; (2) advanced conversion technologies for first and second-generation biofuels, including conversion of lingo-cellulosic materials; (3) technologies for end-use applications, including modification and development of engines for the transport sector and for stationary applications for motive power and electricity production; and (4) utilisation of by-products of biodiesel and bioethanol production processes. The policy notes that demonstration projects will be set up for ethanol and biodiesel production, conversion, and applications based on state-of-the-art technologies through public–private partnership (PPP).[19]

As the National Biofuel Mission was initiated in 2003, several R&D programs were implemented. For instance, the National Oilseed and Vegetable Oils Development Board established a "National Network on Jatropha and Karanja" in 2004 by involving a number of research institutes, with research focus on issues such as identification of elite planting material, tree improvement to develop high-yielding variety seeds with better quality and reliable seed source, intercropping trails, developing a suitable package of practices, postharvest tools and technology, and detoxification of oil meal of important tree-borne oilseeds.[20]

[19] Ministry of New & Renewable Energy, Government of India (2009).

[20] Raju, *et al*. (2012). The institutes involved were the Indian Council of Agricultural Research, State Agricultural Universities, Council of Scientific and Industrial Research, Indian Council of Forestry Research and Education, Central Food Technological Research Institutes, Indian Institute of Technology, and the Energy Research Institute.

The Department of Biotechnology, Ministry of Science and Technology, initiated a "Micro Mission on Production and Demonstration of Quality Planting Material of Jatropha" with the aim of selecting good germplasm and developing quality planting material. With support from the Department of Biotechnology, the Energy Research Institute undertook a project entitled "Biofuel Micro-Mission Network Project on Jatropha" with the aim of screening various jatropha collections across the country for their oil content and composition.[21]

One of the recent developments is that the Indian Oil Corporation has developed a technology to produce bio-hydrogenated diesel by mixing and processing nonfood vegetable oil and petroleum-based feedstock in an oil refinery's diesel hydrotreater unit. The Central Salt and Marine Chemical Research Institute and the National Environmental Engineering Research Institute have also developed a technique for producing biodiesel fuel from microalgae, with driving tests carried out using B20 fuel.[22]

Despite some R&D efforts initiated, most of the R&D programs are still at the laboratory or field trial stage in India. There was dissatisfaction among the farmers in economic terms due to low-yielding cultivars from most of the newly raised seedlings. No research organisation has officially released improved kinds of jatropha so far.

(5) Way Forward

Notwithstanding the efforts that India has made for more than a decade, the country is still surrounded by a number of tasks to make biofuels available for blending with the transport fuels as planned. Such difficult situations result from various issues as described below:

Integrated Approach by the Central Government and State Governments

It is challenging for India to reduce discrepancy in policy and administrative matters concerning biofuel utilisation between the central government and the state governments. Although the central government is responsible for

[21] Ibid.
[22] Asia Biomass Office (2013), 'Status of Biodiesel Fuel in India', October.

strategic decisions on biofuel policies, the fact that agriculture is under the jurisdiction of the state governments empowers them to pursue their own strategy to encourage biofuel production. For this reason, different initiatives have been applied by the state governments, and as a result, there is a wide range of differences not only among the state policies but also between the central government and the state governments. Table A.5.4 exemplifies some major initiatives taken by several states. Apparently, these initiatives on biofuels are not uniform among the states. Such diverse structures are regarded as an obstacle to the implementation of procurement, blending, transport, and trade of biofuels. Therefore, it is critical for biofuel plantation programs to have an integrated approach across the various states of India.

Table A.5.4 State Biofuel Initiatives in India

Initiative	Andhra Pradesh	Rajasthan	Tamil Nadu	Uttarakhand
Feedstock explicitly favoured	Pongamia	Jatropha, Karanj and other oilseed plants	Jatropha, Pongamia	Jatropha
Allocation of government land for TBO plantation	Forestland managed by community committees	Wasteland allotted to government undertakings, companies and societies on the leasehold basis	No significant cultivation on government land (after failed project of cultivation on community land)	Forestland managed by community committees
Input subsidies/ distribution of input	On forestland, seedlings provided by	Government of India funded for 7.5 million of	50% government subsidy for jatropha	Seedlings financed by the government

	government. Free seedlings distributed to small and marginal farmers	seedlings in 2006–2007 and for 17.4 million of seedlings in 2007–2008.	seedlings	
Minimum support price	Pongamia seeds: Rs10/kg, adjusted soon Jatropha seeds: Rs6/kg	Jatropha: Rs7/kg	No	Jatropha seeds: Rs3/kg, SVO: Rs18/kg
Tax exemptions	Reduced VAT of 4% on biodiesel	Jatropha, crude biodiesel and B100 (100% biodiesel) biodiesel exempted from VAT	Exemption of jatropha seeds from purchase tax and jatropha SVO from VAT	Tax exemption of biodiesel from VAT

Note :TBO = tree-borne oilseeds, SVO = straight vegetable oil, VAT = value-added tax.
Source: ADB (2011).

Economic Viability

Establishing the appropriate investment environment is fundamental to facilitating biofuel production. However, in India, the biofuel market does not necessarily attract investors primarily because a government-fixed price of ethanol and biodiesel does not reflect the current market price, and could be set at a price level that would not yield profits. Ethanol production depends, to a large extent, on the price of its feedstock, molasses. The shortage of molasses could trigger a surge in price, which squeezes the profits for distillers. In addition, the distillers are forced to utilise less than their actual plant capacity due to inadequate amount of molasses. The recent ethanol policy change that enables the market to set the price is expected to improve this situation. For biodiesel, its current price of Rs26.50 per litre, which was set administratively, is not adequate to be remunerative. Hence, biodiesel price needs to be revised to meet financial costs.

Further Research on Biofuels

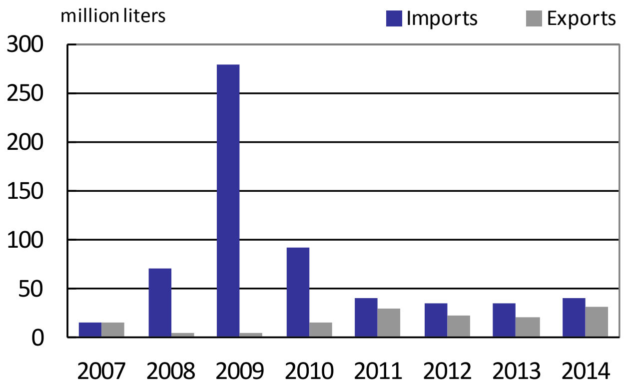
With current technologies available in India, the 20 percent blending target by 2017 does not seem feasible or sustainable for both ethanol and biodiesel. Deployment of improved technology and better management practices are means to bring down the ethanol production cost. Meanwhile, the current situation in which ethanol production is affected by the availability of molasses necessitates the search for alternative feedstocks, such as sweet sorghum and sugar beet. It is also important to expand research for second-generation biofuels.

Even if ethanol production is fully developed and feasible and reasonable prices are provided to producers, the biodiesel market is still in its infancy. More groundwork on R&D is necessary to produce biodiesel on a commercial scale. Since jatropha plantations have been slow due to the lack of good quality planting materials, it is essential to encourage oil seed research for the development of biodiesel production. Superior oil seeds with high-yielding characteristics will result in increased biodiesel production.

Trend of Biofuels Trade in India

India imports ethanol only when it falls short of supply— during years of low sugar production. Figure A.5.1 shows that ethanol imports significantly increased in 2009 when drought substantially reduced sugarcane production.

Figure A.5.1 Conventional Bioethanol Trade in India



Source: USDA GAIN Report (2013), p. 13.

The import tariff on ethanol from all countries was lowered from 28.64 percent to 7.55 percent in March 2012, except for Brazil, which enjoys a preferential rate of 6 percent.[23] Imported ethanol has become more economically viable and attractive due to lower import duty. There are no quantitative restrictions on imports of biofuels.

Table A.5.5 Import Duty on Biofuel in India

Denatured Ethyl Alcohol and Spirits (including ethanol)	7.55%
Chemical Products NES (including biodiesel)	25.85%

Source: USDA GAIN Report (2013), p. 14.

Indonesia

Policies and Programs to Promote the Utilisation of Biofuels

(1) Policy Overview

Biofuels development in Indonesia is one of the government's efforts to diversify energy, through the new National Energy Policy (2006), which has

[23] USDA GAIN Report (2013).

set a target of more than 5 percent biofuels share in the national energy mix by 2025. Biofuels development plan had also been incorporated in the government's planning document *National Energy Policy, 2025 & 2050*, and has been revised several times ever since.

(1.1) Regulation

Presidential Instruction on Biofuels Provision and Utilization as Alternative Fuels No. 1/2006 (PI No.1/2006) is the starting point for the basic policy on biofuels promotion in Indonesia. Under PI No.1/2006, several regulations relate to the provision of facilities and incentives for developing biofuels. These include the (i) Government Regulation No. 1/2007 on Income Tax Facility for Capital Investment in Certain Business Sectors and / or Areas, (ii) Government Regulation No 8/2007 on Government Investment, (iii) Minister of Finance Decree No. 117/PMK.06/2006 on Credit for Bio-energy Development and Revitalization of Plantations (KPEN-RP), and (iv) Minister of Finance Decree No. 79/PMK.05/2007 on Credit for Food and Energy Security (KKPE).

Below are government commitments on policies and incentives for supporting investments in biofuel development:

- Nominal stamp duties
- Agreement with 50 countries on the avoidance of double taxation
- Relief from import duties
- Investment tax allowance in the form of taxable income reduction of up to 30 percent of the realised investment, spread over 6 years
- Accelerated depreciation and amortization
- Loss carried forward facility for a period of no more than 10 years
- 10 percent income tax on dividends, possibly lower if stipulated in the provision of an existing applicable tax treaty
- Selected strategic goods exempt from value-added tax

(1.2) Coordination Team

In line with the PI No.1/2006, two coordination teams were established by the government of Indonesia. The first one is the "Coordination Team on Alternative Energy Provision and Utilization Action Program" through a decree by the coordinating Minister of Economic Affairs (No. KEP-11/M.EKON/02/2006). This regulation is a part of the economic policy package launched on 31 August 2005, which includes three main concerns: (i) Policy for oil fuels demand reduction, (ii) Policy for expanding oil and gas production, and (iii) Policy for promoting energy alternatives. This regulation was later revised by the Decree of the Coordinating Minister of Economic Affairs (No. KEP-11/M.EKON/03/2007) that changed the team's structure and stated their work period.

The second is a specific team called the National Team for Biofuels Development (TimNas BBN) established in July 24, 2006 to accelerate poverty alleviation and unemployment reduction through biofuels development. The team is responsible for the planning and implementation of biofuel development strategies, coordinate the efforts of relevant parties, and monitor and evaluate the implementation activities. As part of the team's duty, TimNas BBN had also established a blueprint for biofuels development, which included a road map toward favourable conditions to be achieved during 2006 ~ 2025.

(1.3) Implementing Regulations

During the initial period, biofuels development was supported by some implementing regulations, including the Regulation by the Minister of Ministry of Energy and Mineral Resource (DEMR) (No. 051/2006) on "Business License Requirements and References" (production, procurement, trading, export and/or import, transporting, storage, and marketing) on biofuels as alternative fuels. This regulation was followed by the issuance of National Biodiesel Standards (SNI 04-7182-2006) and Regulations by the Director General of Oil and Gas (No. 3675K/24/DJM/2006) on "Permit to Mix Biodiesel into Diesel Oil" with a maximum limit of 10 percent.

To accelerate biofuels development, the government issued a Regulation by the Minister of DEMR (No. 32/2008; September 2008) on "Supply, Utilization and Trading Scheme for Biofuels" as alternative fuels. This was a revision of the previous Regulation by the Minister of DEMR (No. 051/2006). This regulation includes biofuels (bioethanol, biodiesel, and bio-oil) mandatory utilisation for the transport, industry, commercial, and electricity sectors. However, the biofuels mandatory policy was not followed as the pricing policy had made it difficult to achieve the target. Hence, in October 2009, the government issued Presidential Regulation No. 45/2009, which was a revision of Presidential Regulation No. 71/2005, regarding the supply and distribution of specific fuels. The main issue of this regulation was the biofuels pricing policy.

(2) Target

In the biofuels development blueprint for accelerating poverty and reducing unemployment, the government divided the road map into two main periods—medium term from 2006 to 2010, and long term from 2010 to 2025. The target for the medium term was to create job opportunities and reduce poverty, while for the long term, the target was to achieve a 5 percent share of biofuels in the national energy mix by 2025. The government's targets for the medium term, until 2010, were as follows:[24]

- ✧ Create 3.5 million jobs
- ✧ Increase revenue with 3.5 million employments for on-farm and off-farm
- ✧ Develop biofuel plantations (in million ha): Palm oil (5.25), Jatropha (1.5), Cassava (1.5), and Sugarcane (0.75) on unutilised land
- ✧ Create 1,000 villages under the Energy Self-Sufficient Village Program (DME) and 12 special biofuel zones
- ✧ Reduce national oil fuel consumption by a minimum of 10 percent
- ✧ Enhance foreign exchange earnings to US$10 billion
- ✧ Meet the domestic and export needs of biofuels.

Unfortunately, there is not much information on the realisation of the targets that had been planned. The government has also required the mining industry sector to use biofuels not later than July 1, 2012. Basically, mining entrepreneurs agreed with the obligation to blend biofuel in their industrial activities, but there are some conditions that they proposed.

(2.1) Realisation of Biofuels Utilisation

Realisation of biofuels use has not been maximised. Although there is mandatory use of biofuels according to the DEMR Regulation No. 32/2008, its realisation has not met the mandatory requirements. Specifically, the

[24] Timnas BBN (2006).

utilisation of bioethanol has no progress because there is no feedstock supply for bioethanol.

Table A.6.1 Biofuel Mandatory Achievements on PSO Fossil Fuel Utilisation

Category	Unit	2011	2012*	2013**	2014***
Biodiesel Utilization					
Mandatory on PSO Transportation Fuel	kL	590,650	694,440	1,202,250	1,464,000
Realization	kL	358,812	669,398	930,561	250,234
Percentage of Utilization	%	60.75	96.39	77.40	17.09
Bioethanol Utilization					
Mandatory on PSO Transportation Fuel	kL	229,600	244,110	146,000	162,300
Realization	kL	0	0	0	0
Percentage of Utilization	%	0	0	0	0

Notes: * B7.5 since February 15, 2012
** B10 since September 1, 2013
*** Until March 31, 2014
Source: The Meeting of the ERIA Working Group for Asian Potential on Biofuel Market (3rd Phase), Tokyo, May 7, 2014.

Biofuels is mainly utilised in three sectors—the transport, industrial, and power generation sectors.

Transport Sector

PERTAMINA as a Public Service Obligation (PSO) and main distributor of transport fuel has utilised biofuels as a mix in several of its products since 2006. As of 15 February 2012, PERTAMINA had increased the content of fatty acid methyl ester (FAME) in biodiesel products originally from 5 percent to 7.5 percent and 10 percent. This step is part of the contribution to the increased use of renewable energy. In determining the suppliers, PERTAMINA prioritises national suppliers of FAME that utilise domestic resources so that PERTAMINA indirectly plays a role in supporting the growth of FAME producers and industry employment.[25] Table A.6.2 summarises the realisation on sales of PERTAMINA's biosolar, biopremium,

[25] See http://www.ebtke.esdm.go.id/energi/energi-terbarukan/bioenergi/501-pertamina-tingkatkan-penggunaan-biodiesel.html

and biopertamax—PERTAMINA's brand names for biofuel blended with high-grade gasoline.[26]

Table A.6.2 PERTAMINA's Sales Volume for Biosolar, Biopremium and Biopertamax (Indonesia)

No.	Commodity	Volume (kL)					
		2006	2007	2008	2009	2010	2011
1	Biosolar	217,048	555,609	931,179	2,398,234	4,460,825	2,328,969
2	Biopremium	1,624	3,776	44,016	105,816	-	-
3	Biopertamax	16	9,958	16,234	20,232	-	-

Source: Directorate of Marketing and Business, Pertamina, May 24, 2011.

Industrial Sector

The use of biodiesel by the industrial sector has yet to reach a maximum due to the lack of government's commitment to implement it, although the regulation that requires industry to use biodiesel has been in existence since 2008. To enhance biodiesel utilisation, experts believe that the use of biofuel should first be implemented in industries under state-owned enterprises so that it can be followed by industries in the private sector.

Power Generation

In addition to the transport and industrial sectors, biofuels have a potential use in power generation. In 2006, there were 12.5 megawatts (MW) of Perusahaan Umum Listrik Negara (PLN) power generated through the use of PPO (pure palm oil), which consisted of 11.0 MW in Lampung and 1.5 MW in Nusa Penida Bali.[27] Meanwhile, the National Team on Biofuels Development reported that until December 2007, installed capacities for PLN's power generation using biofuels was 96 MW. The installed capacities of 96 MW comprised North Sumatera (4.6 MW), Riau and Kepulauan Riau.[28] These numbers show a significant increase when compared to 2006 figures.

[26] Biosolar = Biodiesel blend fuel, Biopremium and Biopertamax = Bioethanol bland fuel
[27] National Team Report of Biofuels Development, 29 December 2006.
[28] Power generated in Riau (23.1 MW), Lampung (11.0 MW), Bali and West Nusa Tenggara (3.5 MW), West Kalimantan (4.0 MW), East Kalimantan (26.0 MW), South and Central Kalimantan (19.9 MW), and Maluku (3.9 MW).

Nevertheless, it was clear that biofuels utilisation by PLN's power plants was still limited.

(2.2) Realisation of Biofuels Production

The Biofuels Producers Association of Indonesia (Aprobi) reported that the production of biodiesel until 28 November 2011 was about 400,000 kilolitres (kL) or 30.84 percent of the mandatory program on the use of biofuels specified in the State Budget (Amendment 2011) at 1,297 million kL. The chairman of Aprobi said that the low production of biodiesel due to poor biofuel price formula is not relevant anymore.[29]

(2.3) Realisation on Absorption of Employment/ Poverty Reduction

The biofuels development had shown little impact on economic growth, despite the fact that it creates more job opportunities (The World Bank, 2010). Job opportunities in the biofuels agricultural sector absorbed more workforce than in the industrial sector. According to the Biofuels National Team report, the number of workers absorbed on-farm (599,000 people) and off-farm (1,040 people) until December 2007 were 17 percent of the target of 3.5 million people for 2010. However, it is suspected that the number is only a proxy of the plan and does not show actual facts in the field.

(2.4) Realisation of Credit Distribution for Biofuels Feedstock Development

At the moment, many private companies have funded their own developments. The credit distribution for the development of biofuel plants by the end of November 2007 was about Rp4 trillion consisting of 2.9 percent or Rp115.4 billion for oil palm, 96.7 percent or Rp3.9 trillion for sugarcane, and 0.4 percent or Rp15.7 billion for cassava. However, the total realisation was only 11.0 percent of the targeted plan for 2010 of about Rp38.0 trillion. Biofuels from jatropha faced the most challenges and barriers due to uncertainty in jatropha's market and its future development.

[29]http://www.indonesiafinancetoday.com/read/18817/Realisasi-Produksi-Biodiesel-Baru-308-dari-Target

(3) Development Program

The development of biofuels is one method used by the government of Indonesia to reduce poverty and unemployment. There were three fast-track approaches used in developing biofuels (Figure 1.1). The first fast-track approach developed by the government was the energy self-sufficient village program (DME). The program was launched in February 2007. DME are villages that have the potential to fulfill at least 60 percent of their energy needs for cooking, transport, and electricity from local renewable energy resources, namely, biofuel (jathropa, coconut, palm, cassava, sugarcane) and non-biofuel (microhydro, wind turbine, solar energy, biogas, and biomass). This program was aimed at encouraging rural economic activities by providing sufficient energy. The program was initiated by promoting biofuel from jatropha under the coordination of the National Team on Biofuels. The team only worked for two years, and the program failed to meet its target due to conflicting and inconsistent policies, poor planning, limited budget, weak institutional capacity, and lack of coordination.

(4) Information on Biofuel RD&D in Indonesia

Technology development has been carried out in Indonesia through institutions such as the Agency for the Assessment of Application and Technology (BPPT), Indonesian Institute of Sciences (LIPI), the Centre for Oil Palm Research (PPKS), and universities. BPPT, being a research and technology institution and also the pioneer in biodiesel production, has developed the first-generation biodiesel since 2000. Almost all biodiesel was produced by the transesterification method with alkaline catalyst because the process is economical and requires only low temperatures and pressures. A summary of existing biofuel technologies in Indonesia are presented in Table A.6.3.

Table A.6.3 Existing Biofuel Technologies in Indonesia

Institution	Feedstock	Technology Process	Fuel
Surabaya Institute of Technology	Cassava	Saccharification and Fermentation	Bioethanol
Surabaya Institute of Technology	Algae spirogyra	Hydrolisis, Fermentation, Distillation	Bioethanol
BPPT and Mitsubishi Heavy Industries, ltd (MHI)	Biomass (lignosellulossic bioethanol) from palm empty fruit bunches	Hydrolisis, Fermentation	Ethanol
BPPT	Palm oil	Hydrotreating	Biodiesel
Lemigas	Vegetable oil (CPO, jatropha, coconut, waste cooking oil)	Esterification, Transesterification, Purification, Glicerol, Recovery Methanol	Biodiesel
PT. Rekayasa Industri, Badan Riset Kelautan & Perikanan dan Bandung Institute of Technology	Micro-algae	Ultrafiltration	Biodiesel
Indonesian Institute of Sciences (LIPI)	Biomass (lignosellulossic)	na.	Biodiesel
University of Gadjah Mada	Vegetable Oil (CPO, jatropha)	Reactive Distillation	Biodiesel
Bogor Institute of Agriculture	Aquatic Microfungi	Acidimpregnasi, Fermentation	Bioethanol
Bogor Institute of Agriculture, SBRC	CPO, olein, stearin, PFAD, waste cooking oil, coconut, jatropha, nyamplung, rubber seed	Esterification, Transesterification	Biodiesel
Purworejo Government	Nyamplung	Esterification, Transesterification	Biodiesel
Ministry of Forestry	Nyamplung	Esterification, Transesterification	Biodiesel
Bandung Institute of Technology	Corn stalk	Grinding and Fermentation	Bioethanol
Indonesian Institute of Sciences (LIPI) & PT. Nusantara Tropocal Fruit	Banana stem	Grinding, hydrolisis and fermentation	Bioethanol
Diponegoro University	Bark, papaya	Saccharification, fermentation and distillation	Ethanol
Gadjah Muda University	Pineapple skin	Saccharification and Fermentation	Ethanol
University of Pembangunan Nasional "Veteran" Yogyakarta	Banana skin	Grinding, hydrolisis and fermentation	Ethanol

Sources: Compiled by the authors from various sources.

Second-generation biofuels are produced from nonfood cellulosic biomass, such as wood, rice straw, and grass. There are a number of second-generation biofuels being developed. Second-generation biofuel technology has been developed by the BPPT since early 2010 in cooperation with Japan. Second-generation biodiesel utilises biomass through liquefaction and gasification processes. Biodiesel is derived from biomass, including palm empty fruit bunches midribs and other agricultural wastes.

(5) Way Forward

(5.1) Biofuel Policy

In general, policies are required at all levels from down, mid, to upstream levels of the biofuels industry. Central and local governments should be consistent in implementing the mandatory policy and provide incentives and tax policies for imports from countries that are export-oriented. The government also needs to develop policies to attract investors, such as ease of use of land, infrastructure, easy procedures and licensing, community acceptance, farm supervisory support, and conditions that are safe and conducive to their operation.

In addition, notification by the Environmental Protection Agency of the United States (US EPA) on standards regarding fuel from renewable sources or the Renewable Fuel Standards (RFS) (27 January 2012, US EPA) will be a challenge for the Indonesian government. US EPA had stated that vegetable oil fuel or biofuel derived from Indonesian palm oil has not met the

Renewable Energy Standards. Thus, it will be a challenge for the government to issue a policy that supports the reduction of greenhouse gas (GHG) emissions from biofuels. There has been no standard policy on the regulation of emission reduction from the use of biofuels or biodiesel products in Indonesia.

(5.2) Competition among feedstock for food and fuel

The increase in the number of companies engaged in biofuels is a good sign. However, a competition to capture the raw materials (such as oil palm, cassava, and maize) among the food industries (such as cooking oil and sugar industries) does exist.

(5.3) Land availability for biofuel development

The accuracy of the field data needs to be confirmed. In the biofuels blueprint (2006–2025), the government had planned for 1.5 million ha of plantations with jatropha for biodiesel development by 2010. For the development of bioethanol, the government had planned for 2.25 million ha of land for sugarcane and cassava by 2010. However, to date, no such land was made available. The land provisioning becomes an obstacle for biofuels development in Indonesia. This was due to concession permissions delivered by the government without verification on land ownership, often causing social conflicts, where the general public has become the victims of land acquisition by corporate bodies.

(5.4) Subsidised Fuel Price

The high amount of subsidies given to the fossil fuel price has led to the situation where the price of biofuel is not competitive compared with fossil fuel. The low selling price of biofuel products does not commensurate the high production costs of biofuel.

Trend in Biofuel Trade

Indonesian biodiesel export increased very significantly from 20,000 kL in 2010 to 1.75 million kL in 2013. Most of the biodiesel exports were for the European market. Several factors contributed to this remarkable change in biodiesel trade. The increase of biodiesel demand from the Europe market was due to the decreasing trend of rapeseed production. The trend of crude palm oil (CPO) price remaining at a low level in the current market has reduced the production cost of biodiesel and offered palm oil-based biodiesel a competitive edge over conventional diesel. Differential export tax on palm oil products had made the price of palm oil-based biodiesel more attractive and a strong competitor at cheaper prices compared with Malaysian biodiesel producers.

Table A.6.4 Trend of Biodiesel Trade in Indonesia

	Unit	2009	2010	2011	2012	2013
Production	Thousand kL	191	243	1,812	2,221	2,805
Export	Thousand kL	70	20	1,453	1,552	1,757
Domestic	Thousand kL	121	223	359	669	1,048

Sources: Ministry of Energy and Mineral Resources, Directorate of Bioenergy.

Japan

Policies and Programs to Promote the Utilisation of Biofuels

(1) Policy Overview

To develop comprehensive measures for the utilisation of biomass, the “Biomass Nippon Strategy” was decided by the Cabinet in December 2002. This strategy was designed to develop a “Biomass Nippon” society that makes comprehensive use of biomass as energy and products from organic resources, derived from living organisms including agricultural and marine resources and organic waste materials. This strategy provides basic policies, goals, specific measures, and processes for “Biomass Nippon” in response to the program on the “Promotion of Utilization of Biomass Capable of Producing Energy Sources and Products out of Animals, Plants, Microorganisms, and Organic Waste Materials.” Given the comprehensive utilisation of biomass, this strategy was also associated with a wide range of technologies, such as biotechnology, nanotechnology, and material engineering.

To facilitate coordination among the different ministries and agencies, it was decided that the Ministry of Agriculture, Forestry and Fisheries; Ministry of Environment; Ministry of Economy, Trade and Industry; Ministry of Education, Culture, Sports, Science and Technology; Ministry of Land; Infrastructure; Transport and Tourism; and the Cabinet Office would jointly address the utilisation of biomass. In December 2010, the "Basic Plan for the Promotion of Biomass Utilization" was approved by the Cabinet.

In 2006, a new national energy strategy until 2030 was enacted, setting a goal of increasing the use of alternative energy to 20 percent in the transport sector. Subsequently, a policy to promote E3 (3% of ethanol blending into gasoline) and B5 (5% of biodiesel blending into diesel) was announced in 2007.

In 2011, the following measures were taken to promote energy diversification in the transport sector:

- Subsidy to support the accelerated introduction of biofuels (\890 million)[30]

- Improvement and enforcement of a taxation system for biofuels (exemption on gasoline tax on bioethanol-blended gasoline; until March 31, 2013).

- Establishment of a "biomass commercialisation strategy study team."

- Initiatives on R&D and demonstration project of biomass energy (\16 billion).

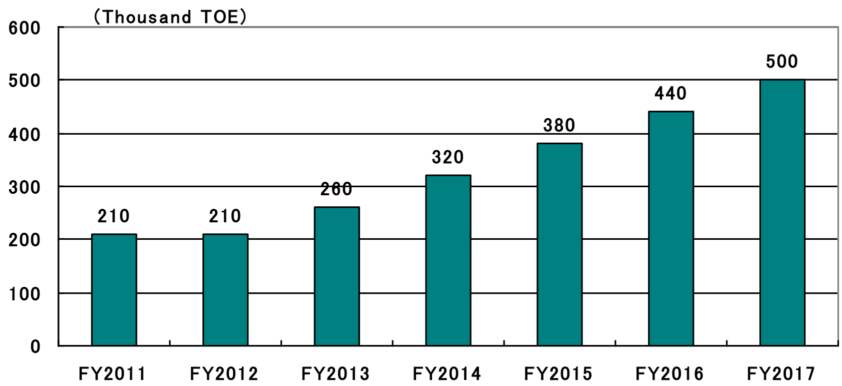
(2) Target

According to the Energy White Paper 2011, biomass energy used in Japan in 2009 was 4.54 million kL (in oil equivalent) and 10.91 million kL in 2010. It accounted for 0.81 percent of the domestic total supply volume of primary energy or 561.76 million kL in 2009 and 1.91 percent of the 569.95 million kL in 2010. As of October 2013, the installed capacity of biomass power generation is 2.3 gigawatts (GW).

[30] Under this category, \1.05 billion of subsidy is allotted in the FY2014 budget.

In 2009, the "Sophisticated Methods of Energy Supply Structures" was enacted to obligate oil and gas business operators to utilise biofuels and biogases. The targets for biofuels utilisation, which has been enforced since November 2010, are shown in Figure A.7.1.

Figure A.7.1 Total Target Volume of Bioethanol Utilisation in Japan (in oil equivalent)



Source: The Institute of Energy Economics, Japan.

(3) Development Program

Under the "Law for Sophisticated Methods of Energy Supply Structure" implemented in 2009, the government of Japan requested the oil industry to increase the use of biofuels to 500,000 kL in 2017.

The government launched the "Biomass Commercialisation Strategy Study Team" in February 2010. The study team published a draft of the biomass commercialisation strategy in June 2012. This was designed to achieve the goals mentioned in the "Basic Plan for the Promotion of Biomass Utilization" as decided by the Cabinet in 2010. This strategy was expected to facilitate 13 billion kilowatt-hours (kWh) of biomass power generation and 11.8 million kL of biofuel utilisation, reducing carbon dioxide (CO_2) emissions by 40.7 million tonnes. Current domestic potential of biomass is estimated at 255.5 million tonnes with an entire recycling rate of 74.8 percent, which will be raised to 88.5 percent in 2030.

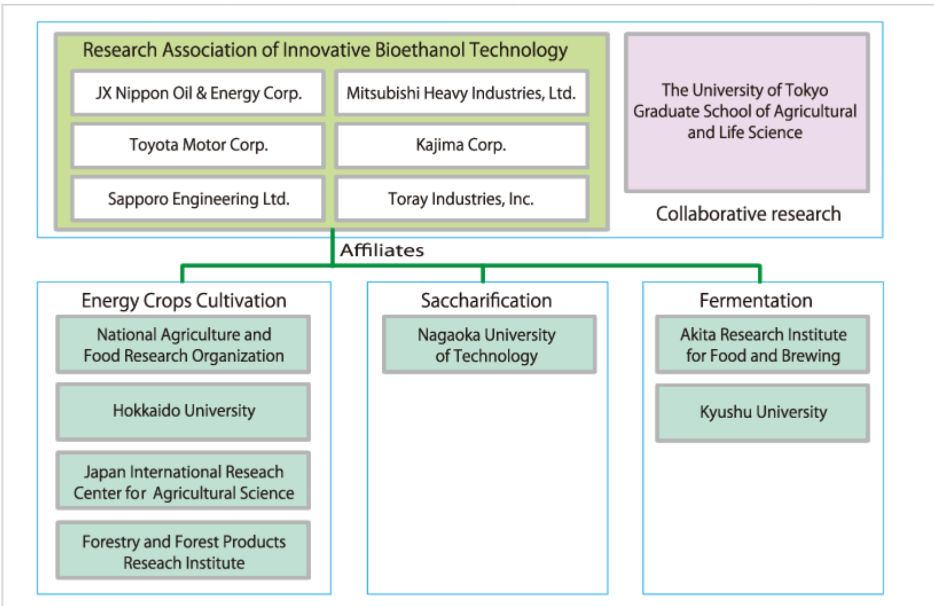
In September 2012, the "Innovative Energy and Environmental Strategy" was launched by the government's Energy and Environment Council, which defined the future introduction goals of renewable energy. According to the strategy, renewable power generation is planned to increase from 14.4 billion kWh in 2010 to 32.8 billion kWh in 2030, with capacity reaching 5.52 million kW in 2030 from 2.42 million kW in 2010.

The Japanese government announced a policy to back up the diffusion of bioethanol as automobile fuel on November 26, 2012. If small and medium-sized companies switch part of their gasoline to biofuels to reduce CO_2, they will be approved of emission rights equivalent to their reduced volume. Emission rights can be sold to major companies setting up a voluntary reduction goal. Small and medium-sized companies will be able to obtain emission rights if they use E3 in their cars or introduce E10 for flexible fuel vehicles (FFV).

(4) Information on Biofuel RD&D in Japan

Figure A.7.2 shows the composition of research associations in Japan.

Figure A.7.2 Research Association of Innovative Bioethanol in Japan



Source: The Institute of Energy Economics, Japan.

On December 17, 2012, the Research Institute of Innovative Technology for the Earth (RITE), Honda R&D Co., Ltd., a subsidiary of Honda Motor Co., Ltd. and the US Department of Energy announced the start of demonstration tests on jointly developed bioethanol in 2013. If everything goes smoothly, they will launch mass-production tests in the US in 2014. It is alleged that ethanol can be produced from inedible vegetable plants, such as stems and leaves, at the price equivalent to gasoline. New technology has been combined with the pretreatment technology of the US Department of Energy to extract sugar, and genetically modified germs developed by Hideaki Yukawa from RITE. These germs are resistant to fermentation inhibitors and capable of utilising sugar obtained by low-cost pretreatment.

In May 2013, the Kawasaki Heavy Industries, Ltd. established a new technology for the low-cost production of bioethanol from rice straw, a nonfood source of biomass. Kawasaki employed a new hydrothermal technique to saccharify cellulose in the process of producing bioethanol. The new process can be completed without sulfuric acid treatment that raised a cost issue in the existing technique.

In August 2013, a research team led by Prof. Hideki Kanda of Nagoya University developed a technology to extract the biofuel of algae by using half the amount of energy needed in the existing technology. The new technology removes the process to dry and destroy algae.

In October 2013, Hamada Kagaku (Hyogo Prefecture), Kobe University, and Bioenergy (Hyogo Prefecture) jointly developed a process to produce biodiesel from waste oil by means of enzyme. Production cost is expected to decline since effluent treatment applied in a current method with the use of alkali catalyst is no longer necessary.

Table A.7.1 lists other biomass projects being promoted in Japan.

Table A.7.1 Biomass Development Projects in Japan

Project	Operator	Technology	Capacity kL/year	Support	Feed	Schedule
Hyogo Pref. soft cellulose usage	Mitsubishi Heavy Ind.; Hakutsuru brewing; Kansai Chemical Machines	Continuous heating water decomposition Nontransgenic yeast	0.8	MAFF	Rice and wheat straw	2008～2010
Hokkaido soft cellulose usage	Taisei Construction, Sapporo Breweries	Alkaline treatment simultaneous hydrolysis and fermentation	1.04	MAFF	Rice and wheat straw	2008～2012
Akita Prefecture soft cellulose usage	Kawasaki Plant systems	Heating water decomposition Nontransgenic yeast	22.5	MAFF	Rice straw	2008～2012
Kashiwanoha soft cellulose usage	Kashiwanoha Bio-ethanol Production Demonstration Limited Liability Company (LLC)	Alkaline treatment GM E.coil	6.7	MAFF	Rice straw	2009～2012

Note : MAFF = Ministry of Agriculture, Forestry and Fisheries, Japan.
Source: The Institute of Energy, Economics, Japan

(5) Way Forward

Given the country's limited land resources, the government's strategy is to focus determinedly on cellulosic ethanol or algae-derived biodiesel as the future for Japan's biofuel production.[31]

Trend of Biofuels Trade in Japan

[31] USDA Global GAIN Report (2012d).

Most of the bioethanol consumed in Japan is imported from Brazil in the form of ethyl tertiary butyl ether(ETBE). The absolute volume of biofuels import is low in Japan. Detailed statistics are not available. For tariffs on the import of ethanol, the petroleum and coal tax (\2,040/kL) is imposed, but the gasoline tax of \53,800/kL is exempted.

Lao People's Democratic Republic

Policies and Programs to Promote the Utilisation of Biofuels

(1) Policy Overview

The "Renewable Energy Development Strategy" was developed in 2010 where the following issues were given high priority:[32]

-Promote the development of sustainable renewable energy to secure energy supply for social and economic development.

-Provide investors with financial incentives to encourage investment in renewable energies.

-Develop and revise laws and regulations to promote the development of renewable energy.

The goal was to increase the use of renewable energy to 30 percent of energy consumption by 2025. The target for biofuels utilisation was that it should account for 10 percent of energy consumption in the transport sector by 2020.

On agricultural policies, one of the significant issues of bioethanol production projects is to secure cultivated land for raw material crops. In the Lao People's Democratic Republic (Lao PDR), the implementation of large-scale cultivation of energy crops must satisfy at least the following two requirements: (i) it must be socially and economically beneficial, including benefiting farming communities; (ii) it must contribute to sustainable

[32] Sithideth (2011).

economic growth. The major considerations in a large-scale cultivation include whether or not it contributes to increased income among farmers, whether or not cultivated land has been obtained by unreasonable deforestation or forest destruction, and whether or not crop conversion has been conducted (which runs counter to food security).

On environmental policies, the Environmental Protection Law of 1999 is the basic law and the "Decree on Environmental Impact Assessment," enforced in 2000, provides the approval procedures for energy development projects.[33]In 2004, the "National Environment Strategy" (until 2020) was laid down, under which the "Second Environment Action Plan, 2006-2010" was formulated and sets the following six priority policies:[34]

- Stabilise the management of natural resources.
- Improve environmental management in the manufacturing industry, infrastructure development, and urban development.
- Enhance institutional framework for the improvement of environmental management capabilities.
- Encourage the involvement of the private sector in environmental management.
- Improve the fund-raising system.
- Enhance international cooperation.

(2) Target

To achieve the government's target for renewable energy utilisation by 2025 (30% in total energy consumption by 2025), the amount of biofuel use needs to reach the level shown in Table A.8.1. The government has also set a target to substitute the 10 percent energy consumption in the transport sector with biofuels by 2020.

[33] Japan Electric Power Information Center, Inc. (2010).
[34] Ibid.

Table A.8.1 Biofuel Introduction Goal in Renewable Energy Development Strategy of Lao PDR

	2015	**2020**	**2025**
Ethanol	10 ML	106 ML	150 ML
Biodiesel	15 ML	205 ML	300 ML

Note : ML = million litre
Source: Lao Institute for Renewable Energy (2011).

(3) Development Program

The Lao PDR government has been focusing on the development of biofuels since early 2006. In 2008, the government established a special committee for its development and launched the formulation of a national strategy and basic policies for developing biofuels. However, biofuels production in the Lao PDR is still in the initial phase, still far from commercial production. As the domestic economic and industrial infrastructure is fragile and the legal systems in the related fields have not been properly developed, it is difficult for the government to politically develop biofuels.

In the Lao PDR, there is no full-fledged commercial bioethanol (BE) or biodiesel fuel (BDF) manufacturing plant yet. For BDF, however, KOLAO[35] has reportedly run an experimental plant with an annual production capacity of about 730,000 litres. Actually, more companies have shown interest in acquisition of land for plantations to produce biofuels. Nevertheless, most of the projects are still in the planning or demonstration phase.

Biodiesel is produced from jatropha, coconuts, palm oil, and castor oil in the test phase.[36]Although foreign investors have attempted to build a jatropha plantation, they were not very successful due to various reasons including mismatch of business form, lack of understanding of local people, lack of experience of jatropha cultivation, and so on.[37] In the Lao PDR, a large

[35]KOLAO Group, named after South Korea and Lao PDR in 1996, is a firm that diversifies business from producing and selling cars and motorcycles to dealing with finance. It is franchised not only in the Lao PDR but also throughout Indo-Chinese and all over the world.
[36] ADB (2012).
[37] Lao Institute for Renewable Energy (2009).

portion of land is used for growing crops such as corn, cassava and sugar cane. However these crops are for edible use or export and not for fuels.

(4) Information on Biofuel RD&D in Lao PDR

Table A.8.2 lists the organisations that are involved in biofuel activities in the Lao PDR.

Table A.8.2 Governmental and Nongovernment Organisations

Related to Biofuel Activities in the Lao PDR

	Government Institute	Main Activities
1	Department of Electricity, Ministry of Energy and Mines	Policies and development plans
2	Prime Minister's Office	Support the plantation of Jatropha
3	Water Resources and Environment Agency	Support the plantation of Jatropha
4	National Agriculture and Forestry Research Institute, Ministry of Agriculture and Forestry	R&D on the plantation of Jatropha
5	National Authority for Sciences and Technology (NAST)	Plantation of Jatropha, production of BDF, etc.
6	Lao State Fuel Co., Ltd	Pilot project of Jatropha plantation
7	Lao Institute for Renewable Energy (LIRE)	Pilot project of Jatropha plantation; Plantation, F/S research, GIS mapping, etc.

Source: Daiwa Institute of Research Holdings Ltd. (2012), 'Current Status and Issues of Biofuels Production in Lao PDR'. *Emerging Markets Newsletter*, (22).

(5) Way Forward

Compared with other neighbouring countries like Thailand, China, and Viet Nam, the yield of feedstoks for biofuel production is relatively low in the Lao PDR. According to an ADB study[38] that used FAO statistics, the average yield (tonne/hectare) of sugarcane in Lao PDR from 2005 to 2009 was 35.28, while that in Yunnan and Guangxi in China was 69.73, 60.83 in Thailand, and 58.31 in Viet Nam. Thus, much could be done to increase yields of biofuel feedstocks.

Like Cambodia, food security is a critical issue for decisionmakers in the Lao PDR. The food security issue might be exacerbated by various external

[38]ADB (2012). http://www.adb.org/publications/biofuels-greater-mekong-subregion

factors, such as increasing food price, extreme weather events, and the threat of climate change.

Trend of Biofuels Trade in the Lao PDR

The tariff rates for the export of crops are very low as the Lao PDR has signed a free trade agreement (FTA) or EPA with neighbouring countries.

Table A.8.3 Tariff Rate on the Export of Raw Material Crops from the Lao PDR

Item/Export Destination		**Viet Nam (%)**	**Thailand (%)**	**China (%)**
Cassava	Frozen	0	0	5
	Powder, Meal Pellet	0	0	0
	Fresh, Frozen	0	0	5
	Starch	0	0	5
Cornstarch		0	0	5
Molasses	Sugarcane	5	0	0
	Others	5	0	0

Source: Daiwa Institute of Research Holdings, Ltd.

Malaysia

Policies and Programs to Promote the Utilisation of Biofuels

(1) Policy Overview

(1.1) National Biofuel Policy

In 21 March 2006, the Malaysian government launched the National Biofuel Policy (NBP) under its "Five Fuel Diversification Strategy" with a view to developing the biofuels industry. The policy provides the overarching framework to develop biofuels as one of the five main energy sources for Malaysia. The policy aimed to encourage the production and usage of palm oil biofuel as an environmentally friendly alternative energy source and also to stabilise the palm oil price at a higher level through increased usage of palm oil.

Five strategic objectives underpin the NBP (Table A.9.1). The first two objectives refer to the institution of a 5 percent biofuel mandate, using palm oil as feedstock. The NBP does not specify whether the "processed palm oil" to be used in the blend would be palm olein ("Envodiesel") or palm methyl ester (PME). In this perspective, as noted in the table, "B5" should be considered a general term for a 5 percent blend palm-based biofuel, and not necessarily a direct blend of palm oil. The policy notes that a B5 mandate would create new demand for 500,000 tonnes of palm oil (assuming a national consumption of 10 million tonnes of diesel per year).

Table A.9.1 National Biofuel Policy–Strategic Objectives of Malaysia

Thrust	Objectives	Contents
Thrust 1	Biofuel for Transport	Diesel for land and sea transport will be a blend of 5% processed palm oil(1) and 95% petroleum diesel. This 'B5' would be made available throughout the country.
Thrust 2	Biofuel for Industry	Supply B5 diesel to the industrial sector, to be used as fuel in industrial boilers, construction machinery and diesel-powered generators.
Thrust 3	Biofuel Indigenous Technologies	Promote research, development and commercialization of biofuel technologies.
Thrust 4	Biofuel for Export	Encourage and facilitate the establishment of plants for producing biofuel for export.
Thrust 5	Biofuel for Cleaner Environment	Enhance the quality of the ambient air, reduce the use of fossil fuels and minimize emissions of greenhouse gases (mainly carbon dioxide), carbon monoxide, sulphur dioxide and particulates through increased use of

Note: The NBPM does not specify whether the "processed palm oil" would be palm methyl esters or direct blending of palm olien. In this context, "B5" can be considered a generic term referring to a 5 percent blend of a palm-based biofuel.
Source: Adapted from the National Biofuel Policy, March 21, 2006.

The NBP outlines more specific milestones for the development and use of palm methyl ester (PME)—the form of biodiesel most commonly used internationally. By the end of 2007, 28 months after the launching of the NBP, the government had completed trials in which a 5 percent blend of PME and 95 percent (PME B5) was used by selected government department fleets, and by selected users in the industry. The Malaysian Standard specifications for PME B5 were set, and some commercial biodiesel plants were established. However, the policy has yet to meet its medium- and long-term goals.

(1.2) Malaysia Biofuel Industry Act 2007 (Laws of Malaysia, Act 666)
The "Malaysian Biofuel Industries Act 2007," gazetted on 26 July 2007, provides for regulations to prescribe the type and percentage of biofuel to be blended in any fuel. In addition, the regulations for a 5 percent blend of biodiesel were made on 3 June 2011 and were being enforced in the Central region beginning 1 November 2011.

(1.3) Malaysian Biofuel Industry (Licensing) Regulations 2008
This Act was enforced on 1 August 2008, while the licensing activities under the Act, as stipulated under the "Malaysian Biofuel Industry (Licensing)

Regulations 2008," was enforced on 1 November 2008. According to Section 5 of the "Malaysian Biofuel Industry Act 2007 (Act 666)," the activities that need to be licensed are as follows:

Production of biofuel:

- commence to construct any biofuel plant or biofuel blending plant,
- produce any biofuel, or
- blend any biofuel with any other fuel or biofuel.

Trading of biofuel:

- export, import, transport, and store any biofuel and blended biofuel

Biofuel services:

- survey and test any biofuel and blended biofuel

Under Section 5(3) of the " Malaysian Biofuel Industry Act 2007 (Act 666)," anybody who conducts activities relating to biofuels without a valid license, shall, on conviction, be liable to a fine not exceeding 250,000 ringgit or imprisonment for a term not exceeding three years or both. In principle, the government had agreed to consider applications for biofuel license on a limited basis until 31 December 2009, subject to the fulfillment of the following conditions:

- applying companies, including new applicants, are required to show proof that they have a secure financial position and a stable feedstock to commence operations; and
- applying companies undertake capacity enhancement and have been in operation since 31 December 2007; or
- applying companies to produce phytonutrients from oil palm products as well as methyl ester as primary product or by-products through the Biofuel Manufacturing License.

For the existing biofuel manufacturing license holders, all applications shall be treated as a fresh application and not as an application for a renewal of license. This is in accordance with Section 56(1) of the "Malaysian Biofuel Industry Act 2007 (Act 666)." It says that applications must be made within six months from the date of the coming into operation of this Act. Hence, the closing date for applying for those with existing biofuel manufacturing licenses was 30 April 2009.

For companies that had applied for the biofuel manufacturing license, which had been frozen since June 29, 2006, they need to reapply for the license on activities related to biofuels as stipulated under Section 5 of the "Malaysian Biofuel Industry Act 2007 (Act 666)."

(1.4) Malaysian Standard on Biodiesel

The drafting of the Malaysian Standard on biodiesel was undertaken by the Standards and Industrial Research Institute of Malaysia (SIRIM), under Technical Committee 28 (TC 28) on Petroleum Fuels. Members and co-opted members included the following: oils and gas companies; Malaysian Automotive Association (MAA); Malaysia Palm Oil Board (MPOB); government agencies such as the Department of Environment Malaysia, Road Transport Department (or JPJ) and others; Malaysian Oleochemical Manufacturers Group (MOMG); and biodiesel manufacturers. The "Malaysian Standard on Biodiesel (Methyl Esters) MS 2008" (similar to EN 14214) was published in November 2008. This standard is incorporated in the biofuels regulation. The Malaysian Standard on petroleum diesel MS 123:2005 (amended in 2010) has been amended to include up to 5 percent of palm methyl ester.

By the end of March 2013, the Malaysian Provisional Standard for petroleum diesel MS2535:2013 was developed and published. These provisional standards allow a blending ratio of up to 10 percent of palm methyl ester.

(2) Target

Biodiesel Industry

The palm oil industry is a key component of the domestic economy, and an influential player in the global edible oils market. In 2013, the total oil palm cultivation in Malaysia was 5.23 million ha and the production of crude palm oil (CPO) was 19.22 million tonnes (excluding palm kernel oil, 4.86 million tonnes). Malaysia is the second-largest palm oil producer in the world, after Indonesia.

Malaysia's first commercial scale biodiesel plant commenced operations in August 2006. From August to December of that year, a total of 55,000 tonnes of biodiesel were produced in Malaysia. The production increased to 130,000 tonnes in 2007 and main feedstock used was refined, bleached, and deodorized (RBD) palm oil, accounting for 94 percent of the total palm oil processed by biodiesel plants. By the end of December 2013, a total of 54 biodiesel manufacturing licenses with a total annual capacity of 5.93 million tonnes were approved under the "Malaysian Biofuel Industry Act, 2007." From the total, 20 biodiesel plants were in commercial production (since 2006) with a production capacity of 2.65 million tonnes per year. In addition, there were 10 plants with a production capacity of 0.78 million tonnes per year, which have completed construction but have yet to commence production. Only 13 biodiesel plants were active in 2013 and most of the plants were partially operative.

Table A.9.2 Status of Approved Biodiesel Licenses in Malaysia (as of April 2013)

Status	No.	Production Capacity (Mil. Tonnes/Year)
Commercial Production	20	2.65
Completed Construction	10	0.78
Construction, Under Planning / Pre- Construction	24	2.50
Total	54	5.93

Source: Ministry of Plantation Industries & Commodities, Malaysia.

(3) Development Program

The B5 implementation program of Malaysia is a program of utilisation of a mixture of 5 percent palm biodiesel and 95 percent diesel fuel. The first phase of the B5 implementation program started in early 2009 in two selected government departments involving 3,900 vehicles. The expansion was set to occur during June 2011–November 2011. Only retail stations in central regions (Putrajaya, Melaka, Negeri Sembilan, Selangor, and Kuala Lumpur) were subjected to the expansion. In early 2012, the implementation of the B5 program in the Central region was extended to other sectors, such as fleet card, skid tanks, and fisheries. The utilisation of palm biodiesel from January to December 2012 was about 110,000 tonnes. The Malaysian government has funded RM55 million for capital expenditure (CAPEX) to set up in-line blending facilities at six petroleum depots in the Central region. After the complete implementation of B5 in the Central region, the program was expanded to the southern region in July 2013, to the eastern region in

February 2014, and to the northern region in March 2014, which will complete the nationwide implementation by the end of 2014. The annual palm biodiesel demand for the nationwide B5 implementation—covering the transport and industrial sectors for the whole of Malaysia—is estimated at 500,000 tonnes per year. The Economic Council Meeting on 3 December 2012 had made a decision to increase the blend rate to B7 or B10 after the B5 program.

(4) Information on Biofuel RD&D in Malaysia

(4.1) RD&D on Palm Biodiesel

There are two existing methods of producing biodiesel from palm oil in Malaysia. The main existing technology is through transesterification, which produces methyl esters that can be used in compression ignition engines (diesel engines) without any modification. Malaysia produces palm methyl esters (PME) primarily for the export market, although consideration is being given to increasing its use domestically. However, there are still some challenges that must be overcome in order to use PME in cold weather. These relate to the "low pour point" of PME, which means that it only solidifies at cold temperatures. Malaysia has developed its own national biodiesel standards for PME. The standards are likely to follow closely the European Union (EU) and US standards.

The second method is direct blending of straight vegetable oil (SVO) with diesel. In Malaysia, an SVO blend of 5 percent refined palm oil and 95 percent diesel is marketed under the name "Envodiesel." Envodiesel is facing resistance from automobile manufacturers, who are hesitant to extend engine warranties when palm oil rather than methyl ester is used in the blending.

R&D in the palm oil industry is conducted at company level, and by dedicated government agencies, such as the MPOB and universities. The MPOB relies mainly on funds generated through compulsory government taxes on the industry, and government grants. Biodiesel production, RD&D and the commercialisation of new technology have been undertaken by the MPOB, together with the government-owned corporation PETRONAS. In 2004, PETRONAS contributed RM12.0 million to build a pilot plant for biodiesel production.

(4.2) RD&D on Bioethanol

Ethanol for energy use is not currently produced in Malaysia because of the lack of feedstock supply. The R&D on bioethanol in Malaysia is not as active as palm oil-based biodiesel. Specifically, the first-generation bioethanol technology has not prospered. Although the palm oil biomass (trunks, fronds, empty fruit bunch (EFB), shells, roots, and fiber) can produce cellulosic ethanol and the volume is enough as a feedstock for ethanol production, the technology is not yet commercialised. However, R&D on second-generation bioethanol technologies are being promoted aggressively.

(4.3) Development of Second-Generation Biofuel Technologies

The development of second-generation biofuels technology is promoted by a few projects. All of these projects are at the research and development phase and have not reached commercial scale. Some of the projects are based on international cooperation supported by developed countries.

Trend of Biofuel Trade

Malaysia began to export biodiesel in 2006 with 47,987 tonnes. The quantity of export increased to 227,457 tonnes in 2009, but the export volume continued to decline rapidly until 2012. The palm oil biodiesel production has lost out to rival producing countries like Indonesia and Thailand due to weak domestic market and a relatively uncompetitive export tax structure. Export volumes in 2013 rose again to 175,032 tonnes, coupled with widespread adoption of domestic production in the same year. The decline in the international price of palm oil in 2013 led to the decrease in the biodiesel production cost, which relatively improved the competitiveness of biodiesel fuel.

Table A.9.3 Production and Exports of Biodiesel in Malaysia (tones)

	2006. 8-12	2007	2008	2009	2010	2011	2012	2013
Production	54,981	129,715	171,555	222,217	117,173	173,220	249,213	472,129
Export	47,986	95,013	182,108	227,457	89,609	49,999	28,983	175,032

Sources: Malaysia Palm Oil Board (MPOB).

Myanmar

Policies and Programs to Promote the Utilisation of Biofuels

(1)Policy Overview

Despite the abundant fossil fuel resources, Myanmar's energy supply depends heavily on conventional (non-commercial) biomass resources (76%).[39]The Ministry of Energy (MOE) highlights the following items as basic energy policy guidelines: (i) maintain the energy self-sufficiency ratio, (ii) promote the use of renewable energies, (iii) promote the efficient use of energy and the awareness of energy conservation, and (iv) protect forest resources from excessive use for firewood and charcoal.

Different ministries have jurisdiction over renewable energy. The MOE develops comprehensive energy policies (especially policies on the upstream development of oil and gas). The Ministry of Agriculture and Irrigation (MAI) has jurisdiction over biofuels, and the Ministry of Science and Technology and the Ministry of Education have jurisdiction over the R&D of renewable energy.

No comprehensive renewable energy development plan has been formulated yet in Myanmar. As part of rural development, however, many small-scale hydroelectric power generation programs (after 2004), and biogas and biofuel programs (after 2005) have been carried out.

[39] IEA (2013), "Energy Balances of Non-OECD Countries".

(2) Target

The government conducted several test programs to formulate a biofuel standard. It seems that the government is also considering the introduction of E5 (regional level) and E15 (national level, fuel mixture by 15% ethanol and 85% gasoline) for gasoline and B5 to B20 (mix of 20% biodiesel and 80% diesel) for diesel,[40] but details were not available.

Consideration of production and commercialisation of biofuels in Myanmar started only in 2008.[41] As of 2010, Myanmar seemed to have developed a production capacity[42] of 100–200 tonnes/month for jatropha seeds, as raw material for biodiesel, and 10–20 tonnes/month for crude jatropha oil. The production[43] of jatropha in the 2010–2011 crop year was 5,498 tonnes (0.07 tonne/ha).[44]

As of 2010, there were six domestic pilot plants for biodiesel production (production capability of 400 gallons/day). For bioethanol, although the crops that can be used to produce bioethanol such as sugarcane and cassava are planted in large quantities in Myanmar, they are mainly consumed for food rather than for fuel. As of 2009, there were three production plants of dehydrated ethanol and their production capability[45] was estimated to be more than 660,000 litres (2.2 million gallons)/year. In addition, there were five or more 99.5 percent ethanol (for drinking) manufacturing plants.[46]

(3) Development Program

The government of Myanmar implemented a three-year jatropha tree-planting project from 2006 to 2008. However, the cultivation of jatropha failed to be commercialised because of insufficient understanding of planting, harvesting,

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[40] ADB (2012). Fuel produced by blending E5 gasoline base material with 5% of bioethanol. Fuel produced by blending B5 diesel fuel base material with 5% of biodiesel fuel.
[41] Ibid.
[42] Japan Bio-Energy Development Corporation (JBEDC), http://www.jbedc.com/en/index.shtml
[43] From the presentation of Mr. Maung Maung Tar of the Ministry of Agriculture and Irrigation of Myanmar at the 11thAsia Biomass Seminar, July 2011.
[44] The potential oil yield of jatropha is 2.4 tons/ha.
[45] ADB (2012).
[46] From the presentation of Dr. Mya Mya Oo of Yangon Technological University at the 11thAsia Biomass Seminar, July 2011.

oil extraction of jatropha, fuel manufacturing process, marketing, and lack of legislation and standards.[47]

In 2006, the government of Myanmar signed an agreement with a Japanese private company, the Japan Bio-Energy Development Corporation (JBEDC), to build a jatropha fuel supply chain and to implement a biofuel project. In response to this, the government set a target[48] to expand the plantation area of jatropha to 850,000 ha by 2008 and to 4 million ha by 2015. According to the agreement, buying and selling of seeds, oil extraction and purification would be carried out as a joint venture[49] between JBEDC and a local private company, and technology development and guidance, while the improvement of policies, regulations, and standards would be implemented in cooperation with the Ministry of Agriculture and Irrigation.[50] Each public corporation under the Ministry of Agriculture and Irrigation had prepared their own jatropha growing manuals and distributed the manuals to the farmers interested in jatropha planting.[51] JBEDC also held seminars to share information on jatropha planting methods and on how to build the supply chain.

A company from Thailand, the Universal Adsorbents & Chemicals (UAC), announced that they would launch a biofuel plant by 2014 through a joint venture with one of the largest corporate groups in Myanmar[52] using palm oil as raw material. The total investment was expected to be THB800 million (approximately US$27 million). Biofuels were planned to be used for power generation and electricity would be sold to both Myanmar and Thailand.

In April 2013, the Nation First International Development Asia signed a memorandum of understanding with Myanmar's firm, Hisham Koh & Associates, to develop algae farms inland area and around Yangon.[53] Algae are expected to be a profitable source of biofuel or commercial animal feeds for aquaculture and agriculture.

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[47] JBEDC, http://www.jbedc.com/en/index.shtml

[48] Kenji Iiyama (2012) Jatropha: Savior or Mediocrity? *(in Japanese)* https://www.jircas.affrc.go.jp/reports/2011/pdf/s20120321_shiryo.pdf

[49] JBEDC announced the establishment of a joint venture called "Japan-Myanmar Green Energy" on February 27, 2009 with an investment ratio of 60% by JBEDC and 40% by a local company.

[50] JBEDC. http://www.jbedc.com/projects-4.html*(in Japanese)* accessed on January 24, 2013.

[51] Ibid.

[52] Myanmar Business Network (2012).

[53] *Myanmar Times*, 'The rise, fall and rebirth of biofuels in Myanmar', 26 August 2013.

(4) Information on Biofuels RD&D in Myanmar

In Myanmar, the following R&D activities on biofuels are being implemented:[54]

-Technology development to increase jatropha seed yield and oil quantity,

- Improvement of the method for producing biodiesel, and

- Technology development of cellulosic and lignocellulosic ethanol (second generation).

(5) Way Forward[55]

It will be challenging for Myanmar to deal with the following issues to promote the use of biofuels:

- Improve the energy balance for biofuels (energy embedded in the fuel plus the energy required to produce and deliver it).

- Technology development of ethanol from cellulose and lignocellulose (second- and third-generation ethanol).

- Promote biofuel development to help mitigate rural poverty.

    -Encourage trade and investment.

    -Government support for the use of biofuel.

Trend of Biofuels Trade in Myanmar

It seems that jatropha seeds, a raw material for biodiesel, have been exported since 2009, but details such as trade volumes are not clear. JBEDC exported 400 tonnes of jatropha seeds from Myanmar in 2009 and 1,000 litres of crude jatropha oil to Japan for the first time in 2010.[56]

[54] Mr. Maung Maung Tar, op.cit., and Dr. Mya Mya Oo, op.cit.
[55] Ibid.
[56] JBEDC http://www.jbedc.com/index.shtml *(in Japanese)* (accessed January 24, 2013).

Myanmar's tariff system [57]

(1) Taxable objects

For all import items, the tax base is the import cargo Common Intermediate Format (CIF) price plus 0.5 percent. However, some items are tax-exempt. Imports of raw materials that are recognised as materials for contract manufacturing by the Myanmar Investment Committee (MIC) or other related government agency, or import items related to investments approved by the MIC, are eligible for exemption from tariffs.

(2) Tariff rate

In Myanmar, the tariff rate could change arbitrarily, but the customs schedule is not updated accordingly. As a result, the latest tariff rates of individual items are not known (one is required to confirm for each case). The latest customs schedule available was issued in January 2012.

New Zealand

Policies and Programs to Promote the Utilisation of Biofuels

(1) Policy Overview

In the "New Zealand Energy Strategy, 2011–2021 (NZES)" and "New Zealand Energy Efficiency and Conservation Strategy, 2011–2016 (NZEECS)" published in August 2011, the New Zealand government aims to reduce greenhouse gas emissions by 10–20 percent from the 1990 level by 2020, and by 50 percent from the 1990 level by 2050. For the transport sector, the government looks to marketing highly energy-efficient light vehicles improved from the 2010 level by 2016. One of the measures is to develop sustainable alternative fuel, but no specific numerical target has been indicated. The government sets a target of 90 percent of electricity generated

[57] Japan External Trade Organization (JETRO), Myanmar/Investment system http://www.jetro.go.jp/world/asia/mm/trade_03/ *(in Japanese)* (accessed January 24, 2013).

from renewable resources by 2025. In New Zealand, renewable energy accounts for about 40 percent of total primary energy demand, which indicates a substantial share among the developed countries.

The New Zealand government aims to expand biofuels utilisation. The Biofuel Act enacted in 2008 obligates the oil companies to supply biofuel: diesel with mixed 5 percent biodiesel, gasoline with mixed 3–10 percent bioethanol.

Table A.11.1 Biofuel Production/Utilisation

Biofuel	**Production/Utilisation**
Biodiesel	Feedstock is tallow, the animal fat by-product produced at meat processing facility, waste food oil, and rapeseed. Companies are marketing a 5% blend
Bioethanol	Feedstock is whey, a by-product of the milk processing industry Bioethanol is imported from Brazil Compan ies are marketing a 3%–10% blend as a premium product

Source: Asia Biomass Office (2013).

(2) Target

In New Zealand, raw materials used for bioethanol production include whey, which is a by-product of dairy farming. Bioethanol is also produced from sugarcane imported from Brazil. Materials used for biodiesel production include tallow, rapeseed, and used cooking oil. Whey, tallow, and used cooking oil are by-products of other industries, and rapeseed is planted as an intercrop to improve the soil condition of grain fields.

Table A.11.2 Major Biofuel Manufacturing Plants in New Zealand

Company	Biofuel	Feedstock	Capacity (kL/year)
Anchor Ethanol	Bioethanol	Whey	15000~20000
BioDiesel	Biodiesel	Tallow	40000
Ecodiesel	Biodiesel	Tallow	20000
Biodiesel New Zealand	Biodiesel	Waste oil, Rapeseed	4000
Floooooo-Dry Engineering	Biodiesel	Tallow	4000
New Zealand Easter Fuels	Biodiesel	Waste oil, Rapeseed	2000
Environfuel	Biodiesel	Waste oil	na
Kiwifuels	Biodiesel	Rapeseed	na

Source: USDA Gain Report (2010).

Table A.11.3 Transition of Biofuel Production Volume in New Zealand

Calendar Year	Biodiesel		Bioethanol		Total	
	million L	PJ	million L	PJ	million L	PJ
2007	1.20	0.04	0.30	0.01	1.50	0.05
2008	1.20	0.04	2.00	0.05	3.20	0.09
2009	1.07	0.04	3.70	0.09	4.77	0.12
2010	1.61	0.06	4.21	0.10	5.82	0.15
2011	2.35	0.08	4.81	0.11	7.16	0.19

Source: Ministry of Economic Development, New Zealand (2012).

According to the *New Zealand's Energy Outlook 2011* released by the Ministry of Economic Development, biofuels are projected to account for 8.5 percent of the total primary energy demand in 2030.

Table A.11.4 Energy Outlook in 2030 (Base Case)

		2010		**2030**	
		TPED (PJ)	**Share (%)**	**TPED (PJ)**	**Share (%)**
Fossil Fuel	Oil	274.0	33.5	315.4	29.8
	Natural Gas	173.4	21.2	167.4	15.8
	Coal	57.9	7.1	49.0	4.6
Renewable Energy	Hydro	89.0	10.9	96.9	9.2
	Geothermal	152.6	18.7	321.3	30.3
	Biofuel	62.5	7.7	90.2	8.5

	Others	6.3	0.8	16.6	1.6
Others	Waste heat	1.3	0.2	2.1	0.2
Total		816.9	100.0	1,058.9	100.0

Note: TPED = total primary energy demand, PJ = petajoules.
Source: Ministry of Economic Development, New Zealand (2012).

(3) Development Program

(3.1) Standards for automotive fuel

The latest quality standards for automotive fuel, "Engine Fuel Specification Regulation 2011", prescribe the following specifications of bioethanol and biodiesel at gas stations:

- Bioethanol: Up to 10 percent gasoline capacity (E10)
- Biodiesel: Up to 5 percent of diesel capacity (B5)

(3.2) Biofuels Sales Obligation

Target: By the end of 2012, 3.4 percent of the total annual sales of gasoline and diesel need to be biofuels.

Application period: April 2008 to December 2012

Support: Excise tax of NZ$0.505/litre is exempted for the use of bioethanol.

(3.3) Biodiesel Grants Scheme

Target: Diffusion of biodiesel use

Application period: Three years from July 2009 (completed in June 2012)

Support: Subsidy of NZ$0.425/litre for biodiesel, NZ$36 million in three years.

(4) Information on Biofuel RD&D in New Zealand

In New Zealand, it is becoming increasingly evident that liquid fuels from woody biomass could contribute to meeting future demand for sustainable transport fuels. Several new technologies are currently under development.

Three crown research institutes, the Institute of Geological and Nuclear Science (GNS), AgReserch, and Scionare members of the New Zealand Renewable Energy Transformation Research Science and Technology group. This group is sponsored by the Ministry of Research Science and Technology to accelerate the R&D efforts on renewable energy technologies and their integration into the New Zealand energy system.

In August 2010, the "New Zealand Bioenergy Strategy" was published by the Bioenergy Association of New Zealand (BANZ) and the Forest Owners Association (NZFOA. The strategy identifies bioenergy as potentially supplying more than 25 percent of New Zealand's projected energy needs by 2040, including 30 percent of the country's transport fuel.

(5) Way Forward

In 2008, a Biofuels Sales Obligation system was put in place but was recently abolished. The Biodiesel Grant Scheme was implemented in July 2009 to encourage domestic biofuels production, but was also removed. As commercialisation of demonstration projects takes time, 5–10 years, it implies that a long-term policy is necessary in order to make projects viable.

Trend of Biofuels Trade in New Zealand

An estimated 7 million litres (ML) of liquid biofuel was produced in 2011, a 22 percent increase from 2010. For comparison, imports of bioethanol were 1.18 ML in 2010 and 2.22 ML in 2011.Table 1.11-5 shows the taxes imposed on automobile fuels in New Zealand. Imported biofuels are dealt with in the same way.

Table A.11.5 List of Taxes on Automobile Fuels in New Zealand (After August 2012)

NZ ¢ /L

	A	B	C	D	Total
Gasoline	50.524	9.9	0.045	0.66	61.129
Biogasoline	0	9.9	0.045	0.66	10.605
Diesel	0	0	0.045	0.33	0.375
Biodiesel	0	0	0.045	0.33	0.375

Note : A ：Excise Duty on Motor Spirits
B ：Accident Compensation Corporation Levy
C ：Petroleum or Engine Fuel Monitoring Levy
D ：Local Authorities Fuel Tax

Source: Ministry of Business, Innovation, and Employment, Government of New Zealand (2012).

The excise duty on diesel (biodiesel included) is exempted because the road user charges are imposed on diesel cars. In addition, 15 percent goods and services tax (GTS) is imposed on automobile fuels across the board (commercial vehicles exempted).

Philippines

Policies and Programs to Promote the Utilisation of Biofuels

(1) Policy Overview

The following table provides the list of agencies in the Philippines responsible for implementing the biofuel program:

Table A.12.1 List of Agencies and their Responsibility in the Philippine Biofuel Program

Institutional	Policy Formulation & Dissemination	Feedstock Production & Extension	Research, Development & Deployment	Investments, Incentives, & Promotions	Standards & Quality Assurance
Department of Energy (DOE)	■		■		■
National Biofuel Board (NBB)	■				
Department of Agriculture (DA)	■	■	■	■	■
Sugar Regulatory Administration (SRA)	■	■	■	■	■
Philippine Coconut Authority (PCA)	■	■	■	■	■
Department of Science and Technology (DOST)	■		■		
Philippine Council for Industry and Energy Research and Development (PCIERD)			■		
Department of Labor and Employment (DOLE)				■	
Department of Environment and Natural Resources (DENR)		■			■
Department of Interior and Local Government (DILG)		■		■	
Department of Agrarian Reforms (DAR)		■			
Board of Investments (BOI)				■	
Department of Trade and Industry (DTI)				■	■
Tariff Commission				■	
Department of Transportation and Communications (DOTC)	■		■		
National Power Corporation (NPC)	■		■		■
Philippine National Oil Company-Alternative Fuels Corporation (PAFC)		■			
Academe		■	■		
Independent Power Producers (IPPs)			■		■
Philippine Economic Zone Authority (PEZA)				■	
Department of Finance (DOF)				■	
National Development Company (NDC)				■	
Government Financial Institutions (GFIs)				■	

Source: Compiled by the authors.

In January 2007, the Philippine government ratified the Biofuels Act of 2006 (RA 9367).[58] The law mandates a minimum of 1 percent biodiesel blend into all diesel fuels within three months following the implementation of the law. In February 2009, it mandated a 2 percent blend of biodiesel, while the bioethanol mandate was a minimum of 5 percent bioethanol fuel blend. In 2011, the government postponed for six months the mandate for raising bioethanol to 10 percent.

To encourage investments in the biofuels industry, RA 9367 provides the following incentives:

- Zero specific tax per litre on local and imported biofuels.

- The sale of raw materials used in the production of biofuels shall be value-added tax (VAT).

- All water effluents considered as “re-useable” are exempt from wastewater charges.

- Government financial institutions shall, in accordance with their respective charters or applicable laws, accord high priority to extend financial support.

In December 2008, the Republic Act 9513 (RA 9513) (or the Renewable Energy Act of 2008) was adopted. RA 9513 sets the framework for the development, utilisation, and commercialisation of renewable energy (RE).

[58] See http://www.doe.gov.ph/AF/BioethanolPolicies.htm

RA 9513 also provides additional incentives for biofuel developers. Incentives for renewable energy projects and activities are as follows:

- Special Realty Tax Rates on equipment and machinery, civil works, and other improvements.

- Corporate tax rates of 10 percent on its net taxable income.

- Net operating loss carryover (NOLCO).

- Income tax holiday (ITH) during the first seven years of commercial operation for renewable energy developers.

- Accelerated depreciation if an RE fails to receive an ITH before full operation.

- Cash incentive of RE developers for missionary electrification.

- Tax exemption of carbon credits.

- Tax credits on domestic capital equipment.

- Duty-free importation of RE machinery equipment and materials.

Bioethanol feedstock used in the Philippines or being considered includes sugarcane, corn, cassava, and nipah.[59] Philippines bioethanol production remains to be based on sugarcane and molasses. As in other ASEAN countries, the first-generation technology is still widely used to produce bioethanol in the Philippines.

The Philippines currently produces biodiesel from coconut oil (CNO) called coco methyl ester (CME) and is expanding jatropha production. CME derived from CNO is the feedstock currently used in the Philippines for biodiesel production.

To ensure the sustainability of the biodiesel program, the government is presently studying other feedstocks such as jatropha or "tuba-tuba" as a potential source for local biodiesel production.

[59] See http://bioenergywiki.net/The_Philippines

(2) Target

The Department of Energy (DOE) of the Philippines is responsible for the Philippine Biofuels Program. The DOE's energy strategy for the country is outlined in the *Philippine Energy Plan, 2012–2030* (PEP 2012-30) and the *National Biofuels Plan* (NBP 2013-2030). The PEP is a plan for the country's whole energy sector while the NBP is a preliminary assessment of the previous NBP 2007–2012 and outlines the country's short-, medium-, and long-term biofuels plans set by the National Biofuels Board (NBB) chaired by the DOE.

Table A.12.2 Targeted Biofuels Blend of the Philippines

	2013~ 2015	2016	2020	2025	2030
Bioethanol	E10	E10	E20	E20	E20/E80
Biodiesel	B2 to B5	B5	B10	B20	B20

Source: Second Working Group Meeting at Tokyo, May 2014.

The NBB endorsed while the DOE approved the 10 percent ethanol mandated blend, but ethanol producers and oil companies were given a transition period of six months to attend to distribution and logistics infrastructure concerns. The E10 blend has been fully implemented since August 2011 and ethanol import is allowed to cover local production deficits through August 2015. At the time of this study, an estimated 90 percent of all local gasoline sold is E10.[60]

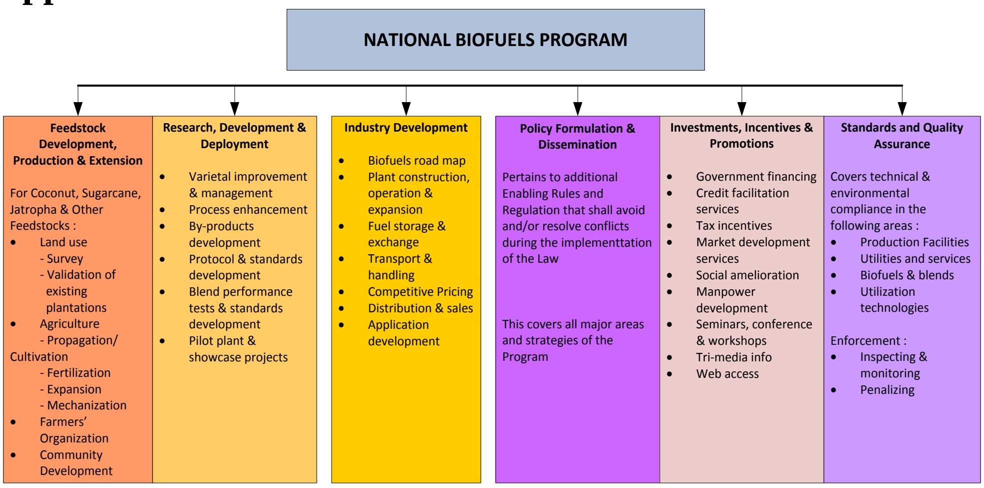
The 1 percent biodiesel blend mandate became effective on May 6, 2007 and the blending rate was increased to 2 percent on February 6, 2009. The biodiesel blend mandate is still at 2 percent, however, the DOE through the NBB will conduct further public consultations to determine the feasibility of further increasing the current biodiesel blend. The NBB is planning to increase biodiesel blend rate from 2 percent to 5 percent.

[60] USDA GAIN Report. (2013b)

(3) Development Program

In accordance with the "National Alternative Fuels Program Framework" and in consideration of the requirements of the Philippine Biofuels Road Map, the National Biofuels Program will help develop and utilise biofuels as an alternative to petroleum fuels. The framework of the national biofuels program development is summarised as follows:

Figure A.12.1 Framework of National Biofuels Program Development in the Philippines



Source: Department of Agriculture, Philippines, Biofuels Feedstock Program (undated).

(4) Information on Biofuel RD&D in the Philippines

In the Philippines, the development of alternative energy sources and innovative energy technologies using non-fossil-based energy resources, with emphasis on biofuels technology development, was initiated in the 1970s. Science and technology interventions for biofuels were geared toward the utilisation of indigenous feedstocks as alternative fuel substitutes. The Department of Science and Technology (DOST) supported and implemented research on the use of indigenous materials, such as coco-methyl ester for biodiesel and bioethanol-based fuel from sugarcane.

Evaluation of vehicle performance using alternative fuel substitutes were conducted using different biofuel blends. Both the government and private institutions such as DOST, Industrial Technology Development Institute

(ITDI), Philippine Coconut Authority (PCA), National Power Corporation (NPC), Philippine National Oil Company–Energy Research and Development Center (PNOC-ERDC), and Philippines Coconut Research Development Foundation (PCRDF) had initiated such studies on fuel application.

In 2007, R&D efforts on biofuel feedstock alternatives were undertaken at the UPLB. The study focused on the use of biodiesel derived from jatropha, and bioethanol from cassava and sweet sorghum. Second- and third-generation biofuel researches are new fields of study in the Philippines, and the current focus for ethanol is on pre-treatment of cellulosic materials, C-5 sugar fermentation, and low ethanol evaporation. There are ongoing research and development efforts on the use of sweet sorghum and cassava as alternative ethanol feedstocks. The University of Philippines at Visayas and Los Baños (UPV/UPLB) have also initiated studies on the viability of marine and freshwater micro algae and seaweed as potential biodiesel feedstock. The DOST-Philippine Council for Aquatic and Marine Research and Development (PCAMRD) monitors both these projects.

Advanced biodiesel research is currently focused on expanding jatropha. The DOST undertook a pilot project on the production and testing of biodiesel from jatropha from January 2007 until December 2011. The Philippine Council for Industry and Energy Research and Development (PCIERD) monitored this project. The UPLB also conducted an integrated RD&D program on jatropha, including germplasm management, varietal improvement, seed technology, and farming systems model development. Besides jatropha, there is a tree in the Philippines that can yield "petroleum" in five years. The tree is known as petroleum nut (*Pittosporum resineferum*) and is endemic in the northern Philippines. The tree is being mass-reared by Dr. Michael A. Bengwayan, an environmentalist who heads the Cordillera Ecological Center known as PINE TREE. This tree is the country's most promising biofuel treasure and perhaps, the best in the world. It has an octane rating of 54, which is higher than that of jatropha that has a rating of 41. It can totally replace liquefied petroleum gas (LPG) for cooking and lighting and it can run engines. PINE TREE has already produced thousands of seedlings and is training farmers on how to plant the trees.

(5) Way Forward

Though there are enough feedstocks for biodiesel production to meet domestic demand at present, with the rapid growth of its population, coconut consumption for food is expected to increase accordingly. As a result, the availability of coconut for biodiesel production is supposed to suffer a decline if there is no significant increase in total coconut production. Thus, attention is needed on how to increase and diversify the feedstock for biodiesel production. The issue on how to expand domestic feedstock supply and domestic production of bioethanol also needs to be addressed since the country has already been confronted with a shortage of bioethanol supply.

To promote the domestic development of the biofuel industry along the whole supply chain, support for infrastructure improvement such as farm-to-market roads, ports, terminals, and others are also needed.

Trend of Biofuels Trade in the Philippines[61]

Ethanol falls under the Harmonised Commodity Description and Coding System (HS) 2207.20.11 or Ethyl Alcohol Strength by Volume of Exceeding 99 percent, according to the Philippine Tariff Commission. There are no entries under HS 2207.20.11 in the Global Trade Atlas (GTA). However, the figures in the trade matrix represent imports under the general heading for alcohol of any strength (HS 2207.20).

Executive Order No. 61 signed in October 2011 modified tariffs for various products. Ethanol’s Most Favoured Nation (MFN) tariffs were left unchanged at 10 percent, and will remain at this level through 2015. However, ethanol imports will be subject to a 1 percent MFN tariff if certified by the DOE that the imported ethanol will be used for fuel-blending purposes. If originating from ASEAN-member countries (i.e., Cambodia, Lao PDR, and Malaysia), ethanol imports will be levied a 5 percent duty.

[61] USDA Global Agriculture Information Network (GAIN) Report (2012).

Table A.12.3 Ethanol Import of the Philippines (million L)

Country of Origin	2011	2012
Singapore	17.8	23.0
Philippines (Subic)	67.3	93.0
Indonesia	3.2	-
USA	56.1	6.9
Vietnam	9.8	6.2
Korea	36.3	3.5
Australia	-	27.1
Thailand	24.4	88.8
Total	215.0	248.4

Source: Quoted from the USDA, *Philippine Biofuels Situation and Outlook*, 7/10/2013; Original data from the Philippine's Department of Energy as provided by the Sugar Regulatory Administration.

Chemrez Inc. had exported 500,000 litres of coconut-based biodiesel to Germany and to Asian markets including China, Chinese Taipei, South Korea, and Malaysia. Currently there is no coco methyl ester (CME) import for fuel use. However, if the government raises the biodiesel blend rate to 5 percent, there might be a need for biodiesel (not necessarily produced from CME) import to meet the regulation.

Singapore

Policies and Programs to Promote the Utilisation of Biofuels

(1) Policy Overview

Energy security is an extremely significant issue for Singapore because almost all the country's energy supply depends on import. In November 2007, the Ministry of Trade and Industry (MTI), Energy Market Authority (EMA), Economic Development Board, and the Ministry of the Environment and Water Resources (MEWR) jointly drafted a national energy strategy called "Energy for Growth." Basically, it includes the following six parts: (i) promotion of market competition, (ii) diversification of energy supply, (iii) enhancement of international cooperation, (iv) government-wide approach, (v) improvement of energy conservation, and (vi) R&D in the energy field and promotion of the energy industry. Based on these six strategies, the government aims to strengthen its position as Asia's no. 1 hub city of oil, to expand the scope of energy trade to liquefied natural gas (LNG), biofuels, and CO_2 emission credits, and to enhance the development of clean and renewable energies including solar energy, bioenergy, and fuel cells.[62] As part of the policy, the government developed a comprehensive policy[63] for the clean energy industry worth S$350 million in 2007. Clean energy industry is perceived as one of the strategic fields of the country's economic growth.

Energy administration in Singapore is implemented by multiple governmental ministries and agencies. The National Climate Change Committee (NCCC) is in charge of renewable energy which is part of energy conservation and environmental measures, while measures and supports are carried out by the National Environment Agency (NEA). Due to the increase in global renewable energy demand, the government is putting more weight on attracting renewable energy processing and manufacturing industries into the country. The Energy Innovation Program Office (EIPO)[64] is responsible for implementing this strategy. As a goal by 2015, the EIPO aims to create S$1.7 billion added value and employment for 7,000 skilled workers in the clean energy field. Specifically, the government intends to turn Singapore into a production and development centre[65] for the renewable energy industry and an export base for products and facilities.

With the completion of a biodiesel plant in Tuas on Jurong island, the government is considering to establish a worldwide biofuel terminal on Jurong island, which is currently a petrochemical hub.

There are few feedstocks (raw materials) for biofuel production in Singapore. Taking advantage of its geographic location and investment environment, Singapore is aiming to attract biofuel purification and processing investment from overseas. Most of the manufactured biofuels (diesel) are exported to the European Union and the United States, and they are domestically supplied only through two companies,[66] Fuelogical and Alpha Biofuels. Major raw materials used for biodiesel production are palm oil[67] from Malaysia and Indonesia, and waste oil and animal fats (tallow) from the food industry. Jatropha and microalgae have also been used.

[62] Ministry of Trade and Industry, Singapore (2007).
[63] Japan Petroleum Energy Center (2011a).
[64] Formerly called "CEPO: Clean Energy Program Office", set up in 2007.
[65] Ministry of Trade and Industry Singapore.
[66] Eco-Business.com, dated Jun. 7, 2010.
[67] Singaporean capital Temasek Group and Wilmar Group are financial cliques owning huge palm oil plantations in Malaysia and Indonesia and are instrumental in promoting the biofuel industry.

(2) Target

In Singapore, there is no plan to enact new standards for biofuels (diesel) in the near future. Meanwhile, to raise the emission control standards, the NEA announced[68] that the standards for automobile gasoline and diesel will comply with EuroIV and EuroV, respectively, (currently Euro II for gasoline and Euro IV [already adopted since 2006] for diesel) by January 2014 (detailed schedule undecided). The NEA says that the use of biofuels will be permitted if the automobile fuel emission standards are met. Production of biodiesel was expected to reach 3 million tonnes/year[69] by 2015 according to an estimate made by the Singapore Economic Development Board as of October 2007.

The NEA has set several goals to prevent air pollution: (i) maintain 85 percent "good" level and 15 percent "medium" level in terms of the Pollutant Standards Index (PSI), (ii) lower the annual average particulate matter (PM) level to 12µg/m^3 or less by 2020 and maintain this level until 2030, and (iii) maintain the annual average SO_2 level at 15µg/m^3 until 2030.[70]

In the downstream market, nine companies including Daimler Chrysler and Shell Eastern Petroleum have started a test project since 2007. The project use commercially available diesel cars to test the blending of biofuel.

As of the end of 2011, there were six biodiesel purification plants with a total capability of 1.3 million tonnes/year. As of 2010, biodiesel had been sold at eight gas stations on Jurong island.[71] Under the abovementioned biofuel test project, 13 diesel cars used B5 during the period Dec. 2007–Dec. 2009. Because of financial trouble caused by a price hike of palm oil, two companies—Australian Natural Fuel and German Peter Cremaer— have withdrawn from the production of biodiesel.[72]

[68] Eco-Business, dated Aug. 9, 2012.
[69]Asia Pacific Economic Cooperation (APEC) Biofuels.
[70]National Environment Agency of Singapore. http://app2.nea.gov.sg/anti-pollution-radiation-protection/air-pollution-control#aqt (accessed January 31, 2013).
[71] Eco-Business (2010).
[72] AsiaX, dated Feb. 11, 2011.

Table A.13.1 Capabilities of Biodiesel Purification Plants in Singapore

Company	Country	Capacity(tonne/year)	Operating Condition
Nature Fuel	Australia	600,000	Closed in 2009; Plan of expansion to 1.8 million tonne/year failed; No details cleared
Peter Cremer GmbH	Germany	200,000	Sold to Stepan Company based in the US (a major global supplier of surfactant technologies)
Neste Oil	Finland	800,000	November 2010-
ADM, Wilmar	US/Singapore	300,000	July 2007-
Continental Bioenergy	Singapore	150,000	September 2006-
Biofuel Research	Singapore	18,000	June 2003-
Fuelogical	Singapore	15,000	October 2010-
Alpha BIofuels	Singapore	2,000	September 2010-

Source: Prepared by the authors based on various documents.

(3) Development Program[73]

The Clean Energy Research Program (CERP)[74]is a comprehensive support program designed to financially support both basic research and applied research on innovative ideas about new processes, technology, and products that have commercial potential. The program covers corporations, research institutes, and higher education institutions based in Singapore, subsidising all the R&D expenses for public organisations and up to 70 percent of the expense for private corporations.

(4) Information on Biofuel RD&D in Singapore

At the time of this study, research institutes were working on second- and third-generation biofuels development in Singapore. These include the Temasek Life Science Laboratory (TLL), the Institute of Chemical and Engineering, and the Institute of Environmental Science & Engineering. TLL, jointly with Indian Tata Chemicals Biofuel Research and cooperating with Chinese scientists[75], have been developing jatropha as a raw material for biodiesel.

In May 2012, in order to produce high-quality biofuels used in automobiles, aircrafts, and power plants, the JOil (Singapore) Pte. Ltd. (JOil)[76], a bioenergy company in Singapore, announced the launching and development of the first commercial plant for genetically modified jatropha.[77] According to JOil, the company would use a 1.4-hectare farm in Singapore to experimentally produce genetically modified jatropha, which contains oil with an oleic acid content of over 75 percent as oleic acid is the fatty acid portion of the oil from the plant's seeds that contributes to the consistency and stability required for biofuels. Project cost is estimated to be approximately S$1 million. The

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[73] JETRO Singapore.

[74] The application period for proposal expired in January 2008 https://rita.nrf.gov.sg/cerp/Guidelines%20and%20Templates/CERP_Guidelines%20for%20Submission.pdf (accessed on January 31, 2013)

[75] Eco-Business (2011a).

[76] 100% parent company of TLL; Japanese Toyota Tsusho Corporation has taken a stake in this project.

[77] Eco-Business (2012).

launching of this project required an approval from the Genetic Modification Advisory Committee.

In September 2013, the Singapore Airlines （SIA） and Civil Aviation Authority of Singapore (CAAS) revealed that they would jointly conduct feasibility study of airlines using biofuels instead of jet fuel to reduce greenhouse gas emissions.[78] They will look into biofuels used in aviation, which are typically extracted from plant sources that are not used in food, such as algae. The details including cost were not clear.

In September 2013, Concord Energy[79] and Cool Planet Energy Systems[80] signed an agreement to establish a joint venture in the Asia-Pacific Region that will develop commercial production facilities for the conversion of nonfood biomass into biofuels and soil-enhancing biochar.[81] Concord Energy believed that Cool Planet had developed a unique technology, which will revolutionise the production of biofuels. Cool Planet chose Concord Energy because the latter has the technological capability to deploy quickly the former’s technology in East Asia and Oceania.

In February 2014, the Westin Singapore Hotel announced a pilot program, the Green Luxury project, under which waste cooking oil from its kitchens is converted into the biodiesel used to power its Jaguar limousines in collaboration with local renewable energy enterprise, the Alpha Biofuels.[82] Biodiesel accounts for 7 percent of the fuel mix and it is expected to reduce carbon gas emissions by 65 percent.

(5) Way Forward

To promote future the introduction of biofuels in Singapore, it is necessary to consider the following issues: (i) introduction of carbon tax, etc. on the use of fossil fuels; and (ii) demonstration of the possibility of producing high-value-added petrochemical products and polymers from raw materials for biofuels,

[78] Eco-Business (2013), ‘CAAS, SIA to study alternative fuel use’, September 6.

[79] Concord Energy is one of Singapore’s leading crude oil and refined petroleum product trading companies, with businesses in Asia, Middle East, Europe, and North and West Africa.

[80] Cool Planet is deploying disruptive technology through capital-efficient, small-scale bio-refineries to economically convert nonfood biomass into high-octane, drop-in biofuels. Investors include BP, Google Ventures, Energy Technology Ventures (GE、 ConocoPhillips、 NRG Energy), and others.

[81] Biofuelsdigest, September 25, 2013

[82] Channel NewsAsia, February 6, 2014

and the expansion of production scale from laboratory level to commercial level.[83]

Trend of Biofuels Trade in Singapore

Singapore's tariff system[84] is a multiple tax system consisting of two types of tariffs—general and preferential. General tariffs are imposed on only six items, such as beers and medicinal liquors. However, preferential tariffs, theoretically zero, are applied to the FTA signatory countries. General tariffs refer to the customs duty.

Preferential tariffs

Preferential tariffs are applied to imports and exports with the signatory countries under (i) ASEAN Trade in Goods Agreement (ATIGA), (ii) Free Trade Agreement (FTA), (iii) Generalized System of Preferences (GSP), (iv) Commonwealth Preferences (CP) System, and (v) Global System of Trade Preferences (GSTP). The effects of import expansion by the application of the preferential tariffs are limited because the customs duty is imposed on only six items in Singapore, but they contribute to the promotion of exports. Excise duty imposed on some items is not included in the preferential tariff system.

After 1999, Singapore has enhanced its initiatives on FTA negotiations on both bilateral and multilateral basis. The FTAs have already been signed with New Zealand; Japan; European Free Trade Association or EFTA comprising Iceland, Liechtenstein, Norway, Switzerland; Australia; the United States; India; Jordan; South Korea; China; Panama; and Peru. Negotiations are now underway with Canada, Mexico, Pakistan, Ukraine, the European Union, and Taiwan.

Other taxes besides the customs duty include the excise duty. A specific duty system is applied to petroleum products (gasoline) (7 items) as follows:

[83] Eco-Business (2011b).
[84] JETRO Singapore.

a. Lead-free gasoline: S$3.7 to S$4.4/10 litres.

b. Leaded gasoline: S$6.3 to S$7.1/10 litres.

c. Natural gas use as automobile fuel: S$0.20/1 kg.

Industrial Exemption Factory Scheme

If an industrial exemption factory certificate is obtained under this system, a factory using or processing the target items of the excise duty—such as alcohol products and petroleum products as raw materials—is exempted from the excise duty. The relevant raw materials must not be resold, transferred, or disposed without permission of the Singapore customs, and their accurate inventory records must be held. In issuing the industrial exemption factory certificate, a fee of S$225 is charged per issue.

South Korea

Policies and Programs to Promote the Utilisation of Biofuels

(1) Policy Overview

The fundamental policy for biofuels in South Korea is the "2nd Biodiesel Long-Term Supply Plan", which was released in 2010. Basically, biodiesel had been commercialised through a pilot test whereas bioethanol is still being reviewed and not yet commercialised.

(1.1) Background for introducing biodiesel

(a) Necessity for introducing biodiesel

- For energy diversification, coping up with an oil crisis, and improving environmental conditions

- There is an increasing interest in biodiesel in the EU and the US since the early 1990s.

(b) Fixing biodiesel long-term supply plan (the first plan was released in 2006)

- The blending rate of biodiesel had been increased since 2007 at the rate of 0.5 percent per year.

Table A.14.1 Blending Rate of Biodiesel in South Korea

Year	2007	2008	2009	2010	2011	2012
Blending rate of biodiesel	0.5%	1.0%	1.5%	2.0%	2.0%	2.0%

Note: Originally, the ratio was planned to be expanded to 3.0% by 2012, but as of the end of 2013, it remains at 2.0% due to the limited success of the expansion strategy.
Source: Japan Petroleum Energy Center (2011b).

- There has also been an exemption from petroleum tax for biodiesel.

(1.2) The 1st biodiesel long-term supply plan

(a) Biodiesel supply: The amount of supply increased gradually in accordance with the 1st biodiesel long-term supply plan (since 2006)

- BD5 was supplied universally in accordance with a voluntary agreement between the government of South Korea and four petroleum companies.

- BD20 was supplied restrictively in designated stations and its main use was limited to public transport.

(b) Outcome/effect of the plan for expanding biodiesel

- Tax incentive system

- Tax exemption on biodiesel amounted to K310 billion (from 2007 to 2010)
- Procuring raw materials

- Encouraged the collection of used cooking oil as raw materials for biodiesel and the recycling of resources.
-Developed foreign plantations of crop feedstocks, such as jatropha

(1.3) Summary of current biodiesel policy

The blending of biodiesel was based on a government notification and a voluntary agreement between biodiesel manufacturers and petroleum companies and was not based on legislation.

Table A.14.2 Government's Notifications on the Use of Biodiesel in South Korea

	Notification for the pilot project	**Notification for commercialisation**
Period	May 2002–December 2005	From January 2006
Contents of biodiesel	BD20	BD5, BD20
Selling channel	Biodiesel manufacturer -> Oil station	- BD5 : Biodiesel manufacturer -> Oil company - BD20 : Biodiesel manufacturer -> Bus, truck with own facilities
Supply region	Capital areas (Seoul, Kyunggi, Incheon) and Jeonbuk province	Whole country
Vehicle	General diesel vehicle	- BD5 : General diesel vehicle - BD20 : Bus, truck

Source: Prepared by the author based on various documents.

(2) Target

The fundamental energy policy directions are provided in the "1st National Energy Fundamental Plan" where it was announced that the target of new renewable energy would be 11 percent. (This proportion was actually 2 percent in 2006. This rate is considered to be low compared to the average rate for an OECD country).

To realise the target, it is necessary to expand financial resources for new and renewable energy and to strengthen the development and use of bioenergy and waste energy. The policy is supported by increasing blending rate of biodiesel and bioethanol, improving domestic feedstock of biomaterials, and promoting foreign plantations. One of the methods considered in developing a cogeneration plant is to effectively utilise household and livestock wastes.

(3) Development Program

The basic strategy for biofuel utilisation are discussed below:

(3.1) In view of the present condition of raw material supply, the blending rate of biodiesel is maintained at 2.0 percent.

- In spite of the expansion strategy for biofuels by the government, the private sector companies have not been competitive due to unfavourable circumstances. Actually, there has been a slowdown in the growth of these companies.
- After reinforcing the R&D innovation strategy, the government will try to raise the blending rate of biodiesel. Instead of a tax incentive policy, which expired at the end of 2011and had brought about the loss of competitiveness in the biodiesel industry, the Renewable Fuel Standard (RFS) was reviewed and will be introduced.
- In this regard, there was a public hearing on the RFS to gather opinion from stakeholders like K-Petro, petroleum companies, and from the associations of the bioenergy industry and the vehicle industry.
- Based on the RFS, blending of biodiesel will become mandatory through a legislation and there is possibility for adding both bioethanol and biogas as well.

(3.2) The biofuel industry will be promoted as a new growth engine by developing foreign plantations and making use of various types of materials.

(4) Information on Biofuel RD&D in South Korea

The first generation of biodiesel in South Korea was dependent on food and about 75–80 percent of the raw materials used in the country was imported. For this reason, South Korea is vulnerable to rising international price of foods and insufficient supply structure.

Under these circumstances, the government aims to strengthen the technology of producing biodiesel and to diversify raw materials. To achieve this, the government will focus on improvements in plant breeding and the development of next-generation technology. The government will pay attention to the development of marine algae, which can be utilised domestically.

(5) Way Forward

(5.1) Problem of maintaining price competitiveness

- Substantial increases in biodiesel price as compared to diesel oil

- Difficulties with stable supply without tax incentive or utilising obligation

(5.2) Problem with feedstock

- Dependence on the materials like palm oil or soybean, which could risk food security.

- High dependence on imports of feedstock, which could be as high as 75–80 percent.

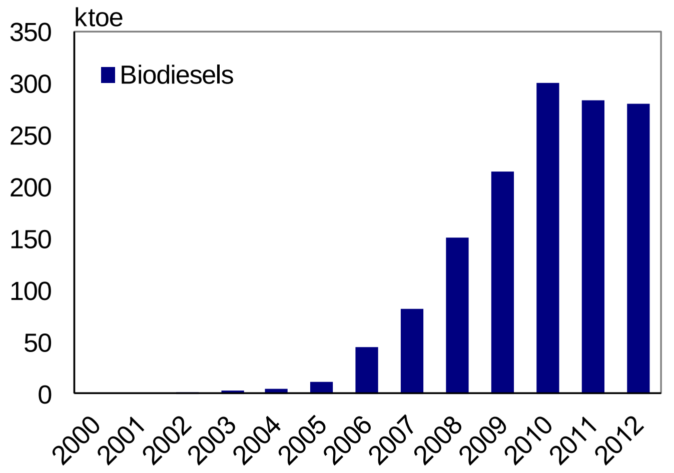
(5.3) Limitation of biofuel industry

- Almost all the companies in the biofuel industry are small and medium-sized ones, hence, it is difficult for them to invest in the long term. In fact, contracts between these companies and petroleum companies are for a single year, instead of multiple years.

Trend of Biofuels Trade in South Korea

Approximately 75–80 percent of biodiesel feedstock is imported soy and palm oil in South Korea.[85] As Figure A.14.1 shows, biodiesel production is at a declining trend after 2010.

Figure A.14.1 Output of Biodiesel in South Korea (in ktoe)



Source: IEA (2013), *Energy Balances of OECD 2013*.

Thailand

Policies and Programs to Promote the Utilisation of Biofuels

(1) Policy Overview

For alternative energy as a whole, Thailand has an Alternative Energy Development Plan (AEDP), which has a clear target and mechanism to drive alternative energy consumption.

[85] USDA GAIN Report (2010).

Figure A.15.1 Thailand Alternative Energy Development Plan (2012–2021)

Goal: Committed to the development of low carbon society

Target: 25% of AE in total energy consumption by 2021

- Promote AE community uses
- Encouraging Private Investment
- Improve Support Infrastructur
- Promote R&D as a Tool for RE Industry
- Publicly Promote Better Understanding
- Supporting Law and Regulations

Solar		MW	2,000	3,200
Wind		MW	1,200	
Hydro Power Plant	Small	MW	324	1,608
	Micro	MW		
	Feedback	MW	1,284	
New Energy	Ocean	MW	2	3
	Geothermal	MW	1	
Bio-energy	Biomass	MW	3,630	4,390
	Biogas	MW	600	
	MSW	MW	160	
Biofuels	Ethanol	Million liter/day	9	Renewable Fuel 44%
	Biodiesel	Million liter/day	5.97	
	New Fuels	Million liter/day	25	

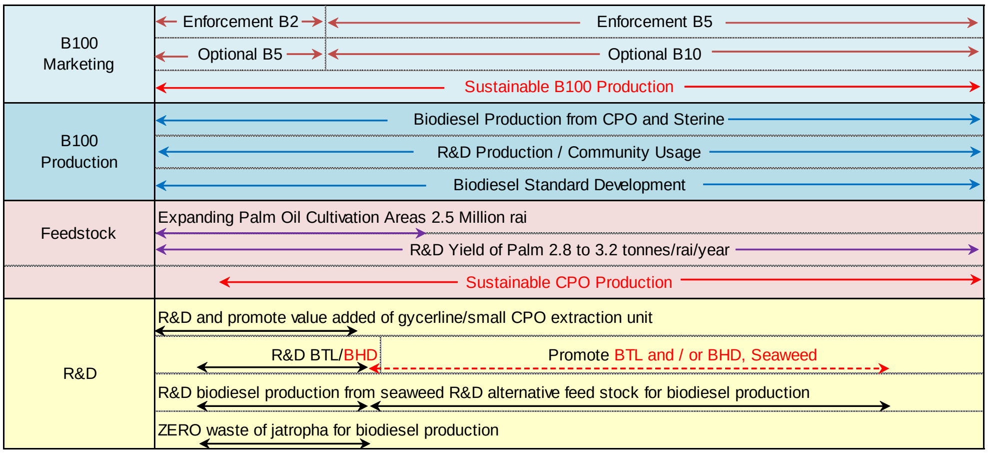
Source: Department of Alternative Energy Development and Efficiency, Ministry of Energy

The target is to make alternative energy (5 alternative energy sources as shown in the figure above) 25 percent of total energy consumption by 2021.

Biodiesel Policy

Figure 1.15-2 provides the overall picture of Thailand's biodiesel policy. The mechanism is to increase biodiesel (B100) production to the targeted level of 7.20 million litres/day by 2021.

Figure A.15.2 Biodiesel Development Plan of Thailand (2008–2021)



Source: Department of Alternative Energy Development and Efficiency, Ministry of Energy.

In 2007, the government, in collaboration with the Ministry of Energy, strongly supported biodiesel by selling B5 in Bangkok and some provinces in the southern part of the country. The implementation of B5 was put on hold in 2010 because of the short supply of palm oil. In November, 2012 the mandatory use of B5 was implemented. The government has announced new mandates that will increase blending requirements to B7 in 2014. However, due to the less-than-expected palm oil production, the government decided to implement B4 instead of B7 in 2014.

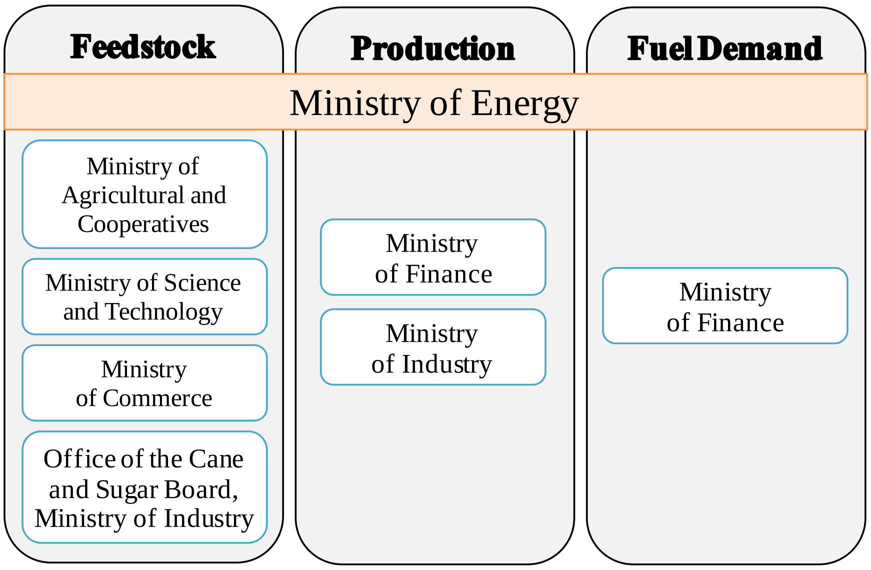
Since April 1, 2008, the government had set a regulation that all high-speed diesel oil (HSD) must be blended with 2 percent of biodiesel (as B2). This blend is still called diesel at the gas station.

At the time of this study, there is government support for the commercial use of biodiesel. For example, palm oil growing areas of 2.5 million *rais* (1 *rais* = 0.8 ha) have privileges under the Board of Investment, including tax relief on imported machinery, income tax relief for eight years, and incentives by lowering the retail biodiesel price, compared to diesel oil.

Bioethanol

For bioethanol/gasohol, Thailand has many policy bodies that participate in ethanol production and use cycles as shown in the figure below. The main responsibility of the Ministry of Energy is to oversee the whole process to make sure that each step is working collaboratively toward the same goal.

Figure A.15.3 Thailand Policy Body involved in Ethanol Processing



Source: Compiled by the authors.

To promote the production of ethanol, the supply policy concentrates on two aspects. The first is to the increase yield of both cassava and sugarcane without increasing the plantation area. The second is to explore alternative feedstocks for ethanol, such as sweet sorghum and cellulosic ethanol

In Thailand, it is clear that E10 is already well accepted by car drivers both at octane 95 and octant 91. The increase in gasohol consumption is due to the government's decision to phase octane 91, or ULG91, and the price advantage of gasohol (with government subsidy) over regular gasoline. To promote E20 usage, the government has set the price of E20 gasohol at 8–14 cents cheaper than E10 gasoline. The price subsidies are paid by the State Oil Fund. The government had also provided gasoline stations marketing subsidies totaling B0.5/litre (about US$0.06/gallon) and B6/litre (about US$0.76/gallon) to encourage them to expand sales of E20 and E85 gasohol.[86]

Different from the strategy to promote E20, E85 needs more support from the car manufacturing industry. Due to its higher concentration of ethanol, normal cars cannot readily use E85. Currently, there are four models of Flex fuel vehicles or FFV in Thailand. The Ministry of Energy is hoping to get supports from the Excise Department to give more tax incentives for FFV

[86] USDA (2013), *Thailand Biofuels Annual*. June 28.

cars. To boost E85 consumptions from existing non-FFV cars, the ministry will work on testing FFV conversion kit, which allows current cars to run on E85, and to make sure that it works properly. There will also be a project that aims to test E85's use in motorcycles.

The result of different funds and taxes on fuel is a complicated pricing structure with different charges on fuels (VAT, excise duties, municipal tax, Oil Fund, Conservation Fund, and so on). The charges vary according to the type of fuel and are changed from time to time as the authorities try to stabilise fuel prices (Table A.15.1).[87]

Table A.15.1 Price Structure of Petroleum Product in Bangkok (30 Sep 13)

Unit: Baht/Liter	Average Ex-Refin.	Tax	Municipal Tax	Oil Fund	Conservation Fund	Wholesale Price	VAT	Marketing Margin	VAT	Retail Price
ULG	**23.7046**	7.0000	0.7000	10.0000	0.2500	**41.6546**	2.9158	1.4762	0.1033	**46.15**
Gasohol 95 E10	**24.1967**	6.3000	0.6300	3.0000	0.2500	**34.3767**	2.4064	1.7261	0.1208	**38.63**
Gasohol 91 (E10)	**23.9771**	6.3000	0.6300	0.9000	0.2500	**32.0571**	2.2440	1.7560	0.1229	**36.18**
Gasohol E20	**24.6020**	5.6000	0.5600	-1.5000	0.2500	**29.5120**	2.0658	1.9647	0.1375	**33.68**
Gasohol 95 E85	**26.3782**	1.0500	0.1050	-11.6000	0.2500	**16.1832**	1.1328	5.2934	0.3705	**22.98**

Source: Presentation material at the 1st WG Meeting at Jakarta. October 2013.

Original data from World Trade Organization, WT/TPR/S/255. Geneva. "Thailand alternative energy development plan (2012-2021). http://www.eppo.go.th/petro/price/index.html (May 14, 2014)

(2) Target

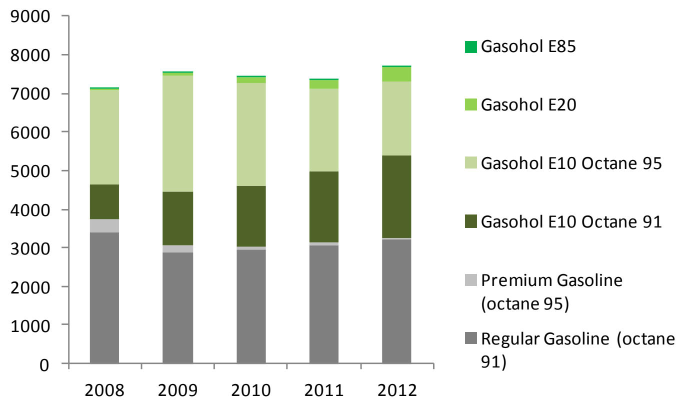
Ethanol

The number of ethanol producers increased remarkably after the blending obligation in 2007.As of February 2013, there were 21 ethanol plants operating with a total capacity of 3.89 million litres per day. The ethanol production for fuel use was 655 million litres in 2012.

The target set by The Renewable Energy Development Plan (REDP) is 9.0 million litres per day by 2021. According to the Ministry of Energy, the capacity of all registered plants has totalled 12.51 million litres/day as of 2013.

[87] WTO (2011a).

Figure A.15.4 Gasoline and Gasohol Consumption in Thailand



Source: Department of Energy Business, Ministry of Energy.

Table A.15.2 Ethanol Plants Operated in Thailand (as of February 2013)

	Number of Plants	Capacity (ML/day)
Sugarcane	1	0.2
Molasses	5	0.78
Cassava	6	1.28
Multi Feed Stock (1)	9	1.63
Total	21	3.89

Note: [1] Molasses is the main feed stocks.
Source: Department of Alternative Energy Development and Efficiency, Ministry of Energy.

Biodiesel

In April 2007, two companies were selling biodiesel (B5) at the gas station. By the end of 2011, the total number of biodiesel gas stations increased to 560 with 141 in the area of Petroleum Authority of Thailand (PPT) and 419 in the Bangkok area. There were 15 biodiesel producers with government certificates ensuring the quality of production. All had production capacities of 5.26 million litres per day.

Table A.15.3 Biodiesel Plants in Thailand

Feedstock	Registered Capacity	
	No. of factories	Capacity (millionL/day)
CPO/RBDPO/Palm stearin	9	4.460
Palm stearin	4	0.750
Used cooking oil	1	0.004
Total	14	5.214

Source: Presentation material at the 1st WG Meeting in Jakarta, October 2013.

The target for biodiesel production set in the REDP is a production capacity of 7.20 million litres per day by 2021. The production of biodiesel was around 400 million litres per year in 2011.

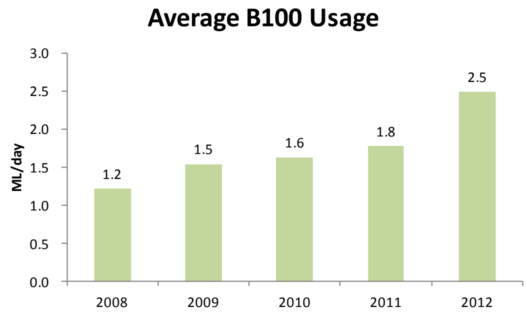
Table A.15.4 Biodiesel Production in Thailand (2006–2012)

1000 Liters	2006	2007	2008	2009	2010	2011	2012
Production	2	68	448	610	660	630	900

Source: USDA (2013), *Thailand Biofuels Annual*, June 28.

The B100 usage has increased steadily after January 2012 when the government mandated the 5 percent blend of B100 in all diesel fuels sold in Thailand.

Figure A.15.5 B2-B4, B5 and Diesel Sales Volume in Thailand (2003–2011)



Source: Department of Energy Business, Ministry of Energy.

(3) Development Program

The biodiesel community

The "biodiesel community" is a biodiesel support program providing knowledge and techniques on biodiesel production, as well as choosing high-potential raw materials in the field, personnel, and other readiness for setting up role model communities as an example for other communities to follow.

Supply side

The expansion of energy crop cultivation areas is the most urgent problem for Thailand. Plans for the cultivation of crops for biodiesel and bioethanol production are presented in the following tables. It should be noted that the use of agriculture land depends less on government plans than on crop prices, farmers' motivation, climate conditions, facilities, transport infrastructure, cultivation technologies, and environmental problems.

Table A.15.5 Development Program on Land Use to Expand the Feedstock Supply for Biodiesel in Thailand

Item		Unit	2011	2015	2020	2021	2022
1	Planting area	m.rai	4.5	5.7	6.0	6.0	6.0
2	FFB	mt	10.9	15.9	17.8	17.8	17.8
3	Crude Palm Oil (CPO)	mt	1.9	2.7	3.0	3.0	3.0
4	Stock	mt	0.2	0.2	0.2	0.2	0.2
5	Vetgetable oil consumption (Domestic + Export)	mt	1.0	1.1	1.2	1.2	1.2
7	Bioethanol demand (REDP)	ml/d	2.5	3.5	4.2	4.3	4.5
8	B100 from CPO+RBD	ml/d	1.9	2.9	3.5	3.7	3.8
9	Demand CPO for biodiesel (B100)	mt	0.7	1.0	1.2	1.2	1.3
10	Export CPO for national balance	mt	0.3	0.8	0.8	0.8	0.7
11	Stock at year end	mt	0.2	0.2	0.2	0.2	0.2

Notes:
(1) FFB&CPO planting area in 2010–2011 are from the Office of Agricultural Economics (OAE) estimation (Oct 2010).
(2) Figure in 2012–2022 is estimated by adjusting to proportion of OAE planting area (Prelim. est.)
(3) 2010 B100 estimation calculated from compulsory of B3 replacing B2 since June 1, 2010.
(4) CPO & RBD consumption is calculated by deducting 20 percent from the start of vegetable oil consumption.
(5) Stock at year end is 0.15 million tonnes.

Source: Department of Alternative Energy Development and Efficiency, Ministry of Energy.

Table A.15.6 Development Program on Land Use to Expand the Feedstock Supply for Bioethanol in Thailand

Item	2010	2015	2020	2021	2022
Ethanol demand (REDP) (ml/d)	2.1	5.4	8.5	8.8	9.0
Cassava*					
Planting area (m.rai)	7.5	7.2	7.2	7.2	7.2
Yield /rai (t/rai/yr)	3.1	3.6	4.0	4.0	4.0
Yield (mt)	22.9	25.9	28.8	28.8	28.8
Per cent consumption	0.5	0.8	0.9	0.9	0.9
Accounted to ethanol (ml/d)	1.1	4.1	7.2	7.5	7.7
The rest of cassava for producing ethanol (ml)	2.3	8.7	15.5	16.1	16.4
Domestic demand (mt)	9.2	9.7	10.1	10.2	10.3
Export demand (mt)	11.4	7.6	3.2	2.5	2.0
***Sugarcane** **					
Planting area (m.rai)	6.9	7.2	7.2	7.2	7.2
Yield /rai (t/rai/yr)	10.4	11.2	11.5	11.5	11.5
Yield (mt)	71.7	80.6	82.8	82.8	82.8
Molasses (mt)	3.2	3.6	3.7	3.7	3.7
Per cent consumption	0.5	0.3	0.2	0.2	0.2
Accounted to ethanol (ml/d)	1.1	1.4	1.3	1.3	1.4
The rest of molasses for producing ethanol (ml)	1.5	2.0	1.9	1.9	2.0
Domestic demand (mt)	1.3	1.4	1.4	1.4	1.5
Export demand (mt)	0.4	0.3	0.4	0.4	0.3

Notes: (1)* Data for 2010 refer to the Office of Agricultural Economics (OAE).
(2)** Data for 2010 refer to the Office of Cane and Sugar Board (OCSB). 2011–2022 are estimated from minimum yield/rai.
Source: Department of Alternative Energy Development and Efficiency, Ministry of Energy

(4) Information on Biofuels RD&D in Thailand

Thailand has mastered the first-generation technology for converting raw materials to biodiesel and bioethanol, while second-generation technologies are still at the research stage.

Several institutions are involved in biofuel technology development in Thailand. The National Science and Technology Development Agency (NSTDA), Thailand Institute of Scientific and Technological Research (TISTR), and King Mongkut's University of Technology North Bangkok (KMUTNB) had been working mainly on R&D. These three institutions had carried out basic research on biofuel production technology, maintaining the research environment, and supporting the development of the country's biofuels industry.

TISTR as a research institute has been promoting both basic and applied research on bio-sciences, materials, energy, and the environment. Thailand began ethanol fuel production since November 2003 using sugarcane molasses and cassava starch as raw materials. The demonstration tests by TISTR on the “Royal Ethanol Project” had established basic techniques and had disseminated the experience in Thailand’s biofuel industry. NSTDA has expertise on catalyst technology, while KMUTNB has expertise on bio-oil reforming technology and both of these institutions play an important role on biofuel technology development in Thailand.

The research institutions mentioned above are also involved in the development of second-generation biofuel production technologies. However, many of the researches are in the experimental stages and are not ready for commercial application. Current research focuses on advanced second-generation bioethanol technology development that includes:

- Cellulosic ethanol
- FFV conversion kit
-ED95 [88]

Table A.15.7 Bioethanol Technology Development in Thailand

	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22
Ethanol Demand (Million Liters/day)	1.24	1.34	2.11	2.96					6.20						9.00
R&D	R&D 2nd generation of ethanol production (Cellulosic)									Promote 2nd generation of ethanol production					
	Value added ex. Sewage														
	Study E85														

Source: Bureau of Biofuel Development, Department of Alternative Energy Development and Efficiency.

The second-generation biodiesel technology development projects include:

- Bio-hydrogenated diesel
- Biomass to liquid
- Biodiesel from algae

[88] ED95 is an ethanol-based fuel for adapted diesel engines.

Table A.15.8 Biodiesel Technology Development in Thailand

	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22
B100 Demand (Million Liters/day)	1.35	1.35	1.35	3.02	3.64					4.50					
R&D	R&D and promote value added of gycerline/small CPO extraction unit														
	R&D BTL/BHD				Promote BTL and / or BHD, Seaweed										
	R&D biodiesel production from seaweed R&D alternative feed stock for biodiesel production														
	ZERO waste of jatropha for biodiesel production														

Source: Bureau of Biofuel Development, Department of Alternative Energy Development and Efficiency

(5) Way Forward

In the national energy program, the promotion of biodiesel and ethanol plays an important role. Biodiesel was planned to be a local product in certain areas, and ethanol was targeted to be used nationwide. Cassava is the cheapest source of starch and based on the long experience of Thailand's cassava industry, this crop can support the national policy and strategy on biofuels, especially in the production and use of bioethanol. Future development faces several challenges.

Food vs. Fuel

There has been a lot of debates on the issue of food vs. fuel. However, the Ministry of Agriculture of Thailand has confidently announced a national program to increase the average yield of fresh roots by up to 30 tonnes/ha by promoting the use of newly released high-yielding varieties, along with good irrigation and fertilizer management. Thus, root productivity is expected to increase without an expansion of land area and without competition from the food sector. However, given that Thailand is among the world's largest producers and exporters of rice and an important global supplier of sugar, the impact of a switch from food to fuel cultivation raises concerns on not only the country's food security but also on the global food supply chain.

Environment issues

Usually, about 2,500 litres of water will be needed to produce 1 litre of biofuel. It is believed that the promotion of biofuels in Thailand will cause rivers to be polluted by the wastewater from the manufacturing activities. The methane gas recovery technology by anaerobic fermentation will probably become one of the measures to help prevent water pollution.

RD&D for Second-Generation Biofuel Technologies

Development of second-generation biofuel technologies is an important strategy for sustainable development of biofuels in the future. The development of bioethanol production technology using cellulose will have important implications for Thailand.

Trend of Biofuels Trade in Thailand[89],[90]

As of 2007, Thailand began to promote the export of ethanol as fuel. The government is contemplating on how to revise the current regulatory framework to enable greater flexibility to exporting ethanol. Alcohol production is strictly controlled under the Cane and Sugar Act (1984). Ethanol producers in Thailand must declare whether the ethanol produced is for fuel use or for liquor. Exports are under the review of Finance Ministry's Excise Department. Given the excess domestic supply, in 2008, approximately 71 million litres of ethanol were authorised for export to Singapore, the Philippines, Taiwan, South Korea, Australia, and the Netherlands. There are only five ethanol producers authorised to export in 2009 according to the Department of Alternative Energy Development and Efficiency.

Ethanol exports (HS2207.10.00) more than tripled in 2011 to 167 million litres, as compared to 48.2 million litres in the previous year. The increase reflected import demand from the Philippines to fulfill its E10 mandate that became effective on August 6, 2011. Ethanol exports continued to grow during January–March 2012 to 84.0 million litres, as compared to 22.7 million litres in the same period of the previous year, again, primarily to the demand from the Philippines where the operation of its new ethanol plants had been delayed.

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[89] Morgera, Kulovesi, and Gobena (2009).
[90] USDA GAIN Report (2012f).

Currently, the Philippines is the main destination for Thailand's ethanol export. Ethanol exports to China are expected to increase significantly as a new Thai export-oriented ethanol plant with a production capacity of 400,000 litres/day will likely be fully operated after its commissioning in the last quarter of 2012. This ethanol plant is a cassava-based ethanol with an export contract of 100 million litres/year to China. Thailand does not import ethanol for fuel use given the country's abundant domestic supply.

Table A.15.9 Thailand's Export of Ethanol (in million litres)

	2009	2010	2011	2012
Philippines	-	5.5	61.3	142.3
Singapore	3.1	19.3	68.5	76.8
Japan	7.4	20.0	16.5	24.9
Australia	0.0	-	2.1	-
Taiwan	3.1	1.2	3.2	1.5
Indonesia	-	-	-	1.5
Europe	-	-	-	9.3
South Korea	-	2.1	12.8	45.5
Other	2.0	-	2.6	2.1
Total	15.6	48.1	167.0	303.9

Note: The number are based on 19 online ethanol plants exporting 95 percent purity ethanol.
Sources: Department of Alternative Energy Development and Efficiency, Ministry of Energy. Quoted in the USDA, Foreign Agricultural Service. *Thailand Biofuels Annual 2013*.

In January 2008, given the abrupt shortage of palm oil, both for cooking oil and as an input for biodiesel, the Ministry of Energy requested the Ministry of Commerce to allow, as an exceptional measure, increased imports of palm oil. Crude palm oil imports and exports are restricted under the Fuel Trade Act (2000). According to the latest Trade Policy Review undertaken by the World Trade Organization, Thailand has a tariff-rate quota regime for palm oil imports. Tariff quotas do not apply to imports from ASEAN countries, which may, upon legal enactment by the Ministry of Finance, supply items benefiting from the preferential ASEAN Free Trade Area (AFTA) duty rates. This was the case, for example, with palm oil imports.[91]

[91] WTO (2007).

Legislative authority for regulating imports is provided by the Export and Import Act (1979). The Act empowers the Minister of Commerce, with the approval of the Cabinet, to restrict imports for reasons of economic stability, public interest, public health, national security, peace and order, morals, or for any other reason in the nation's interest. Imports may be "absolutely" or "conditionally" prohibited; in the latter case (for example, those requiring non-automatic licensing), imports are allowed if specified conditions are satisfied. Palm oil is among the imports that may be prohibited under the various laws in place for health and safety reasons.

Viet Nam

Policies and Programs to Promote the Utilisation of Biofuels

(1) Policy Overview

The fundamental energy policy directions of Viet Nam are provided in "National Energy Development Strategy up to 2020, with 2050 Vision (the Strategy, hereinafter)" approved by the Viet Nam's Cabinet in December 2007. The strategy sets a long-term target for renewable energy's share in the total primary energy supply at 5 percent as of 2020 and 11 percent as of 2050. This strategy, however, did not specify how the country would meet this target with what kind of renewable energy sources, although these numerical targets were the supreme goals for the country's renewable energy policy. As a means to meet the targets, biofuels is considered as a major policy option by the government of Viet Nam. The country's first biofuels policy was provided in the Prime Minister's Decision No. 177 on November 20, 2007 (the 2007 Decision, hereinafter). The outline of this decision is provided later in this section.

(2) Target

The first numerical target for biofuels utilisation was provided in the 2007 Decision (details in Table A.16.1). The 2007 Decision aimed at attaining the goal that all motor gasoline and auto diesel oil consumed in Viet Nam should essentially be either E5 gasoline or B5 diesel by 2025.

Table A.16.1 Volume Target of Biofuels in Viet Nam

Item	2010	2015	2025
Volume of biofuels (‘000 tonnes)	7.5	250	1,800
Volume of E5 and B5 (‘000 tonnes)	150	5,000	36,000
Ratio of pure biofuel to the total petroleum product	0.04%	1.0%	5.0%
Ratio of E5/B5 to the total petroleum demand	Up to 1%	21%	100%

Note: E5 is blended motor gasoline with 5% ethanol; B5 is blended auto diesel oil with 5% biodiesel.
Source: Prime Minister’s Decision No. 177.

It was reported that the government of Viet Nam had set another target specifically for E5 gasoline in November 2012.[92] According to the government, blending 5 percent of ethanol in motor gasoline will become mandatory from December 1, 2014 in seven provinces and cities, namely Ha Noi, Ho Chi Minh, Hai Phong, Da Nang, Can Tho, Quang Ngai, and Ba Ria–Vung Tau. For the remaining areas of the country, December 1, 2015 will be the deadline to adopt E5 gasoline. The government also set the target to raise the share of ethanol from 5 percent to 10 percent by December 1, 2016 in the seven provinces and cities, and by December 1, 2017 in the whole country.[93]As the 2007 Decision did not assume 10 percent blending of ethanol, the government in November 2012 set a tougher target for biofuel adoption for motor gasoline.

As for the actual production and consumption of biofuels in Viet Nam, official statistics is not available. Six ethanol plants are in operation as of November 2012 and the combined production capacity is 550,000

[92] VietnamNet (2012). http://english.vietnamnet.vn/fms/environment/53707/vietnam-vows-to-use-green-fuels-to-keep-air-fresh.html.
[93] VietnamNet (2012).

kL/year.[94]Approximately 80 percent of the production is exported.[95] Three of the six plants are jointly owned by PV Oil, a marketing subsidiary of state-owned PetroVietnam Group, and the total capacity of the three plants is approximately 300,000 kL/year.[96] Domestic ethanol production capacity has already exceeded the target set in the 2007 Decision, but the government has set a tougher target as mentioned above, and additional capacity investments as well as maintaining a higher utilisation will be required to meet the new target.

B5 is still at the experimental stage in Viet Nam. Test marketing of B5 has already started since August 2010, but E5 is prioritised over B5 as the primary means to expand biofuels adoption in the country.

(3) Development Program

The principal biofuels policy program of Viet Nam is the 2007 Decision. The decision provides short-term objectives through 2010, mid-term objectives through 2015, and a vision for 2025 as summarised in Table A.16.2. As of March 2014, it is unclear as to how much the road map has achieved because no formal review had been reported so far.

Table A.16.2 Objectives Provided in the Prime Minister's Decision, Viet Nam

Term	Objectives
To 2010	1. Building legal corridor to encourage industrial-scale biofuel product and using biofuel as replacement fuel in Viet Nam. Raising public awareness of the role and benefit of biofuel. 2. Building road map to use biofuel as a spare fuel in the transport and other industries, and constructing pilot distributing stations in some cities. 3. Approaching and mastering technology for biofuels

[94] Nam News Network (2012)..

[95] *Biofuels Digest*, July 15, 2013. http://www.biofuelsdigest.com/bdigest/2013/07/15/vietnam-biofuel-faces-poor-sales-government-to-implement-mandate/

[96] Petro Vietnam Oil. List of Biofuels plants. https://www.pvoil.com.vn/en-US/pvoil/plants-products/303.

	production from biomass, including blending technology; and improving the efficiency of transforming biomass into fuel. 4. Planning and developing raw material zones for biofuels production. 5. Training of human resources to handle the initial stage of biofuels development. 6. Building and developing trial models for producing and using biofuels with capacity of 100,000 tonnes of E5 and 50,000 tonnes of B5 per year; ensuring supply of 0.4% of total demand for E5 and B5. 7. Approaching and mastering high-yield variety technology for biofuels production.
2011–2015	1. Research, mastering, and production of materials, and additives for biofuel production. 2. Developing and using biofuel for replacing part of conventional fuel. Expanding scale of biofuel production and network of distribution for transport and other industries. 3. Developing material zones according to plan; planning on a large scale for new varieties, which have high yield and pests and disease resistance, to ensure enough supply input for biomass transformation. 4. Successful application of modern fermentation technology to diversify feedstock sources for transforming biomass to biofuel. 5. Building and developing mills and using biofuel nationwide. By 2015, output of ethanol and oil-plants-based biofuel will be 250,000 tonnes (blending of 5 million tonnes E5 and B5), meeting 1% of total demand for gasoline and diesel. 6. Training of human resources in areas related to biofuels production and training of technical workers to meet human resources needed for biofuels production.

Vision as for 2025	Technology for biofuels production in Viet Nam will be at an advanced level. Output of ethanol and biodiesel fuel will reach 1.8 million tonnes, meeting 5% of total demand for gasoline and diesel in the country.

Source: Government of Viet Nam (2007), Prime Minister's Decision No. 177.

The decision provides the necessary mechanisms as follows:

- As the government funding to support biofuels program, VND259.2 billion during 2007–2015, equal to VND28.8 billion per year, is allocated.
- Government funds for fundamental scientific research and technology development.
- Private enterprises are expected to take care of capital investment for developing the biofuels production industry.

Although it is not the government's policy, the ADB published its review of Viet Nam's biofuels policy and deployment in 2009.[97] ADB's review included market outlook of biofuels in Viet Nam, assessment of potential resources to produce biofuels, and policy recommendations. ADB recommended that the government needed to (i) provide the best political and economic environment rather than direct subsidies to avoid conflicts under the World Trade Organization framework, (ii) identify the primary feedstock for biofuels to streamline policy efforts across different ministries, and (iii) set up an organisation that oversees the biofuels industry.[98]

(4) Information on Biofuel RD&D in Viet Nam

Research, development, and dissemination (RD&D) activities of biofuels in Viet Nam are undertaken by the state-owned PetroVietnam group and through other governmental organisations' initiatives. Vietnam Petroleum Institute (VPI), a research institute of PetroVietnam group, is pursuing R&D activities based on the group's R&D road map as illustrated in the following table.

[97] ADB (2009).
[98] Ibid, p. 51.

Table A.16.3 PetroVietnam's Biofuel R&D Road Map

Item	**2011–2015**	**2016–2025**
Feedstock	Developing another biomass for biofuels production; Planning raw material areas for third-generation biofuels production (algae and microalgae).	Establishing technological process for cultivating algae and microalgae.
Technology	Approaching and researching the modern technologies for biodiesel production; Deploying trial production of bioethanol, bio-butanol, and liquid fuels from biomass.	Deploying trial production of bioethanol and biodiesel from algae, microalgae; Approaching and researching new technologies for producing third-generation biofuels.
Blending, Storage, Transport, and Distribution	Conducting research on establishment and mastering of technology for blending biodiesel (fossil diesel, biodiesel and additives) and technology for storage, transport and distribution of pure biodiesel and biodiesel.	-
Environment	Developing the technology for treating by-products and wastewater from biofuel plants of VPI	-
Additives, Chemicals, and Catalyst	Trial production of the additives for gasohol, biodiesel;	-

	Conducting research on additives from glycerin derived from biodiesel production as well as catalysts for F-T synthesis.	
Application	•Large-scale on-road test (B2, B5) in some provinces and cities; •Distribution of E5, B5 on a national scale; •Large-scale on-road test of E10 & B10.	Large-scale on-road test of E25 (Fuel mixture by 25% ethanol and 75% gasoline) & B25 (Mix of 25% biodiesel and 75% diesel) or higher blends

Source: Vietnam Petroleum Institute

As another R&D activity, the Vietnam Academy of Science and Technology Institute of Tropical Biology and Algen Sustainables, a research initiative funded by the Danish and Dutch governments, are researching biofuel production possibility using seaweed. The project is currently examining the viability of biofuel production process by using traditional acid/enzyme to extract cellulosic sugar that can be fermented to produce ethanol. The project is also studying a biofuel production process based on rice straw.[99]

(5) Way Forward

The biggest challenge to expanding biofuels use in Viet Nam is how to attract consumers' as well as petroleum product marketers' interest. It is reported that E5 gasoline is sold at VND100 discount to conventional motor gasoline A92.[100] Yet, given the ethanol's lower calorific value compared with that of conventional gasoline, the discount is not sufficient to make up the calorific deficit.[101] In addition to such insufficient price incentive, consumers are

[99] Algen Sustainables, (www.algensustainables.com/) (accessed April 9, 2013).
[100] Nam News Network (2012).
[101] Because ethanol's calorific value is approximately 60% of conventional gasoline, E5 has a 2% calorific deficit compared to the conventional gasoline. The A92 gasoline price as of April 2013 is VND24,000 and, thus, VND100 is just 0.4% of the total price.

concerned about the potential quality problem using E5 in their vehicles. Petroleum product distributors are also not willing to market E5 gasoline because they need additional investments at their gas stations. Only three out of more than 10 marketers are dealing with E5 gasoline in Viet Nam, and Petrolimex—the largest petroleum product marketer in Viet Nam—has not shown interest in selling E5 gasoline. Without sufficient financial support from the government or large petroleum products suppliers such as PetroVietnam, small agents may not be able to afford to invest in separate pillars or tanks for E5 gasoline.

Trend of Biofuels Trade in Viet Nam

Viet Nam does not import biofuels from abroad. Instead, it is reported that the country exports ethanol to Asian countries like the Philippines, South Korea, and China. This is because Viet Nam cannot find buyers in the domestic market due to the marketers' reluctance to adopt E5 gasoline as mentioned above.[102]

[102] Nam News Network (2012).