The CO_2 emissions reduction of road transportation is estimated to be 21.7 kt-CO_2 (sum of –22.0 kt-CO_2 through reduction of oil use and +0.3 kt-CO_2 through CNG use) under the condition of 20% reduced energy consumption by 2030.

5-3) Summary

Energy issues, today and in future (up to 2030)

1) Increasing import dependency of oil and lack of domestic refining capacity compared to demand
2) For fossil fuels, gasoline and diesel fuel consumption is balanced, but gasoline consumption may further increase because of the large number of motorcycles in the future.
3) For biofuels, insufficient biofuels feedstock supply ability and production capacity, especially for biodiesel.
4) Production of ethanol (from cassava) could possibly increase, but securing a sufficient amount of biodiesel domestically is difficult (no appropriate feedstock).

Possible measures

1) To reduce oil consumption in the future, an integrated approach of oil reduction measures is required through efficiency improvement of the traffic system, such as infrastructure development and traffic flow management.
2) Utilisation of domestic gas for public transportation including taxis
3) To reduce petroleum products consumption, introduction of both ethanol and biodiesel is required; securing feedstock or products, especially for biodiesel, is a key to achieving the Biofuel Roadmap.
4) For a system to support increased biofuel implementation, not only fiscal support but also trading (import raw materials or products) is required.

3. Policy Recommendation

3.1. Evaluation of the Current Energy Policies and Needs for Multinational Cooperation within ASEAN

The investigation of existing energy policies and possible measures to achieve policy targets by estimating energy consumption of road transportation up to 2030 has revealed the following concerns and limitations to solve energy issues within each country.

1) Thailand

For the AEDP, excess introduction of ethanol deteriorates the gasoline and diesel fuel consumption balance, and priority should be put on biodiesel as diesel fuel consumption is larger compared to that of gasoline in Thailand.

2) Indonesia

In accordance with KEN/RUEN direction, the key issues are to realise use of gas in the transportation sector and introduction of ethanol for the gasoline blend together with use of biodiesel. Gasoline consumption is higher than that of diesel fuel in Indonesia, and reduction of gasoline consumption should be prioritised. Institutional design and fiscal support for those must be considered as promoting measures.

3) Philippines

As far as the current PEP is concerned, there is a mismatch in the LCS projection of the transportation sector between the amount of energy to be reduced and that to be achieved by proposed measures. Validation is required and the energy conservation target needs to be revised. Achieving the biofuel introduction target is difficult as raw material production in the Philippines is limited.

4) Malaysia

Promotion of EEVs by setting a clear oil reduction target and efficiency improvement of the traffic system are required for energy conservation. Introduction of ethanol besides biodiesel must be considered given the imbalance between gasoline and diesel fuel consumption. However, lack of domestic ethanol production is an issue in Malaysia. Expansion of the use of domestic gas as an alternative fuel is necessary.

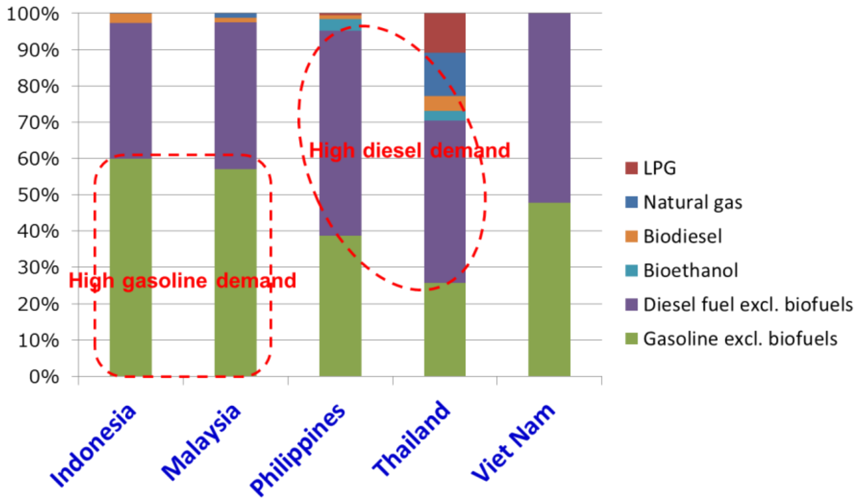
5) Viet Nam

For energy conservation, a clear oil reduction target and incentive scheme for better fuel economy vehicles along with energy efficiency labelling are needed. A concrete plan of biofuel introduction (moderate blending ratio is acceptable) with countermeasures to increase domestic raw material production is required, and import of biodiesel is definitely necessary as domestic production is quite difficult.

6) Discussion as ASEAN

Figure 2.3.1-1 shows the share of fuel types for road transportation in the five main study countries. In Indonesia and Malaysia, gasoline consumption is higher than that of diesel fuel, but in Thailand and the Philippines, diesel fuel consumption is higher than that of gasoline. In Viet Nam, both are fairly balanced at the moment.

Figure 2.3.1-1. Transportation Energy Share by Fuel Type in the Five Countries

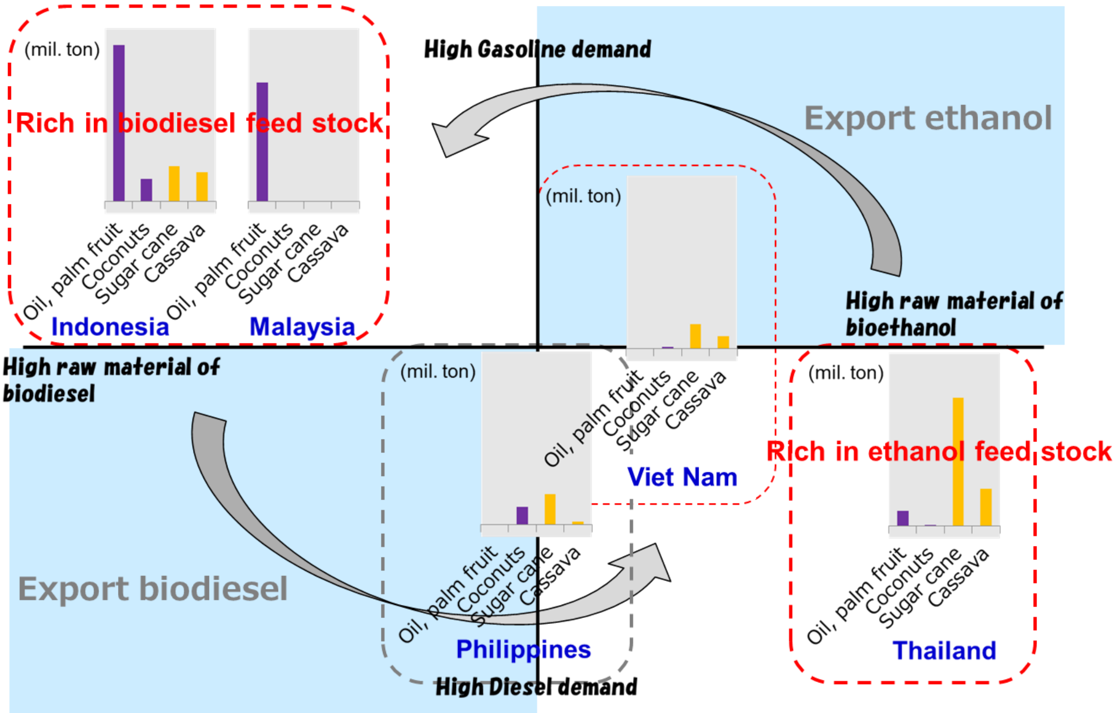


LPG = liquefied petroleum gas.
Source: International Energy Agency, World Energy Balances 2016.

To maintain healthy operations of oil refineries, the imbalance between gasoline and diesel fuel consumption must be small enough (below twofold if possible). To realise balanced consumption of gasoline and diesel fuel in terms of biofuels blending, the ideal relationship between petroleum products demand and biofuel supply ability is schematically illustrated in Figure 2.3.1-2.

As shown and made clear through our investigation and evaluation, unfortunately none of the countries in ASEAN meet this condition, and one of the concerns is insufficient raw materials for biofuels production in some countries. Then, multi-national cooperation amongst the ASEAN countries is worth considering for the sake of balanced biofuel supply and demand situation (biofuels security) in the region, together with appropriate biofuels utilisation target setting in each country.

Figure 2.3.1-2. Multinational Cooperation of Biofuel Supply in ASEAN



Source: Food and Agriculture Organization of the United Nations Statistical Database (FAOSTAT) 2016.

3.2. Cost of Measures to Reduce Oil Consumption and Proposal of Alternative Combination of Measures to Achieve the Policy Requirement

In order to propose an appropriate combination of oil reduction measures, the cost of each oil reduction measure, such as better FE vehicle introduction, biofuels (ethanol and biodiesel), and natural gas utilisation, was evaluated. A case study has been carried out for Indonesia as an example.

The evaluation method is as follows. First, we used the Energy Mix Model to calculate and sum up all the related costs paid by the government as social cost and user cost such as increased vehicle/maintenance cost and fuel expenditure from 2015 to 2030.

Then, we compared the amount of oil reduced by each measure and total cost of implementation of each measure, and calculated the cost per unit energy (oil) reduction. Table 2.3.2-1 shows the conditions (fuel prices, increased cost of vehicle/maintenance, infrastructure cost, etc.) of calculation for the total implementation cost of each measure, and Table 2.3.2-2 summarises scenarios and their condition setting for the Energy Mix Model simulation.

Table 2.3.2-1. Conditions for Total Cost Calculation, 2015–2030

Item/Measure	Cost calculation data
Gasoline & Diesel fuel	MOPS price of December, 2015 Gasoline price; **5,820 Rp/L**, Diesel fuel price; **6,490 Rp/L**
Biofuels	MOPS price of December, 2015 Ethanol price; **7,560 Rp/L**, Biodiesel price; **8,000 Rp/L** Estimated more frequent fuel filter/engine oil change Diesel vehicle maintenance cost; **+500,000 Rp/year/unit vehicle**
FE improvement	Estimated 5,000 JPY (= 500,000 Rp) per 1.0% FE improvement, Vehicle cost-up for FE improvement; **+750,000 Rp/unit vehicle**
CNG use	CNG retail price in Jakarta CNG price; **3,100 Rp/L eq. gasoline** Estimated additional construction of CNG refueling SS CNG infrastructure cost; Mother SS, **80 billion Rp** / Daughter SS, **25 billion Rp**

CNG = compressed natural gas, FE = fuel economy, JPY = yen, L = litre, MOPS = mean of Plats Singapore, Rp = rupiah, SS = service station.
Source: Authors.

Table 2.3.2-2. Scenarios for Total Cost Calculation, 2015–2030, and Their Condition Setting for the Energy Mix Model Simulation

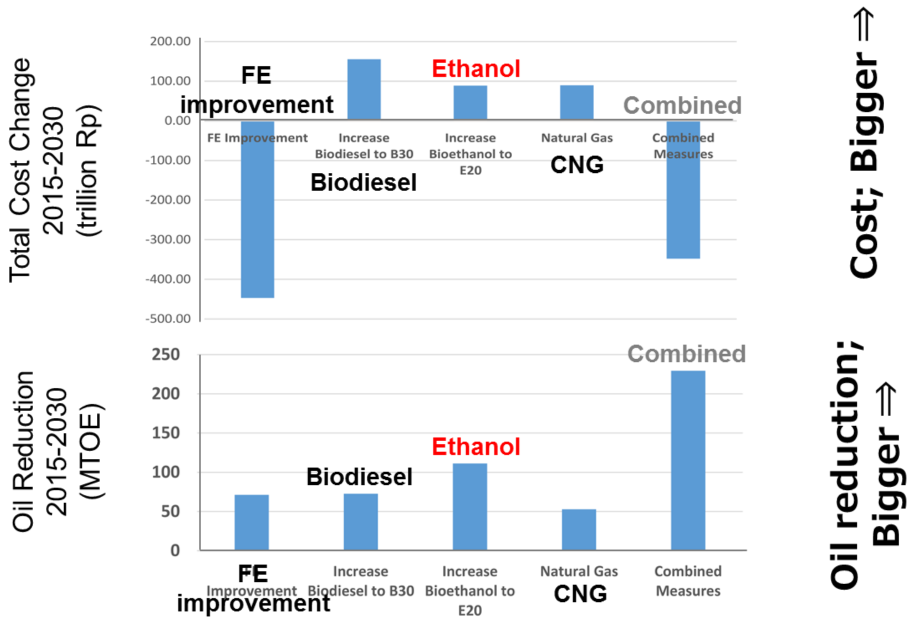
Scenario	FE improvement	Biofuels	CNG
Reference (BAU)	FE improvement, 0.5% a year	**B10**, No ethanol	No CNG vehicles
Increased FE improvement	FE improvement, **2.0% a year**	**B10**, No ethanol	No CNG vehicles
Increased biodiesel usage	FE improvement, 0.5% a year	**up to B30 in 2020** No ethanol	No CNG vehicles
Increased bioethanol usage	FE improvement, 0.5% a year	**B10**, **up to E20 in 2025**	No CNG vehicles
CNG vehicle introduction	FE improvement, 0.5% a year	**B10**, No ethanol	**Bus & Taxi in 5* cities**

* Jakarta, Surabaya, Palembang, Medan & Bandung

BAU = business as usual, CNG = compressed natural gas, FE = fuel economy.
Source: Authors.

After the calculation with the Energy Mix Model, the total cost change compared to BAU, or the difference in total cost between each scenario and BAU during 2015–2030, and the amount of oil reduced during 2015–2030 were calculated and compared with each other (Figure 2.3.2-1). As the condition setting in each scenario specifically focuses on one of the oil reduction measures, other conditions are set to be same as BAU and the difference of total costs reveals introduction/implementation cost for the specified oil reduction measure.

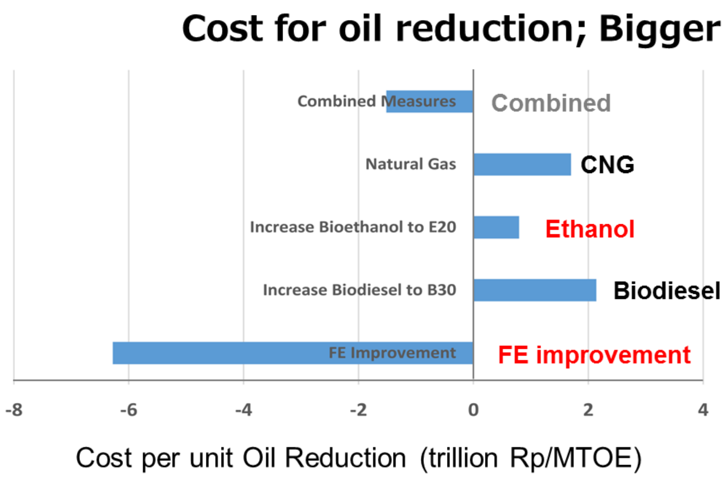
Figure 2.3.2-1. Total Cost Change and Amount of Oil Reduced during 2015–2030



CNG = compressed natural gas, FE = fuel economy, MTOE = million tonnes of oil equivalent, Rp = rupiah.
Source: Authors.

Finally, by using the data obtained, the required cost for reducing oil by means of each measure is calculated and shown in Figure 2.3.2-2. Amongst the alternative fuels for oil replacement, blending ethanol with gasoline can effectively reduce oil at minimum cost and using biodiesel has the highest cost. Generally speaking, the cost of biofuels is higher than that of gasoline/diesel fuel, which requires an increased cost for introduction. Normally, the price of CNG is lower than that of gasoline/diesel fuel and the cost of gas fuel utilisation is lower, whereas CNG refuelling infrastructure development requires additional costs. FE improvement of new vehicles reduces the total amount of fuels used compared to BAU with the limited price increase paid by users, leading to a negative cost of implementation.

Figure 2.3.2-2. Cost-effectiveness of Each Oil Reduction Measure



CNG = compressed natural gas, FE = fuel economy, MTOE = million tonnes of oil equivalent, Rp = rupiah.
Source: Authors.

This case study has been done for Indonesia in 2015, and some of the details may be different from other countries. Also, the fuel price data are past examples and do not reflect the exact current status. However, the indicative direction should be the same and the overall order of cost-effectiveness is still the same, and the results can be applied to other countries as well. Thus, we have calculated and evaluated the oil reduction cost in each country based on the Indonesian case study by changing the currency into US dollars (Table 2.3.2-3).

Table 2.3.2-3. Oil Reduction Cost Equivalents

Measure	Cost in trillion Rp/MTOE	Cost in million US$/MTOE
FE improvement	**-6.25**	**-46.8**
Biodiesel blending	**2.13**	**16.0**
Ethanol blending	**0.76**	**5.70**
CNG use	**1.69**	**12.7**

CNG = compressed natural gas, FE = fuel economy, MTOE = million tonnes of oil equivalent.
Note: Rp1 = US$0.00075 (July 2017).
Source: Authors.

1) Thailand

For Thailand, one of the concerns is deterioration of the gasoline and diesel fuel consumption balance through excess introduction of ethanol under the current policy due to the considerably larger diesel fuel consumption compared to that of gasoline. We have considered less ethanol blending as an alternative case, then kept the same level of biodiesel/CNG utilisation and FE improvement of new vehicles compared to those of the base case as summarised in Table 2.3.2-

4. The same oil reduction (–14.7 MTOE) can be achieved by increasing the allocation to efficiency improvement of the traffic system by 2030. As a result, the total oil reduction cost of the alternative case is calculated as US$3.4 million less than the base case. The figures inserted in the biofuels cells are the required amounts of ethanol/biodiesel in terms of volume in million litres.

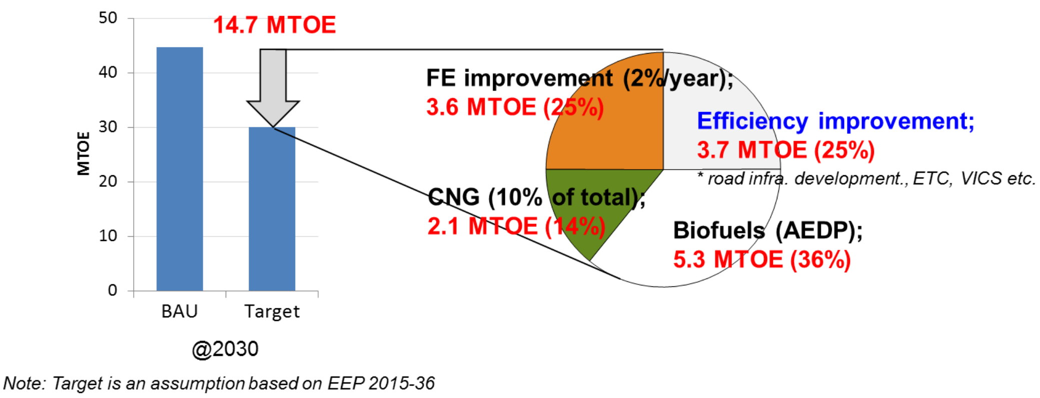
Table 2.3.2-4. Proposal of Alternative Combination of Oil Reduction Measures (Alternative Case) and Cost Comparison with Existing Policy (Base Case)

		Oil reduction (MTOE)		Difference (MTOE)	Cost change (mill. US$)
		Base Case	Alternative Case		
Biofuels	Ethanol	3.1 (21%) : **4,136 ML**	2.5 (17%) : **3,340 ML**	**-0.6**	**-3.4**
	B.diesel	2.8 (19%) : **3,812 ML**	2.8 (19%) : **3,813 ML**	-	-
CNG		2.1 (14%)	2.1 (14%)	-	-
FE improvement		3.6 (25%)	3.6 (25%)	-	-
Traffic system		3.1 (21%)	3.7 (25%)	**+0.6**	
Total		▲14.7 @2030		**±0**	**-3.4**

CNG = compressed natural gas, FE = fuel economy, ML = megalitre, MTOE = million tonnes of oil equivalent.
Source: Authors.

Figure 2.3.2-3 shows the oil reduction potential of the alternative case. The total biofuel consumption will decrease by 5.3 MTOE, CNG can replace 2.1 MTOE of oil, and FE improvement of new vehicles will reduce 3.6 MTOE. A further 3.7 MTOE of oil reduction has to be achieved through efficiency improvement of the traffic system to reduce the same amount of oil by 2030.

Figure 2.3.2-3. Oil Reduction Potential of the Alternative Case for Thailand



AEDP = Alternative Energy Development Plan, BAU = business as usual, CNG = compressed natural gas, ETC = electronic toll collection, FE = fuel economy, MTOE = million tonnes of oil equivalent, VICS = vehicle information and communication system.
Note: Target is an assumption based on EEP 2015-36.
Source: Authors.

CO_2 emissions reduction of road transportation is estimated to be 37.1 kt-CO_2 (sum of –43.3 kt-CO_2 through reduction of oil use and +6.2 kt-CO_2 through CNG use) by 2030, and the CO_2 reduction potential is equal to the base case.

2) Indonesia

In Indonesia, one of the key issues is the introduction of ethanol for the gasoline blend together with use of biodiesel. Gasoline consumption is higher than that of diesel fuel, and reduction of gasoline consumption must be considered. We have considered ethanol blending and reduced the biodiesel introduction amount instead as the alternative case. The level of CNG utilisation has also been reduced as the planned CNG introduction amount in the RUEN is too big, We set it to be same as the current CNG utilisation ratio in Thailand – that is, 10% of the current road transportation energy total consumption. Lastly, FE improvement of new vehicles and efficiency improvement of the traffic system have been kept same as the base case, as summarised in Table 2.3.2-5. The same oil reduction (–40.2 MTOE) can be achieved by 2030, with the total cost reduced at the same time by US$75.4 million compared to the base case. The figures inserted in the biofuels cells are the required amounts of ethanol/biodiesel in million litres.

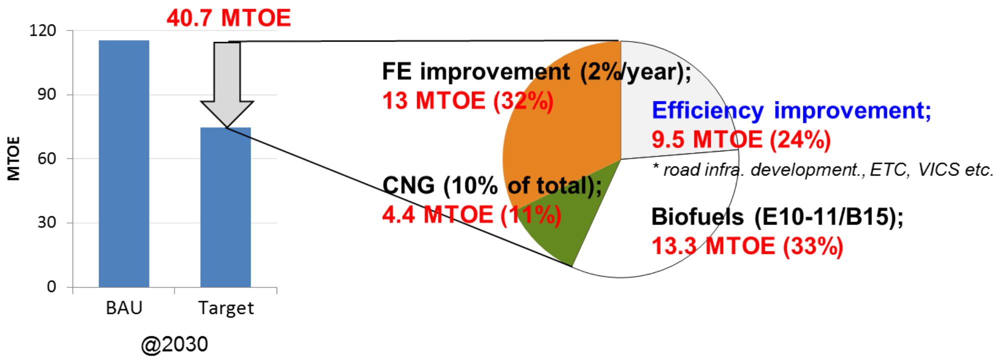
Table 2.3.2-5. Proposal of Alternative Combination of Oil Reduction Measures (Alternative Case) and Cost Comparison with Existing Policy (Base Case)

		Oil reduction (MTOE)		Difference (MTOE)	Cost change (mill. US$)
		Base Case	Alternative Case		
Biofuels	Ethanol	0 (0%) : **0 ML**	8.6 (21%) : **11,666 ML**	**+8.6**	**+49.0**
	B.diesel	9.3 (23%) : **12,568 ML**	4.7 (12%) : **6,284 ML**	**-4.6**	**-73.6**
CNG		8.4 (21%)	4.4 (11%)	**-4.0**	**-50.8**
FE improvement		13.0 (32%)	13.0 (32%)	-	-
Traffic system		9.5 (24%)	9.5 (24%)	-	
Total		**▲40.2 @2030**		**±0**	**-75.4**

CNG = compressed natural gas, FE = fuel economy, ML = megalitre, MTOE = million tonnes of oil equivalent.
Source: Authors.

Figure 2.3.2-4 shows the oil reduction potential of the alternative case. Biofuels, a combination of E10-11/B15 introduction, and CNG utilisation at 10% of the current total energy consumption can replace 13.3 MTOE and 4.4 MTOE of oil, respectively, and FE improvement of new vehicles will reduce oil consumption by 13 MTOE. In order to reduce same amount of oil by 2030, the remaining 9.5 MTOE of oil reduction has to be achieved through efficiency improvement of the traffic system.

Figure 2.3.2-4. Oil Reduction Potential of the Alternative Case for Indonesia



BAU = business as usual, CNG = compressed natural gas, ETC = electronic toll collection, FE = fuel economy, MTOE = million tonnes of oil equivalent, VICS = vehicle information and communication system.
Note: reduction by each measure are assumption based on RUEN transport sector.
Source: Authors.

The CO_2 emissions reduction of road transportation is estimated to be 114.2 kt-CO_2 (sum of –128.2 kt-CO_2 through reduction of oil use and +14.0 kt-CO_2 through CNG use) by 2030, and the CO_2 reduction potential is bigger (potential reduction of additional 12.8 kt-CO_2) than the base case.

3) Philippines

As far as the current PEP is concerned, the energy conservation target seems to be unrealistic and necessary to be revised as the energy reduction required by the LCS for the transportation sector of the PEP is too large compared to the total energy consumption scale. Also, securing a sufficient amount of biofuels to meet the target is difficult as raw material production in the Philippines is limited.

We set the revised target of oil reduction for the Philippines to be 35%, as in Malaysia (35% is the largest reduction target amongst the five countries investigated in this study). The required amount of oil to be reduced will be 6.5 MTOE by 2030, instead of 12.1 MTOE of the base case. We considered the same level of ethanol blending and increased biodiesel introduction amount as the revised target case. The CNG utilisation level has also been reduced as the planned CNG introduction amount in the PEP is too large and set to be the same as the current CNG utilisation ratio in Thailand (i.e. 10% of current road transportation energy total consumption). FE improvement of new vehicles has been kept the same as the base case, as summarised in Table 2.3.2-6. The oil reduction allocated to efficiency improvement of the traffic system is not too large to achieve the revised target. The total cost is reduced by US$18.6 million compared to the base case. The figures inserted in the biofuels cells are the required amounts of ethanol/biodiesel in million litres.

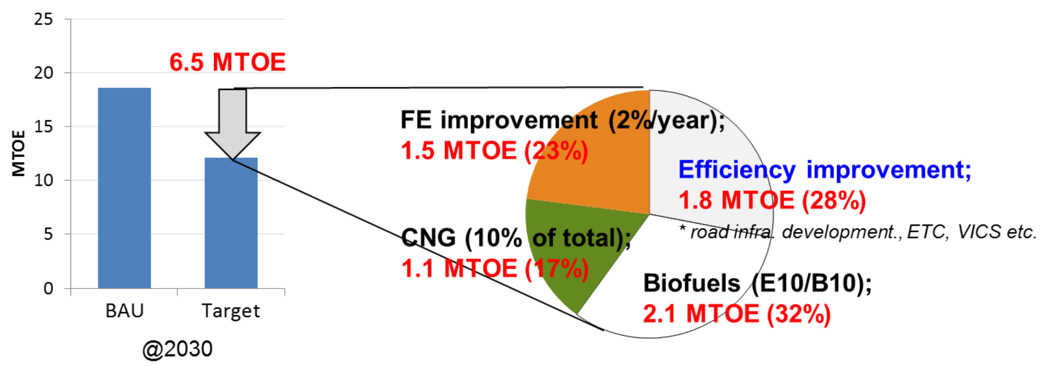
Table 2.3.2-6. Proposal of Alternative Combination of Oil Reduction Measures (Revised Target Case) and Cost Comparison with Existing Policy (Base Case)

		Oil reduction (MTOE)		Difference (MTOE)	Cost change (mill. US$)
		Base Case	Revised Target Case		
Biofuels	Ethanol	0.9 (12%) : **1,178 ML**	0.8 (12%) : **1,013 ML**	**-1.0**	**-5.7**
	B.diesel	0.6 (21%) : **848 ML**	1.3 (20%) : **1,698 ML**	**+0.7**	**+11.2**
CNG		3.0 (25%)	1.1 (17%)	**-1.9**	**-24.1**
FE improvement		1.5 (12%)	1.5 (23%)	-	-
Traffic system		6.1 (30%)	1.8 (28%)	**-4.3**	
Total		**▲12.1 ⇒ ▲6.5 @2030**		**-5.6**	**-18.6**

CNG = compressed natural gas, FE = fuel economy, ML = megalitre, MTOE = million tonnes of oil equivalent.
Source: Authors.

Figure 2.3.2-5 shows the oil reduction potential of the revised target case with the revised target. Biofuels, a combination of E10/B10 introduction, and CNG utilisation of 10% of the current total energy consumption can replace 2.1 MTOE and 1.1 MTOE of oil, respectively. FE improvement of new vehicles will reduce oil consumption by 1.5 MTOE, and the remaining 1.8 MTOE of oil reduction has to be achieved through efficiency improvement of the traffic system.

Figure 2.3.2-5. Oil Reduction Potential of the Revised Target Case for the Philippines



BAU = business as usual, CNG = compressed natural gas, ETC = electronic toll collection, FE = fuel economy, MTOE = million tonnes of oil equivalent, VICS = vehicle information and communication system.
Note: Target is our own assumption and tentatively set to 35% reduction.
Source: Authors.

The CO_2 emissions reduction of road transportation is estimated to be 19.5 kt-CO_2 (sum of –20.7 kt-CO_2 through reduction of oil use and +1.2 kt-CO_2 through CNG use) by 2030, and the CO_2 reduction potential is smaller (emission increases 15.9 kt-CO_2) than the base case due to the revised target setting (amount of oil reduced is smaller by 5.6 MTOE).

4) Malaysia

For Malaysia, introduction of ethanol besides biodiesel must be considered, given the imbalance between gasoline and diesel fuel consumption. Gasoline consumption is higher than that of diesel fuel, and reduction of gasoline consumption must be considered as in Indonesia. We have considered ethanol blending and a reduced biodiesel introduction amount instead as the alternative case. The level of CNG utilisation has been kept the same. Lastly, FE improvement of new vehicles and efficiency improvement of the traffic system have also been kept the same as the base case, as summarised in Table 2.3.2-7. The same oil reduction amount (–13.2 MTOE) can be achieved by 2030, with the total cost reduced at the same time by US$16.0 million compared to the base case. The figures inserted in the biofuels cells are the required amounts of ethanol/biodiesel in million litres.

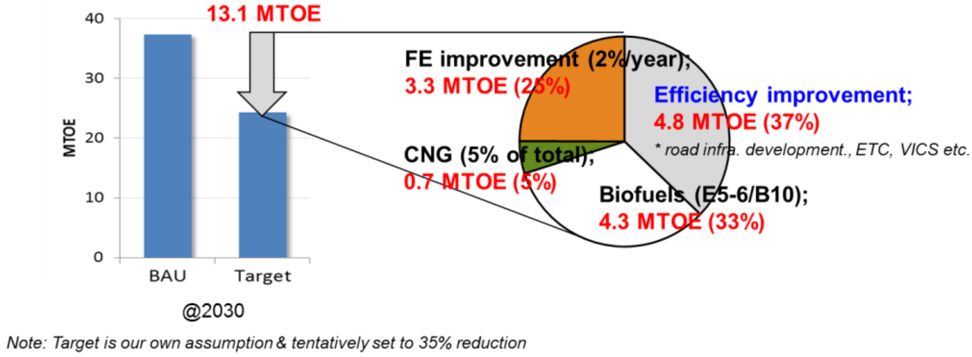
Table 2.3.2-7. Proposal of Alternative Combination of Oil Reduction Measures (Alternative Case) and Cost Comparison with Existing Policy (Base Case)

		Oil reduction (MTOE)		Difference (MTOE)	Cost change (mill. US$)
		Base Case	Alternative Case		
Biofuels	Ethanol	0 (0%) : **0 ML**	1.4 (11%) : **1,847 ML**	**+1.4**	**+8.0**
	B.diesel	4.3 (33%) : **5,946 ML**	2.9 (22%) : **3,964 ML**	**-1.4**	**-24.0**
CNG		0.7 (5%)	0.7 (5%)	-	-
FE improvement		3.3 (25%)	3.3 (25%)	-	-
Traffic system		4.8 (37%)	4.8 (37%)	-	
Total		**▲13.1 @2030**		**±0**	**-16.0**

CNG = compressed natural gas, FE = fuel economy, ML = megalitre, MTOE = million tonnes of oil equivalent.
Source: Authors.

Figure 2.3.2-6 shows the oil reduction potential of the alternative case. Biofuels, a combination of E5-6/B10 introduction, and CNG utilisation of 5% of the current total energy consumption can replace 4.3 MTOE and 0.7 MTOE of oil, respectively, and FE improvement of new vehicles will reduce oil consumption by 3.3 MTOE. In order to reduce same amount of oil by 2030, the remaining 4.8 MTOE of oil reduction has to be achieved through efficiency improvement of the traffic system.

Figure 2.3.2-6. Oil Reduction Potential of the Alternative Case for Malaysia



BAU = business as usual, CNG = compressed natural gas, ETC = electronic toll collection, FE = fuel economy, MTOE = million tonnes of oil equivalent, VICS = vehicle information and communication system.
Note: Target is our own assumption and tentatively set to 35% reduction.
Source: Authors.

The CO_2 emissions reduction of road transportation is estimated to be 39.9 kt-CO_2 (sum of –42.1 kt-CO_2 through reduction of oil use and +2.2 kt-CO_2 through CNG use) by 2030, and the CO_2 reduction potential is equal to the base case.

5) Viet Nam

In Viet Nam, gasoline and diesel fuel consumption are fairly balanced, but as far as biofuels are concerned, one concern is the insufficient biofuels feedstock supply ability, especially for biodiesel. We have considered less ethanol blending as the alternative case and kept the same biodiesel utilisation level. The CNG utilisation level has been increased by considering domestically produced natural gas resources in Viet Nam, and set at 5% of the current road transportation energy total consumption (as in Malaysia). Finally, FE improvement of new vehicles and efficiency improvement of traffic system have also been kept the same as the base case, as summarised in Table 2.3.2-8. The same oil reduction amount (–6.9 MTOE) can be achieved by 2030, with the total cost slightly increased by US$2.8 million compared to the base case. The figures inserted in the biofuels cells are the required amounts of ethanol/biodiesel in million litres.

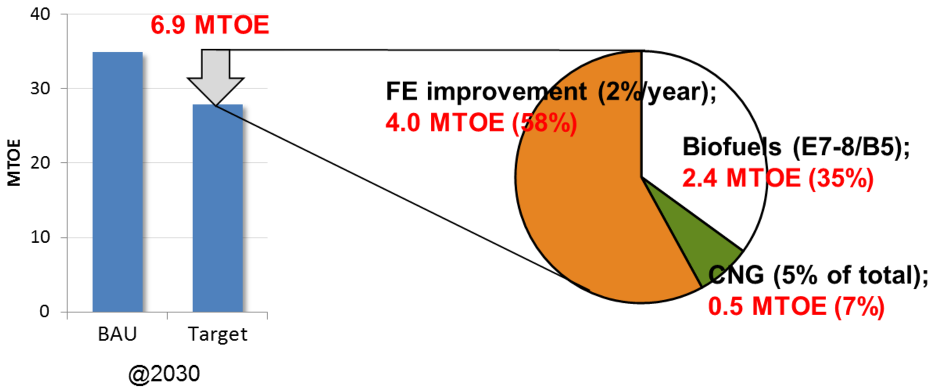
Table 2.3.2-8. Proposal of Alternative Combination of Oil Reduction Measures (Alternative Case) and Cost Comparison with Existing Policy (Base Case)

		Oil reduction (MTOE)		Difference (MTOE)	Cost change (mill. US$)
		Base Case	Alternative Case		
Biofuels	Ethanol	2.0 (29%) : **2,740 ML**	1.6 (23%) : **2,158 ML**	**-0.4**	**-2.3**
	B.diesel	0.8 (12%) : **1,085 ML**	0.8 (12%) : **1,085 ML**	-	-
CNG		0.1 (1%)	0.5 (7%)	**+0.4**	**+5.1**
FE improvement		4.0 (58%)	4.0 (58%)	-	-
Traffic system		0 (0%)	0 (0%)	-	
Total		**▲6.9 @2030**		**±0**	**+2.8**

CNG = compressed natural gas, FE = fuel economy, ML = megalitre, MTOE = million tonnes of oil equivalent.
Source: Authors.

Figure 2.3.2-7 shows the oil reduction potential of the alternative case. Biofuels, a combination of E7-8/B5 introduction, and CNG utilisation of 5% of the current total energy consumption can replace 2.4 MTOE and 0.5 MTOE of oil, respectively, and FE improvement of new vehicles will reduce oil consumption by 4.0 MTOE. As our tentative target setting of a 20% oil reduction by 2030 for Viet Nam is not large, an integrated approach of oil reduction measures including efficiency improvement of the traffic system is not required.

Figure 2.3.2-7. Oil Reduction Potential of the Alternative Case for Viet Nam



BAU = business as usual, CNG = compressed natural gas, FE = fuel economy, MTOE = million tonnes of oil equivalent.
Note: Target is our own assumption and tentatively set to 20% reduction.
Source: Authors.

The CO_2 emissions reduction of road transportation is estimated to be 20.5 kt-CO_2 (sum of –22.0 kt-CO_2 through reduction of oil use and +1.5 kt-CO_2 through CNG use) by 2030, and the CO_2 reduction potential is slightly smaller (emission increases of 1.2 kt-CO_2) than the base case due to increased use of CNG.

3.3. Proposal of Biofuels Balancing Concept in ASEAN

Existing energy policies as well as gasoline/diesel fuel supply and demand status issues of road transportation, including alternative fuels (natural gas and biofuels), were studied for the five main countries in ASEAN. The priority was on discussing measures for mitigating energy issues in each country by achieving the policy targets, but concerns and limitations of solving energy issues within each country have been made clear. In order to minimise the concerns and limitations, we also proposed an appropriate combination of oil reduction measures as the alternative case.

1) Biofuel supply/demand status in each country

Under the condition of a more cost-effective combination of oil reduction measures to achieve the policy target, together with adequate biofuel utilisation for replacing gasoline/diesel fuel, the required amounts of ethanol/biodiesel in each country by 2030 are summarised in Table 2.3.3-1 (the figures inserted in the biofuels cells of Table 2.3.2-3 to Table 2.3.2-7 are the required amounts of ethanol/biodiesel in units of million litres).

Table 2.3.3-1. Required Amount of Ethanol and Biodiesel in Each Country by 2030 for the Alternative Case

	Ethanol for gasoline blend		Biodiesel for diesel blend	
Thailand (TH)	**3.3** billion L	**E10/20/85**	**3.8** billion L	up to **B10**
Indonesia (IN)	**11.6** billion L	up to **E10-11**	**6.3** billion L	up to **B15**
Philippines (PH)*	**1.0** billion L	up to **E10**	**1.7** billion L	up to **B10**
Malaysia (MA)	**1.8** billion L	up to **E5-6**	**3.9** billion L	up to **B10**
Viet Nam (VN)	**2.1** billion L	up to **E7-8**	**1.1** billion L	up to **B5**

* Oil reduction target for Philippines is a Tentative target of ▲35% (revised target)

Source: Authors.

Next, we examined the supply ability or potential of ethanol/biodiesel in each country up to 2030 to fulfil demand. Each country conducted a survey, based on their own projection/estimation, and the possible supply potentials of ethanol/biodiesel up to 2030 are shown in Table 2.3.3-2 to Table 2.3.3-6, respectively.

Table 2.3.3-2. Ethanol and Biodiesel Supply Potentials up to 2030 in Thailand

Ethanol	unit	2015	2020	2025	2030	notes
Sugar cane	mil.t	4.03	5.96	6.80	7.38	
Cassava	mil.t	2.00	3.22	5.19	8.36	
Feedstock total	mil.t	**6.03**	**9.18**	**11.99**	**15.74**	
Nr. of plants	-	22	26			Currently 26 (capacity; 5.79 ML/d, registered license; 6.35 ML/d), and 2 more with registered license of 0.71 ML/d
Capacity	bil.L	1.64	5.79			
Ethanol total	bil.L	**1.21**	**4.42**	**6.08**	**8.33**	
Biodiesel	**unit**	**2015**	**2020**	**2025**	**2030**	**notes**
Palm	mil.t	0.82	1.1	1.56	1.67	
Coconuts	mil.t	-	-	-	-	Not planed to be used for biodiesel
Feedstock total	mil.t	**0.82**	**1.10**	**1.56**	**1.67**	
Nr. of plants	-	11	13			Currently 13 (capacity; 6.62 ML/d)
Capacity	bil.L	1.62	6.62			
Biodiesel total	bil.L	**1.24**	**3.50**	**4.91**	**5.26**	

Source: Authors.

Table 2.3.3-3. Ethanol and Biodiesel Supply Potentials up to 2030 in Indonesia

Ethanol	unit	2015	2020	2025	2030	notes
Sugar cane	mil.t	28 (1.2)	31 (1.8)	35 (2.1)	40 (2.4)	50 sugarcane mills, (available molasses for ethanol feedstock)
Cassava	mil.t	24	26	28	30	Even imported from VN to fulfill t starch prod.
Feedstock total	mil.t	**52**	**57**	**63**	**70**	
Nr. of plants	-	3	6	6	6	Total 14 plants, only 3 are capable of producing ethanol for fuel grade
Capacity	bil.L	0.1	0.4	0.6	0.8	
Ethanol total	bil.L	**0.1**	**0.4**	**0.6**	**0.8**	
Biodiesel	**unit**	**2015**	**2020**	**2025**	**2030**	**notes**
Palm	mil.t	30	40	50	60	
Coconuts	mil.t	0.9	1.2	1.5	1.8	Govt. is pushing to increase production
Feedstock total	mil.t	**33.9**	**41.2**	**51.5**	**61.8**	
Nr. of plants	-	15	25	30	40	Capacity is underutilized, need to secure sufficient CPO to maintain prod.
Capacity	bil.L	4.5	12	20	24	
Biodiesel total	bil.L	**4.5**	**12**	**20**	**24**	

Source: Authors.

Table 2.3.3-4. Ethanol and Biodiesel Supply Potentials up to 2030 in the Philippines

Ethanol	unit	2015	2020	2025	2030	notes
Sugar cane	mil.t	0.51 (0.47)	3.37 (0.80)	3.71 (1.00)	4.08 (1.10)	(available molasses for ethanol feedstock)
Cassava	mil.t	-	-	-	-	No plan
Feedstock total	mil.t	**0.47**	**0.80**	**1.00**	**1.10**	
Nr. of plants	-	10	14	38	52	Estimated number with annual production capacity of 30 million L/year to be added
Capacity	bil.L	0.28	0.41	1.13	1.55	
Ethanol total	bil.L	**0.28**	**0.85**	**1.13**	**1.55**	Maintain E10 mandate until 2020
Biodiesel	**unit**	**2015**	**2020**	**2025**	**2030**	**notes**
Palm	mil.t	-	-	-	-	No plan
Coconuts	mil.t	0.76	1.03	1.66	2.67	CNO equivalent
Feedstock total	mil.t	**0.76**	**1.038**	**1.66**	**2.67**	
Nr. of plants	-	11	13	13	15	
Capacity	bil.L	0.58	0.74	0.74	0.79	
Biodiesel total	bil.L	**0.20**	**0.22**	**0.66**	**0.79**	Maintain B2 until 2020, B5 beginning 2021

Source: Authors.

Table 2.3.3-5. Ethanol and Biodiesel Supply Potentials up to 2030 in Malaysia

Ethanol	unit	2015	2020	2025	2030	notes
Sugar cane	mil.t	-	-	-	-	
Cassava	mil.t	-	-	-	-	
Feedstock total	mil.t	-	-	-	-	
Nr. of plants	-	-	-	-	-	No new plants being constructed within next 5 years
Capacity	bil.L	-	-	-	-	
Ethanol total	bil.L	-	-	-	-	
Biodiesel	**unit**	**2015**	**2020**	**2025**	**2030**	**notes**
Palm	mil.t	0.36	0.67	1.11	2.92	Huge potential for palm
Coconuts	mil.t	-	-	-	-	No plan
Jatropha	mil.t	-	-	-	-	Plans of introducing Jatropha as feedstock
Feedstock total	mil.t	**0.36**	**0.67**	**1.11**	**2.92**	
Nr. of plants	-	31	31	31	31	22 plants in operation, 9 plants are idling (2017)
Capacity	bil.L	3.4	3.4	3.4	3.4	
Biodiesel total	bil.L	**0.67**	**1.5**	**2.5**	**3.4**	Projected incl. export

No ethanol production

Source: Authors.

Table 2.3.3-6. Ethanol and Biodiesel Supply Potentials up to 2030 in Viet Nam

Ethanol	unit	2015	2020	2025	2030	notes
Sugar cane	mil.t	18.0	25.5			Mainly for sugar industry
Cassava	mil.t	11.0 (fresh	12.7 (fresh)	-	16.5 (fresh)	Cassava is mainly used for starch production and export, only a part is used for ethanol prod.
Corn	mil.t	18.0	25.5			Mainly for food & animal
Feedstock total	mil.t		**1.6** (dried)	-	**1.8** (dried)	Feedstock for ethanol prod., dried cassava is for ethanol production
Nr. of plants	-	2	7		7	4 plants (total capacity, 400kL/y) produce E100; 2 plants (total capacity, 126kL/y) are upgraded to produce E100; 1 plant (capacity, 100kL/y) is under construction
Capacity	bil.L	0.17	0.62		0.62	
Ethanol total	bil.L	**0.17**	**0.52**		**0.62**	
Biodiesel	**unit**	**2015**	**2020**	**2025**	**2030**	**notes**
Palm	mil.t	-	-	-	-	
Coconuts	mil.t	-	-	-	-	
Fish oil	mil.t	-	-	-	-	Plans to use as feedstock
Feedstock total	mil.t	-		-	-	
Nr. of plants	-		-	-	-	
Capacity	bil.L	-	-	-	-	
Biodiesel total	bil.L	-	-	-	-	

No biodiesel production

CNO = coconut oil, CPO = crude palm oil, kL/y = kilolitre per year, L = litre, ML/d = million litres per day, t = tonne, VN = Viet Nam.
Source: Authors.

Based on the provided information on the future biofuel supply potential from each country, the estimated domestic supply potentials of ethanol/biodiesel in each country by 2030 are summarised in Table 2.3.3-7, together with the information on the main feedstock/raw materials for biofuels production. Further, the biofuel supply/demand status for the five main countries in ASEAN by 2030 are finally summarised in Table 2.3.3-8, based on the information shown in Table 2.3.3-1 and Table 2.3.3-7.

The evaluation criteria are as follows. If estimated supply volume, for example, of ethanol exceeds demand in a country, the country has the potential for export ethanol. If the estimated supply volume, for example, of biodiesel is less than demand in another country, the country does not have the potential to meet demand by itself and needs to import biodiesel (in this case, figures in the excess/deficit cells are indicated as negative).

Table 2.3.3-7. Estimated Domestic Supply Potential of Ethanol and Biodiesel in Each Country by 2030

	Ethanol for gasoline blend		Biodiesel for diesel blend	
Thailand (TH)	**8.3** billion L	from **Sugar cane** and **Cassava**	**5.2** billion L	from **Palm**
Indonesia (IN)	**0.8** billion L	from **Sugar cane**	**24** billion L	from **Palm**
Philippines (PH)	**1.5** billion L	from **Sugar cane**	**0.8** billion L	from **Coconuts**
Malaysia (MA)	No production	-	**3.4** billion L	from **Palm**
Viet Nam (VN)	**0.6** billion L	mainly from **Cassava**	No production	-

Source: Authors.

Table 2.3.3-8. Biofuel Supply/Demand Status Summary for the Five Countries by 2030

	Ethanol for gasoline blend			Biodiesel for diesel blend		
	Supply (billion L)	Demand (billion L)	Excess/ Deficit	Supply (billion L)	Demand (billion L)	Excess/ Deficit
Thailand (TH)	8.3	3.3	5.0 billion L	5.2	3.8	1.4 billion L
Indonesia (IN)	0.8	11.6	▲10.8 billion L	24	6.3	17.7 billion L
Philippines (PH)	1.5	1.0	0.5 billion L	0.8	1.7	▲0.9 billion L
Malaysia (MA)	-	1.8	▲1.8 billion L	3.4	3.9	▲0.5 billion L
Viet Nam (VN)	0.6	2.1	▲1.5 billion L	-	1.1	▲1.1 billion L

* **Blue deficit**; shall be covered by the country's own effort first,
Red deficit; can be fulfilled by means of regional cooperation through trading of biofuels

Source: Authors.

2) Discussions and possibility for multinational cooperation of biofuel supply

Taking into account the estimated biofuel supply potentials in each country by 2030, there are deficits of ethanol supply in Indonesia (–10.8 billion L), Malaysia (–1.8 billion L), and Viet Nam (–1.5 billion L) to fulfil demand, as well as deficits of biodiesel supply in the Philippines (–0.9 billion L), Malaysia (–0.5 billion L), and Viet Nam (–1.1 billion L) to meet the respective demand as shown in Table 2.3.3-8. However, as far as the deficit of ethanol in Viet Nam is concerned, Viet Nam has a large cassava production potential and only a part is currently used for ethanol production as mentioned in Table 2.3.3-6. The same can be said for the biodiesel deficit in Malaysia as a huge volume of CPO is produced in Malaysia, including applications other than biodiesel production (Table 2.3.3-5). Thus, we see possibilities for Viet Nam and Malaysia, respectively, to solve their ethanol and biodiesel deficits through domestic efforts to increase either raw material or biofuel production by themselves.

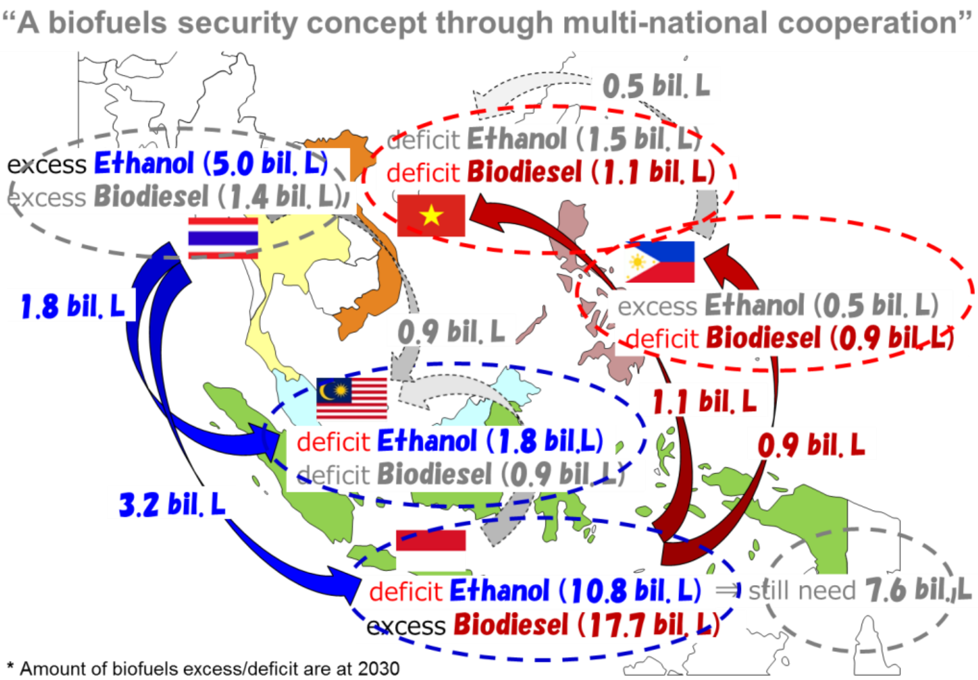
As excess supply of biofuels is concerned, Thailand has an excess volume of ethanol of 5.0 billion litres and the same for the Philippines of 0.5 billion litres. Indonesia has an excess of biodiesel of 17.7 billion litres and the same for Thailand of 1.4 billion litres, as shown in Table 2.3.3-8. The excess ethanol supply in Thailand (and also that in the Philippines) can be exported to Malaysia and Indonesia to fulfil demand as their domestic ethanol production is not sufficient, and the excess biodiesel supply in Indonesia (and that in Thailand as well) can be exported to the Philippines and Viet Nam as their domestic biodiesel is in short supply.

As an overall result, we see possibilities to supplement each other's biofuels within the ASEAN region, acting as a form of biofuel security within the ASEAN region. Multinational cooperation in export/import of biofuels between the neighbouring countries will be able to help achieve the policy requirements in each country. However, the issue of insufficient total ethanol production volume in ASEAN as a whole remains to support the huge demand in Indonesia and cannot be fully supplemented within the ASEAN region. Finally, there are request for additional ethanol to be imported from outside ASEAN (e.g. from Brazil or the United States).

3) Proposal of 'Biofuels Balancing Concept in ASEAN'

As discussed above, multinational cooperation of biofuel supply can be a measure for biofuel security within the ASEAN region except for ethanol to fulfil the huge demand in Indonesia, and ethanol is required to be imported from outside ASEAN additionally as the total ethanol production in ASEAN is not sufficient. We have named this biofuel security concept the 'Biofuels Balancing Concept in ASEAN', which schematically shown in Figure 2.3.3-1 with the volume of ethanol and/or biodiesel to be exported/imported by 2030. We consider the excess amount of ethanol in the Philippines and biodiesel in Thailand to be used for supporting Viet Nam and Malaysia in making their own respective effort to cover their ethanol or biodiesel deficit by themselves. The required amount of ethanol to be imported from outside ASEAN by 2030 will be around 7.6 billion litres.

Figure 2.3.3-1. Proposal of the Biofuel Supplementation Scheme within the ASEAN Region: Biofuels Balancing Concept in ASEAN



Source: Authors.

In order to realise this biofuel security concept through multinational cooperation in practice, taking measures to get rid of barriers to prevent trading of biofuels between the neighbouring countries is the key to success.

Examples of necessary measures

1) Harmonisation of biofuel quality standards amongst the ASEAN Member States
2) NOT to specify feedstock for biofuel production only for domestic resources (e.g. coconuts for biodiesel production in the Philippines), performance-based and feedstock-neutral specifications are required.

The automotive industry globally (under the collaboration amongst the European Automobile Manufacturers Association, Alliance of Automobile Manufacturers in the United States, Engine Manufacturers Association in the United States, and Japan Automobile Manufacturers Association) has conducted the above-mentioned activities to promote high-quality fuels and harmonise fuel standards to ensure proper engine and vehicle operations and thus to benefit consumers. Proposed examples of recommendations by the automotive industry include the 'World-wide Fuel Charter Ethanol Guidelines' and 'Biodiesel Guidelines'. The 'EAS–ERIA Biodiesel Fuel Standard: 2013' proposed by the ERIA Energy Project Working Group through its activity as the benchmarking standard for biodiesel (FAME) in ASEAN and East Asia is another example.

The recommendation to the governments of ASEAN Member States are as follows: the key is to consider the opinions of all related stakeholders such as vehicle manufactures, fuel suppliers including biofuel producers, consumers, and policy makers, especially to follow the requirements and proposals initiated by the automotive industry for vehicle and fuel users to accept the increased biofuel utilisation and for all related stakeholders to discuss in each country for the sake of aligning opinions on how to realise biofuel security within the ASEAN region.

The Philippines is currently importing ethanol from Brazil and/or the United States, and even from Thailand in some cases. This could compel us to study more in detail the practices already being applied in the Philippines, how they are managing to import ethanol from outside the country to fulfil demand given the deficit in domestic production by giving priority to using domestically produced ethanol.

References

Asia Pacific Energy Research Centre, Institute of Energy Economics Japan (2016), 'APEC Energy Demand and Supply Outlook', 6th Edition, Vol. 1.

BMI Research (2015), 'Malaysia Oil and Gas Report Q1 2016, Includes 10-Year Forecasts to 2024'.

Clean Air Asia (2012), 'Accessing Asia: Air Pollution and Greenhouse Gas Emissions Indicators for Road Transport and Electricity 2012'.

Department of Environment, Ministry of Transport, Viet Nam (2015), 'Tracking Sustainable Transport in Vietnam: Data and Policy Review for Energy Efficiency and Climate Change 2015'.

Energy Policy and Planning Office, Ministry of Energy, Thailand (2013), 'Energy Statistics of Thailand 2013'.

ERIA Energy Project Working Group (2012–2013), 'EAS-ERIA Biodiesel Fuel Standard: 2013, as Benchmarking Standard for Biodiesel (FAME) in ASEAN and East Asia'.

Japan Automobile Manufacturers Association, Environment Committee, Climate Change Subcommittee, Kazuhisa Mogi (2016), 'CO_2 Emissions Reduction in Road Transport Sector (in Japan)', RITE Symposium, 7 March 2016.

Ministry of Energy and Mineral Resources, Indonesia (2013), 'Handbook of Energy and Economy Statistics Indonesia, 2013'.

Ong, H.C., T.M.I. Mahlia, and H.H. Masjuki (2011), 'A Review on Energy Pattern and Policy for Transportation Sector in Malaysia', *Renewable and Sustainable Energy Reviews*, Vol. 16, Issue 2012, pp. 532–42.

Pongthanaisawan, J., C. Sorapipatana, and B. Limmeechokchai (2007), 'Road Transport Energy Demand Analysis and Energy Saving Potentials in Thailand', *Asian J. Energy Environ.,* Vol. 8, Issue 1 and 2, pp. 49–72.