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Petroleum Product Trading and Security

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FOREWORD

During the 11^{th} APEC Energy Ministersô Meeting (EMM11) held in Beijing, China on 2^{nd} September 2014, the Ministers issued instructions to the Energy Working Group (EWG). This includes an instruction to Asia Pacific Energy Research Centre (APERC) to continue its cooperation on emergency response so as to improve the capacity building in oil and gas emergency response in APEC region.

Following this instruction, APERC has started implementing the Oil and Gas Security Initiative (OGSI) in November 2014. One of the three overarching pillars of the OGSI is the publication of the Oil and Gas Security Studies (OGSS).

The OGSS serves as a useful publication to APEC economies by having access to developments and issues on oil and gas security, and information on individual economyôs policies related to oil and gas security including responses to emergency situation. The research studies included in OGSS will help encourage the APEC economies to review and revisit their respective policies, plans, programmes and measures on oil and gas security, and may probably help them adopt appropriate approaches to handling possible supply shortage or supply emergencies in the future.

I would like to thank the contributors to the OGSS for the time they have spent doing research works. May I however highlight that the independent research project contents herein reflect only the respective authorsô view and not necessarily APERCôs and might change in the future depending on unexpected external events or changes in the oil and gas and policy agendas of particular economies or countries.

I do hope that the OGSS will serve its purpose especially to the policy makers in APEC in addressing the oil and gas security issues in the region.

Takato OJIMI
President
Asia Pacific Energy Research Centre

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I would like to thank all those who contributed to the completion of this report in various forms. It would not have been completed without their valuable contributions. I wish to express my deepest appreciation to my colleagues, Mr. Yuji Matsuo, Senior Economist and Mr. Yasuaki Kawakami, Economist in EDMC, IEEJ for reviewing this report and providing me with their constructive advices and comments. This report has benefited enormously from their valuable contributions.

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Chapter 3

Executive Summary

Diesel fuel, which has increased in quantity in close association with economic growth, is used for various purposes, such as truck transport, railroads, power generation (including private power generation), and industrial fuel. Along with the recent progress in fuel substitution and energy saving, reforms toward the reduction or discontinuation of subsidies are making headway. For gasoline, on the other hand, a standard of living of each person has improved, and people in the middle-income group have become eager to own private cars. As is the case with diesel fuel, the retail prices of gasoline are controlled to remains below the international market through providing subsidies. Even if prices rise due to the discontinuation of subsidies, it will have little impact on gasoline demand as people's motive to buy private cars as a status symbol is strong. On the other hand, since the price elasticity of diesel fuel demand is relatively great, the growth rate in diesel fuel demand is expected to decline. Consequently, the present demand structure of petroleum products, which is extremely skewed toward diesel fuel, will gradually change to a more balanced one as the ratio of gasoline increases and that of diesel fuel decreases. In light of this, closer attention should be paid to the success or failure of the subsidy reforms in Indonesia that has the largest petroleum demand in the region.

On the other hand, environmental issues and fuel quality improvement have become matters requiring urgent attention. While progress in efforts toward the quality improvement (standards) of gasoline and diesel fuel varies from country to country, most countries aim to shift from standards equivalent to EURO III to those equivalent to EURO IV in the 2010s (some countries aim to shift to standards equivalent to EURO V). While such a goal requires a considerable investment in the construction and expansion of secondary facilities, most countries, except Indonesia, will achieve it, although there may be some delay.

Based on these conditions, the supply-demand balance from 2011 to 2020 was estimated. The supply-demand balance for gasoline and diesel fuel will be confirmedly improved on the ground that efforts to improve fuel quality will continue and that imports from outside the region (supply-demand gaps) will shrink significantly. Numerically, it was confirmed that these gaps could be fully filled by exports from Japan, Korea, and Chinese Taipei (actually, exports from China are also great in volume).

While the ASEAN region as a whole is heading toward improvement and seems to have no problems, when viewed individually, there are countries that have many problems. In Indonesia, which has the largest petroleum demand in the region, the supply-demand gap in gasoline and diesel fuel reached no less than 520,000 b/d in 2011, and fuel

quality has been slow to improve. In order to solve this gap all at once, three to four 200,000 b/d-class refineries must be built, which is difficult to achieve due to a considerable investment required for it. While it is already being implemented, it is essential to make an effort to prevent the aggravation of the current supply-demand balance by creating more additional production capacity than incremental demand through de-bottlenecking of existing refineries. In this respect, the aforementioned demand control via reduction or discontinuation of subsidies will also play a key role.

For the solutions to the current significant supply-demand gaps, it seems effective to create a framework that achieves not exports on an as-needed basis, but long-term exports[1], that is, stable exports for a long period of time, such as about 10 years, through cooperation with Japan, Korea, and Chinese Taipei. The establishment of a stable supply system will enable these ASEAN countries to concentrate on solving domestic problems. On the other hand, it is very likely that petroleum demand will further decline in Japan after the 2020 Olympics. Therefore, the establishment of win-win relationships between the ASEAN region and Japan, Korea, and Chinese Taipei seems to serve as one of various useful approaches toward a good supply-demand balance, including efforts to reduce facilities to realize supply commensurate with domestic demand.

As discussed so far, the supply-demand balance in the ASEAN region, its member states, and neighboring economies was examined and analysed in this article. In the future, it is planned to examine more specifically the development of mutual trading flows with a focus on Indonesia, Singapore, Japan, Korea, and Chinese Taipei while giving due consideration to long-term contract refining (exports).

1 Contract refining is the way the payment (lease fees and refining direct costs) is implemented in the form of leasing a refinery or refining facilities instead of trading products..

1. Introduction

Demand for petroleum products in the APEC region, particularly in the ASEAN region, has been increasing significantly. While the expansion of refining facilities is underway, demand still outstrips supply, and imports from outside the region remain high. This research study aims analysing how the supply and demand balance of petroleum products in the ASEAN region would change over the period of 2011 to 2020 and identify problems and issues while considering the impact of the following:

(1) Restraining growth in demand for gasoline and diesel fuel by reducing or discontinuing subsidies

(2) Measures to improve fuel quality in response to the aggravation of environmental problems (reduction in sulfur content, a shift from standards equivalent to EURO III to those equivalent to EURO IV)

(3) Progress in the plan to expand the capacity of major refining units

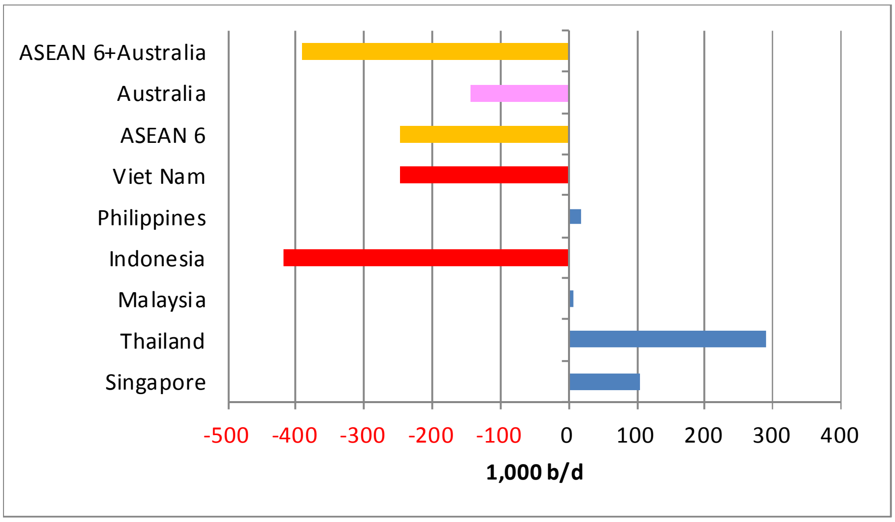
Since quantitative considerations are required to achieve the purpose, it was decided to make a trial calculation of the supply-demand balance of petroleum products centering on gasoline and diesel fuel in the ASEAN region (six major ASEAN countries + Australia) using the petroleum-refining model (LP model) developed by IEEJ and to examine the export capabilities of neighboring economies (Japan, Korea, Chinese Taipei, and China).

2. Supply and demand balance in the ASEAN and surrounding regions

2.1 Demand structure in the ASEAN region

Figure 2.1-1 shows the supply-demand balance in the six major ASEAN countries as of 2011 (Singapore, Thailand, Malaysia, Indonesia, Viet Nam, and the Philippines) and Australia where efforts toward integration into the ASEAN region are being made. The region including these countries can be divided into three groups: The first group includes Singapore which, despite low domestic demand for petroleum products, has refineries that export petroleum products to countries in the region, and Thailand and Malaysia where highly sophisticated refineries exist, which enable not only to meet domestic demand, but also to export some. The second group includes Indonesia, a resource-rich country in the region, where despite a long history of petroleum refining, ever-increasing demand outstrips its refining capacity, leading to a significant gap between supply and demand (over 400,000 b/d), and emerging Viet Nam, which currently faces a great supply-demand gap (approx. 200,000 b/d) despite the fact that the first refinery was built and put into operation in 2009, and the second and third refinery construction plans are currently underway. The Philippines is also included in this group, where the rehabilitation of aging refineries has made little headway, leading to a reliance on imports. The third group includes Australia, although it is not included in the ASEAN region. In Australia, while aging or unprofitable refineries have been closed and the gap between supply and demand is widening, efforts toward integration with the ASEAN region have been promoted, as exemplified by the fact that, coupled with distributional advantages, the supply of petroleum products to the northern and northwestern regions of the country depends heavily on imports from Singapore.[2]

In 2011, the average supply-demand gap in the six major ASEAN countries was approximately 250,000 b/d and that in the six majors and Australia was approximately 390,000 b/d. Thus, the gap became too great to be filled only by trading within the ASEAN region in the broad sense, leading to needs for imports from neighboring economies.



[2] Currently, since Singapore does not export sulfur-free gasoline or diesel fuel, it is imported from Korea and Japan. However, the supply of diesel fuel is expected to become available from Singapore by 2014 and that of gasoline by about 2020.

(1,000b/d)

Singapore			Thailand			Malaysia		
Demand	CDU Capacity	Availability	Demand	CDU Capacity	Availability	Demand	CDU Capacity	Availability
1,153	1,257	104	858	1,146	288	580	588	8

Indonesia			Philippines			Viet Nam		
Demand	CDU Capacity	Availability	Demand	CDU Capacity	Availability	Demand	CDU Capacity	Availability
1,431	1,012	-419	254	273	19	388	140	-248

ASEAN 6			Australia			ASEAN 6+Australia		
Demand	CDU Capacity	Availability	Demand	CDU Capacity	Availability	Demand	CDU Capacity	Availability
4,664	4,416	-248	901	757	-144	5,565	5,173	-392

Figure 2.1-1: Current Supply-Demand Gaps in Major ASEAN Countries in 2011

(Source) Data for petroleum product demand are from IEA, while data for refining capacity were created by IEEJ based on NEXANT and FGE reports.
(Note) LPG is excluded from demand for petroleum products.[3]

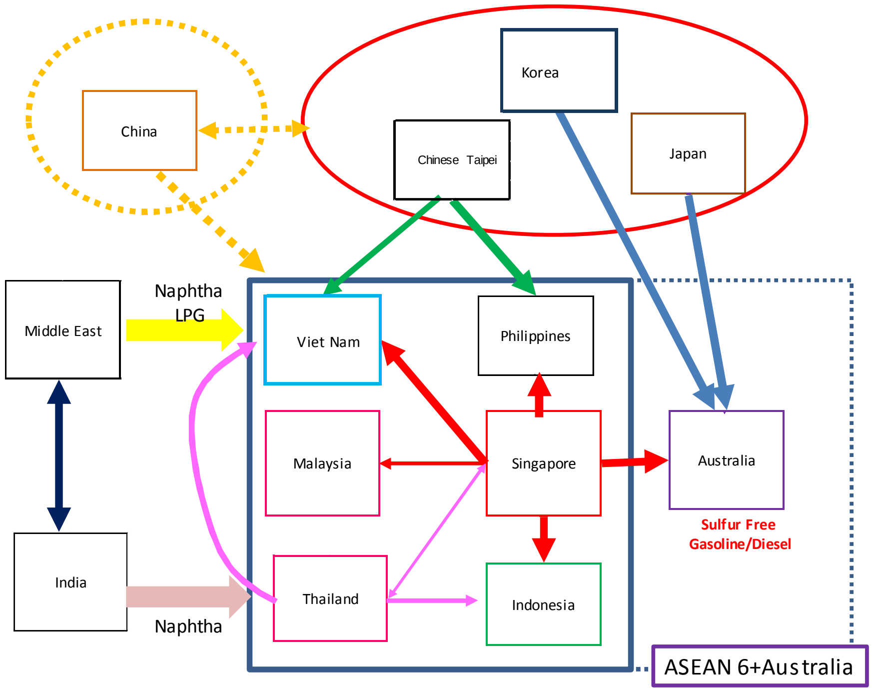
Then, the issues are how much the ASEAN intraregional trade can compensate the supply-demand gap in petroleum products and how the imports from neighboring economies cover the remaining products that cannot be compensated by the intraregional trade. Figure 2.1-2 shows a conceptual trade flow[4] of gasoline and diesel fuel between the ASEAN region and neighboring economies.

In the ASEAN region, products are supplied mainly from Singapore to Indonesia to Viet Nam and to Australia as well. On the other hand, Viet Nam and the Philippines import products from Chinese Taipei and China partly because of geographical closeness. For neighboring economies, while Japan, Korea, and Chinese Taipei played an important role in the past as product suppliers to the ASESAN region, their supply capabilities have been gradually decreasing due to a reduction in refining facilities (a slight increase in Korea) in response to a downturn or stagnation in domestic demand. On the contrary, China now has the greatest supply capability due to the significant expansion of the refining capacity. However, China, for the time being, must make the utmost effort to improve the quality of petroleum products to solve serious environmental problems that exist within the country. Consequently, it seems that China will not aim boosting the production ratio of refineries to increase the exports of

[3] Although LPG can be produced from a petroleum refining process, most of it is separated from associated gas obtained when crude oil and natural gas are produced. Therefore, when considering supply from the petroleum refining process, the impact of LPG that was produced from processes other than the petroleum refining process must be excluded. LPG, therefore, was excluded all together from petroleum product demand in this study for convenience sake.

[4] The directions of arrows in the diagram show the directions of product exports, more specifically, the directions of net exports (the difference between a country's total value of exports and total value of imports). While realistically speaking, products can be exported and imported,the net exports were used in this study to see how the supply-demand gap in each country and region is filled.

petroleum products, but limit its trading of petroleum products to the extent necessary to achieve the domestic supply-demand balance. In any case, if China is added to Japan, Korea, and Chinese Taipei, the supply-demand gap in the ASEAN region will be resolved. Finally, the ASEAN six majors are heavily reliant on imports from outside the region for LPG whose demand is increasing significantly in the region, naphtha that is a petrochemical raw material, and heavy oil.



		Net Export (Net Import)							(1,000 b/d)
		Singapore	Thailand	Malaysia	Indonesia	Philippines	Viet Nam	ASEAN 6	Australia
2011	Gasoline	218	15	-95	-275	-30	-64	-231	-41
	Gasoil	175	71	14	-251	-49	-88	-128	-151

Figure 2.1-2 Petroleum product flow between major ASEAN countries and neighboring countries (net exports)

(Conceptual diagram for gasoline and diesel fuel)

2.2 Prospects for Petroleum Product Demand

2.2.1 Current Situation and Future Outlook of the ASEAN Region

Table 2.2-1 shows growth in gasoline and diesel fuel demand in each country for two periods (from 2005 to 2010 and from 2011 to 2020). While there is no change in the basic trend in the ASEAN region that product demand increases along with continuing economic growth, the growth rate in gasoline demand in the second period is expected to decrease from the annual rate of 4.2% to 2.8% and that of diesel fuel from 2.4% to 2.1%. This is due to a financial shortage in each country, which resulted partly from a slowdown in China's economic growth and soaring oil prices, and the consequent discontinuation of or reduction in subsidies for gasoline and diesel fuel (which in turn results in an increase in retail prices). While there are countries, such as Viet Nam and the Philippines, where the existing trends continue, Thailand, Malaysia, and Indonesia are expected to experience a significant change. That is, due to the reduced subsidies and fuel alternatives, fuel demand for power generation and industrial uses except vehicles has been decreasing continuously, and the growth rates in fuel demand for vehicles, such as trucks, show signs of stagnation. In particular, Indonesia decided to discontinue subsidies by 2020 and raised fuel prices by over 30% in November 2014. Despite such drastic measures, the fuel prices will be further raised in stages in the future, during which diesel fuel demand is expected to remain at the same level or decrease.

Table 2.2-1: Estimates of changes in gasoline and diesel fuel demand in major ASEAN countries (2011–2020)

(1,000 b/d)

	Incremental Demand				Annual Average Growth Rate (AAGR)			
	Gasoline		Diesel		Gasoline		Diesel	
	05-11	11-20	05-11	11-20	05-11	11-20	05-11	11-20
Singapore	4	1	9	96	4.1%	0.6%	2.4%	10.1%
Thailand	−1	33	5	59	−0.2%	2.7%	0.3%	1.8%
Malaysia	−1	55	17	−1	−0.1%	2.9%	1.5%	0.0%
Indonesia	155	101	112	−107	7.1%	2.2%	3.5%	−2.1%
Philippines	6	29	11	42	1.4%	3.9%	1.6%	3.3%
Viet Nam	54	51	46	63	11.1%	4.2%	5.8%	3.7%
Asean6	216	271	201	152	4.2%	2.8%	2.4%	1.1%
Australia	−13	−26	97	49	−0.7%	−0.9%	5.3%	1.4%
Asean6+Australia	203	245	297	202	2.9%	1.9%	2.9%	1.1%
Asean5 (ex. Singapore)	211	270	191	57	4.2%	2.8%	2.4%	0.4%

(Source) Actual figures are based on data from IEA while estimates for 2020 were created by IEEJ based on FACTS (autumn 2014) data.

Since raising the retail prices of diesel fuel all at once in the current situation may significantly affect economic growth, policymakers are cautious about doing it, and it seems unlikely that the discontinuation of subsidies will be implemented in one stroke. Therefore, demand restraints may not have a profound effect on diesel fuel for the time being. On the other hand, gasoline demand may increase as income levels rise and the individual ownership of private cars (status symbol) increases. Therefore, the impact of a price increase (the discontinuation of subsidies) on gasoline demand could be relatively small.

It follows then that if subsidies for gasoline and diesel fuel are discontinued while economic growth continues, the composition ratio of diesel fuel, which has accounted for a large portion of petroleum product demand in recent years, will gradually decrease as shown in Table 2.2-2 and that of gasoline will increase instead. Figures 2.2-1 to 2.2-3 show the component ratio of domestic demand by product in each country in 2005, 2011, and 2020.

Table 2.2-2: Estimates of the component ratios of gasoline and diesel fuel in major ASEAN countries (2011–2020)

	Gasoline			Diesel		
	2005	2011	2020	2005	2011	2020
Singapore	2%	2%	1%	7%	5%	11%
Thailand	17%	15%	16%	45%	40%	41%
Malaysia	36%	35%	40%	35%	37%	33%
Indonesia	26%	34%	42%	43%	46%	38%
Philippines	25%	26%	27%	43%	45%	44%
Viet Nam	25%	31%	32%	47%	43%	42%
Asean6	20%	21%	23%	35%	33%	31%
Australia	43%	38%	33%	34%	43%	47%
Asean6+Australia	24%	24%	25%	35%	34%	33%
Asean5 (ex. Singapore)	25%	28%	32%	42%	43%	39%

(Source) Actual performance is based on IEA data and estimates for 2020 were created by IEEJ based on FACTS (autumn 2014) data.

(Note) LPG is excluded from petroleum product demand.

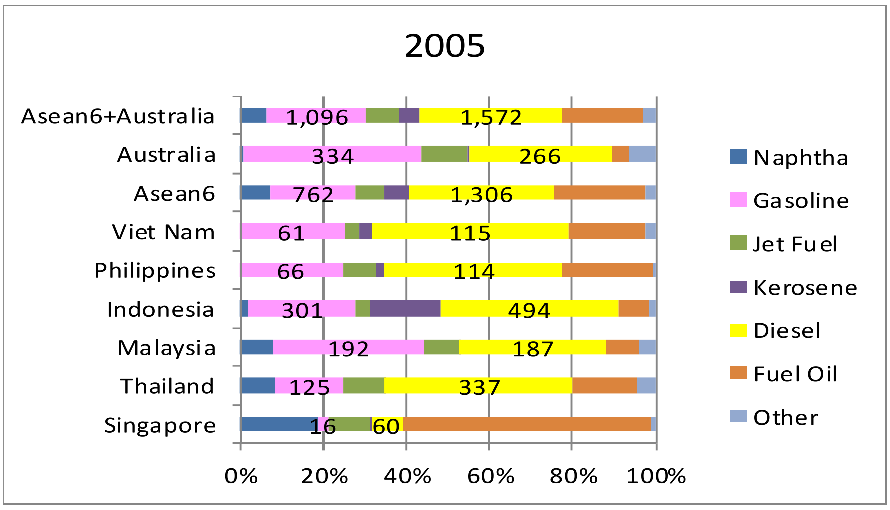


Figure 2.2-1: Breakdown of Petroleum Product Demand in Major ASEAN Countries (2005)

(Source) Actual performance is based on IEA data and estimates for 2020 were created by IEEJ based on FACTS (autumn 2014) data.

(Note) LPG is excluded from product demand. Figures in the diagram are absolute values (1000 b/d), not component ratios.

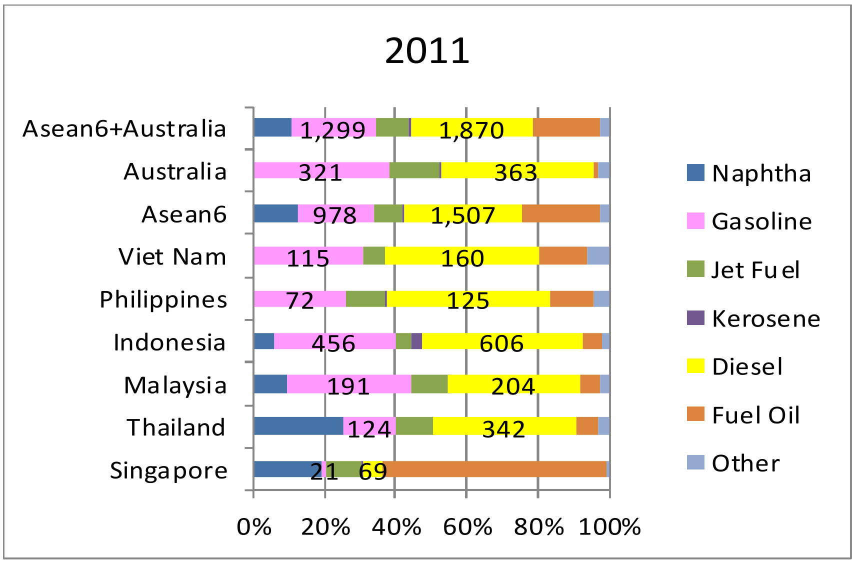


Figure 2.2-2: Breakdown of Petroleum Product Demand in Major ASEAN Countries (2011)

(Source) Actual performance is based on IEA data and estimates for 2020 were created by IEEJ based on FACTS (autumn 2014) data.
(Note) LPG is excluded from product demand. Figures in the diagram are absolute values (1000 b/d), not component ratios.

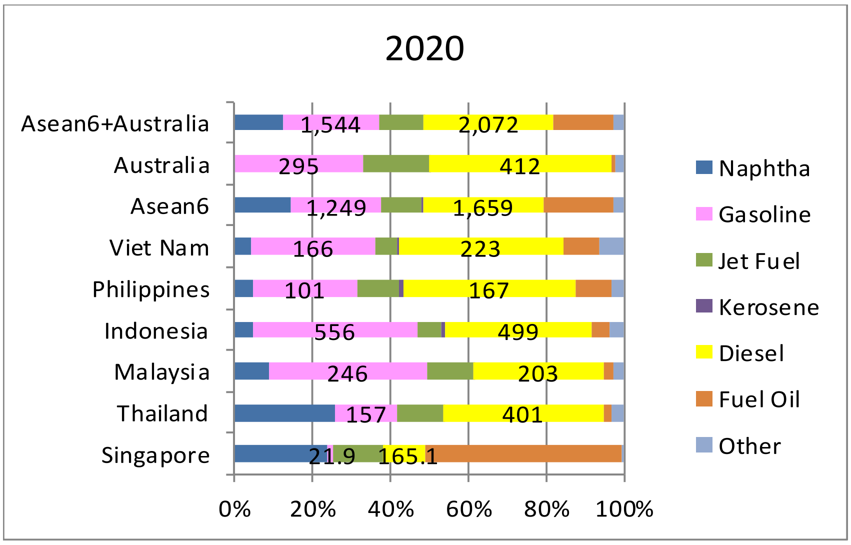


Figure 2.2-3: Breakdown of Petroleum Product Demand in Major ASEAN Countries (2020)

(Source) Actual performance is based on IEA data and estimates for 2020 were created by IEEJ based on FACTS (autumn 2014) data.
(Note) LPG is excluded from product demand. Figures in the diagram are absolute values (1000 b/d), not component ratios.

2.2.2 Current Situation and Future Outlook of the Surrounding Region

Table 2.2-3 shows the growth rates in gasoline and diesel fuel in each country for the two periods of 2005 to 2010 and 2011 to 2020. The three economies of Japan, Korea, and Chinese Taipei have mature economy, where petroleum product demand has been on the decrease or remained the same. It is expected that this trend will continue in the future. The decrease in demand is particularly great in Japan. The low decrease rates in diesel fuel demand or demand at almost the same level in the second period represent a temporary trend due to public works for the 2020 Tokyo Olympics, and the decrease rates in diesel fuel demand are expected to become high after 2020.

China has so far maintained high economic growth, and petroleum product demand has increased greatly. In the first period that includes the 2008 Beijing Olympics and the 2010 Shanghai World Expo, the annual growth rate of gasoline demand and that of diesel fuel demand were high (7.8% and 7.3% respectively). In the second period, however, China's economic growth decelerated and growth in demand for different types of diesel fuel (for trucks, railways, power generation, and industrial fuel), which had driven high economic growth of China, dropped significantly to the annual rate of less than 1%. On the other hand, the annual growth rate of gasoline demand is expected to remain high (6%) due to the improved standard of living and the continued momentum in purchasing private cars.

Consequently, as Table 2.2-4 shows, while the composition ratios of domestic gasoline and diesel fuel demand in Japan, Korea, and Chinese Taipei remain the same, the composition ratio of gasoline is expected to increase and that of diesel fuel is expected to decrease in China. Figures 2.2-4 to 2.2-6 show the breakdown of domestic demand by petroleum product in each country for the years of 2005, 2011, and 2020.

Table 2.2-3: Estimates of changes in gasoline and diesel fuel demand in neighboring economies

	Incremental Demand				Annual Average Growth Rate (AAGR)			
	Gasoline		Diesel		Gasoline		Diesel	
	05-11	11-20	05-11	11-20	05-11	11-20	05-11	11-20
Japan	−79	−120	−323	−17	−1.3%	−1.4%	−5.4%	−0.2%
Korea	27	25	−25	29	2.6%	1.4%	−1.0%	0.8%
Chinese Taipei	−11	4	−11	−2	−1.0%	0.2%	−1.8%	−0.2%
JST	−62	−91	−359	10	−0.7%	−0.8%	−3.9%	0.1%
China	653	1,252	1,170	247	7.8%	6.0%	7.3%	0.8%
JST+China	591	1,161	810	257	3.5%	3.5%	3.2%	0.6%

(Source) Actual performance is based on IEA data and estimates for 2020 were created by IEEJ based on FACTS (autumn 2014) data.

Table 2.2-4: Breakdown of Gasoline and Diesel fuel Demand in Neighboring Economies

	Gasoline			Diesel		
	2005	2011	2020	2005	2011	2020
Japan	23%	26%	26%	25%	22%	24%
Korea	8%	9%	9%	21%	19%	18%
Chinese Taipei	21%	21%	21%	13%	12%	12%
JST	19%	20%	19%	22%	20%	20%
China	20%	21%	28%	39%	39%	34%
JST+China	19%	21%	25%	30%	31%	29%

(Source) Actual performance is based on IEA data and estimates for 2020 were created by IEEJ based on FACTS (autumn 2014) data.
(Note) LPG is excluded from product demand.

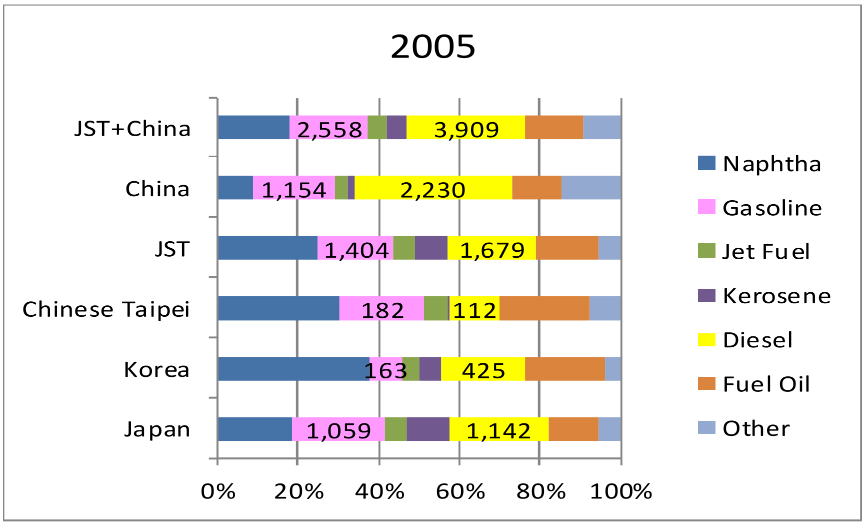


Figure 2.2-4: Breakdown of Petroleum Product Demand in Neighboring Economies (2005)

(Source) Created by IEEJ based on IEA data

(Note) LPG is excluded from product demand. Figures in the diagram are absolute values (1000 b/d), not component ratios.

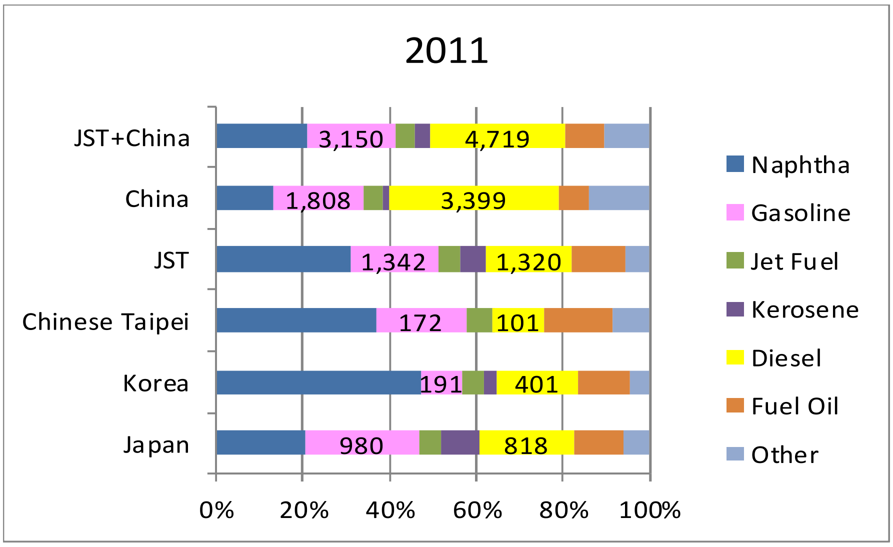


Figure 2.2-5: Breakdown of Petroleum Product Demand in Neighboring Economies (2011)

(Source) Created by IEEJ based on IEA data

(Note) LPG is excluded from product demand. Figures in the diagram are absolute values (1000 b/d), not component ratios.

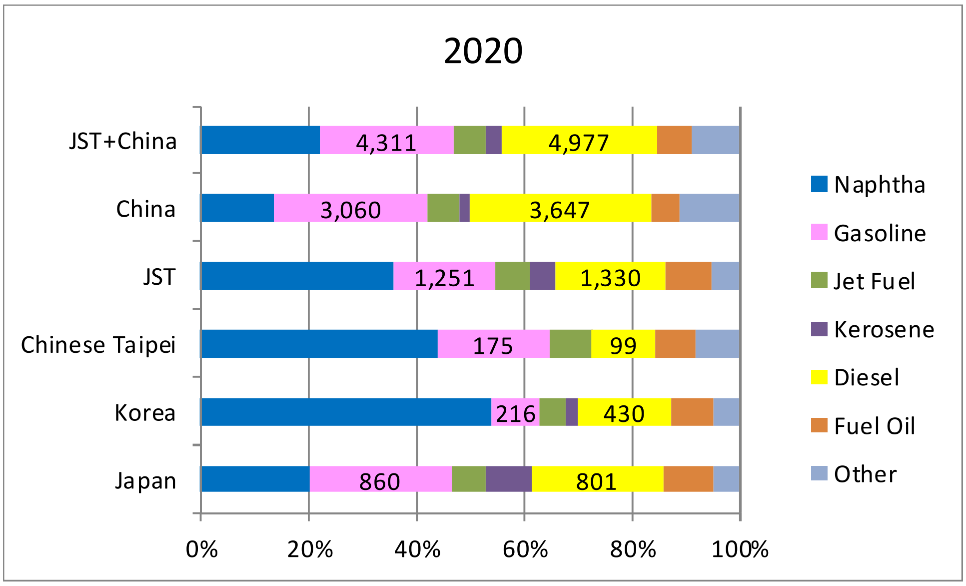


Figure 2.2-6: Breakdown of Petroleum Product Demand in Neighboring Economies (2020)

(Source) Created by IEEJ based on IEA data

(Note) LPG is excluded from product demand. Figures in the diagram are absolute values (1000 b/d), not component ratios.

2.3 Current Situation of and Future Outlook of Petroleum Refining Facilities and Quality (product standards)

2.3.1 Low-sulfurization of Gasoline and Diesel fuel

Quality (product standards) of gasoline and diesel fuel in the ASEAN region from 2011 to 2020 can be said roughly in transition from the EURO III standard (or equivalent) to the EURO IV standard (or equivalent). While there are a variety of quality items in the standards, this study focuses on the low sulfurization of petroleum products, which is important in terms of both environment and capital investment. Table 2.3-1 shows the schedule for the low sulfurization of gasoline and Table 2.3-2 shows the schedule for the low sulfurization of diesel fuel.

(1) Low sulfurization of gasoline

Low sulfurization of gasoline can be divided into the following three groups:

(i) Shift to 10 ppm, a level equivalent to the EURO V standard in or before 2020
(ii) Shift to 50 ppm, a level equivalent to the EURO IV standard, in 2020
(iii) Remain at the level of 100 ppm or higher in 2020 due to a failure to reach the level equivalent to the EURO IV standard.

In the ASEAN region, Singapore and Thailand fall under (i), while Malaysia and the Philippines fall under (ii) and Indonesia and Viet Nam (iii). In particular, as shown in Figure 2.3-1, Indonesia remains at the lowest level with the research octane number (RON) of 88 for regular gasoline. Japan and Korea shifted to (i) before 2010 and Chinese Taipei in 2014. In China that has the highest petroleum demand in Asia, the sulfur content of gasoline in major cities including Beijing is 50 ppm and it is 500 pm in other cities. Coupled with worsening environmental problems, China aims at lowering the sulfur content of gasoline to a 10 ppm level in the entire economy by 2020.

Table 2.3-1: Changes in the sulfur content of gasoline in major ASEAN and neighboring economies
Gasoline: sulfur content (ppm)

	2005	2010	2011	2012	2014	2015	2020
Japan	50	<10	<10	<10	<10	<10	<10
Korea	130	10	10	10	10	10	10
Chinese Taipei	180	50	50	50	10	10	10
China	800-150	150-50	150-50	150-10	50-10	50-10	10
Singapore	180	50	50	50	10	10	10
Thailand	500	500	500	50	50	10	10
Malaysia	1000	500	500	500	500	500-50	50
Indonesia	2,000	500	500	500	500	150	150
Philippines	500	150-500	150-500	150-500	50	50	50
Viet Nam	5,000	500	500	500	500	150	150
Australia	150	50	50	50	50	50	50

(Source) Created by IEEJ based on FACTS (autumn 2014) data

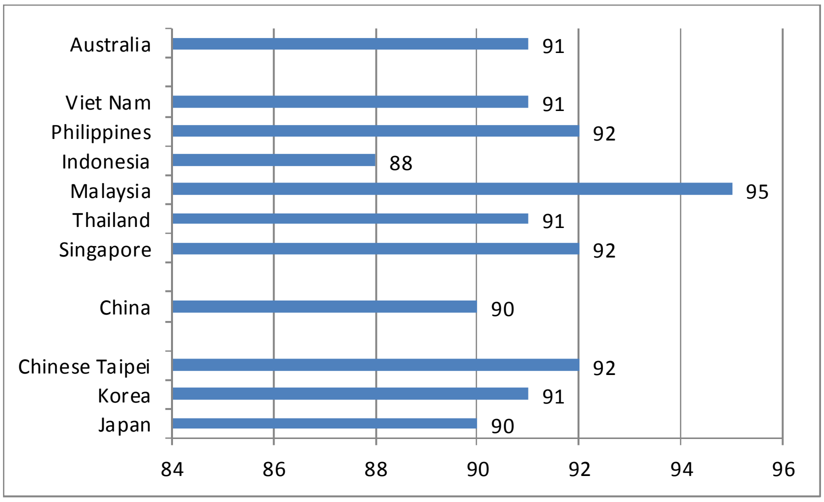


Figure 2.3-1: Comparison of the research octane number (RON) of regular gasoline among major ASEAN countries and neighboring economies

(Note) When there are three grades, the one with the lowest RON is listed.
(Source) Created by IEEJ based on FACTS (autumn 2014) data

Desulfurization up to 50 ppm is relatively easy to achieve by enhancing desulfurization of feed for Fluid catalytic cracking (FCC). However, various facilities need to be added to lower the level to sulfur-free levels (10 ppm or lower). Even if low sulfurization of feed (sulfur content of 0.2% at the maximum) is implemented, the sulfur content of 20 ppm to several dozen ppm is left in FCC gasoline, requiring further desulfurization (after treatment). Since desulfurization is generally conducted by adding hydrogen, which lowers the research octane number of gasoline, different blending stock are required to fill this gap. When there are not enough blending stocks for gasoline, it is often the case that facilities, such as isomer, alkylation, and ether (ETBE/MEBE), need to be added or their capacity increased to comply with regulations for benzene concentration, olefin concentration, and vapor pressure.

(2) Low sulfurization of diesel fuel

Low sulfurization of diesel fuel can be divided into the following three groups:

(i) Shift to 10 ppm, a level equivalent to the EURO V standard, in or before 2020
(ii) Shift to 50 ppm, a level equivalent to the EURO IV standard, in 2020
(iii) Remain at the level of 100 ppm or higher in 2020 due to a failure to reach the level equivalent to the EURO IV standard.

In the ASEAN region, Singapore and Thailand fall under (i), while Malaysia and the Philippines fall under (ii) and Indonesia and Viet Nam (iii). Among neighboring economies, Japan and Korea shifted to (i) before 2010 and Chinese Taipei in 2014. In China that has the highest petroleum demand in Asia, the sulfur content of gasoline in major cities, including Beijing, is 50 ppm and it is 500 pm in other cities. Coupled with worsening environmental problems, China aims to lower the sulfur content of diesel fuel to a 10 ppm level in the entire country by 2020.

Table 2.3-2: Changes in the sulfur content of diesel fuel in major ASEAN and neighboring economies

Diesel Fuel: Sulfur Content (ppm)

	2005	2010	2011	2012	2013	2015	2020
Japan	50	<10	<10	<10	<10	<10	<10
Korea	430	10	10	10	10	10	10
Chinese Taipei	350-50	50	50-10	10	10	10	10
China	2,000-350	500-50	500-50	500-10	350-10	50-10	10*
Singapore	500-50	50	50	50	50	10	10
Thailand	350	350	350	50	50	10	10
Malaysia	3,000-500	500	500	500	500	500-50	50
Indonesia	5,000	3,500	3,500-500	3,500-500	3,500-500	3,500-500	3,500-500
Philippines	500	350	350	350	350	350-50	350-50
Viet Nam	5,000	2,500-500	500	500	500	500	350
Australia	500	10	10	10	10	10	10

(Source) Created by IEEJ based on FACTS (autumn 2014) data

Desulfurization of diesel fuel up to 50 ppm can be achieved by using desulfurization technology for 500 ppm although the remaining quantitative issue (if throughput can be reduced, catalysts of desulfurization for 500 ppm can be used) should be addressed. When shifting to the 10 ppm level, however, the severity of desulfurization conditions, such as reaction temperature, pressure, and hydrogen consumption, significantly rises nearly to that of the conditions required for indirect heavy oil desulfurization (VDS) that desulfurizes vacuum gas oil. Therefore, an enormous amount of capital investment will be needed.

2.3.2 Expansion of major refining facilities

(1) Expansion of major facilities in the ASEAN region

Table 2.3-4 shows the expansion of major facilities, which was implemented in the ASEAN region from 2011 to 2020. It is expected that the overall petroleum product demand (excluding LPG) in the six major ASEAN countries will increase by about

940,000 b/d, among which gasoline will increase by about 270,000 b/d and diesel fuel by about 150,000 b/d. Since the capacity of crude distillation unit (CDU) is expected to increase by about 590,000 b/d and that of cracking by about 400,000 b/d, an increase of about 420,000 b/d in the total demand for gasoline and diesel fuel can be fully met. It can also be expected that a certain amount of production capacity[5] is added. Since the increment of diesel fuel desulfurization capacity is about 150,000 b/d, numerically speaking, it can meet the increase of about 150,000 b/d in demand and at the same time can enhance[6] the severity of desulfurization levels. Figures 2.3-2 and 2.3-3 show the summary of these points by country and by region.

Table 2.3-4: Estimates of the capacity expansion of major refining facilities in major ASEAN countries (2011-2020)

(1,000b/d)

	Singapore	Thailand	Malaysia	Indonesia	Philippines	Viet Nam	ASEAN 6	Australia	ASEAN 6 +Australia
CDU	0	0	300	90	0	200	590	-313	277
Cracking Unit	-2	0	140	107	71	80	396	-118	277
Diesel Desulfurization	81	0	93	0	0	61	235	-90	145
Up-grading Unit (Gasoline)	47	0	30	9	2	62	149	-83	66
Breakdown:Diesel Desulfurization									
(Diesel<10ppm)	278	262	0	0	0	0	540	-90	450
(Diesel <50ppm)	-197	0	149	0	10	0	-38	0	-38
(Diesel >50ppm)	0	-262	-56	0	-10	61	-267	0	-267
Between 2011 and 2020									
Dammed Increase (Total)	284	158	73	139	110	180	943	20	963
Demand Increase (Gasoline)	1	33	55	101	29	51	271	-26	245
Demand Increase (Gas Oil)	96	59	-1	-107	42	63	152	49	202

(Source) Appendix: Estimates of the capacity expansion of major refining facilities in major ASEAN and neighboring economies
(Note) Definition of secondary facility rates
Cracking: FCC +Coker +Hydrocracker, Up-grading Unit (Gasoline): Reformer +Isomerization +Alkylation

5 In order to obtain accurate results, the production balance should be examined using a petroleum refining LP (Linear Programming) model.

6 This is a net increment produced when devices with higher sulfurization capability are built by scrapping devices with lower sulfurization capability.

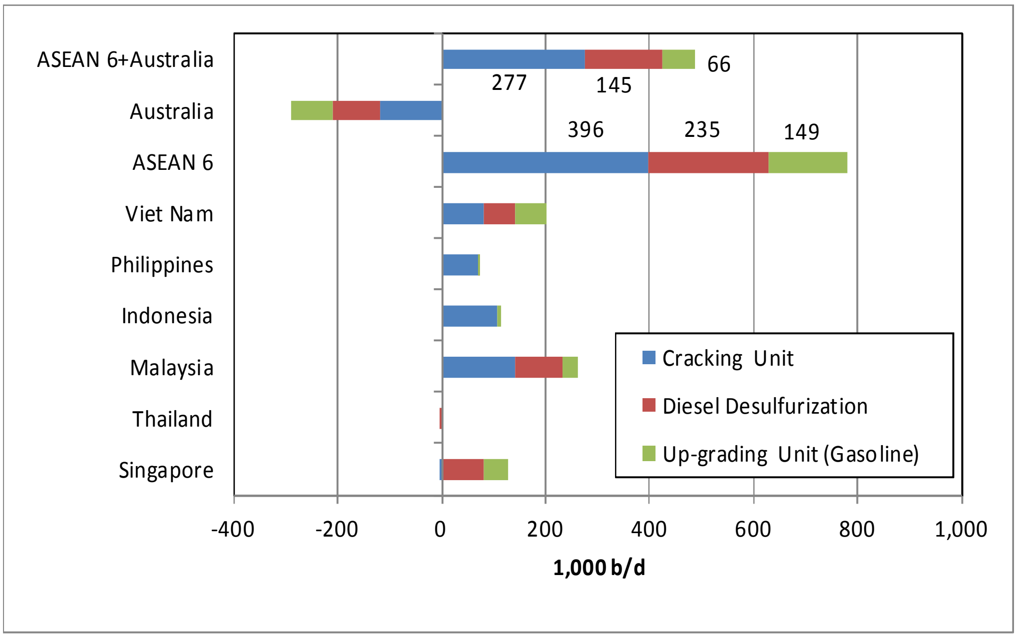


Figure 2.3-2: Estimates of the capacity expansion of secondary facilities in major ASEAN countries (2011–2020)

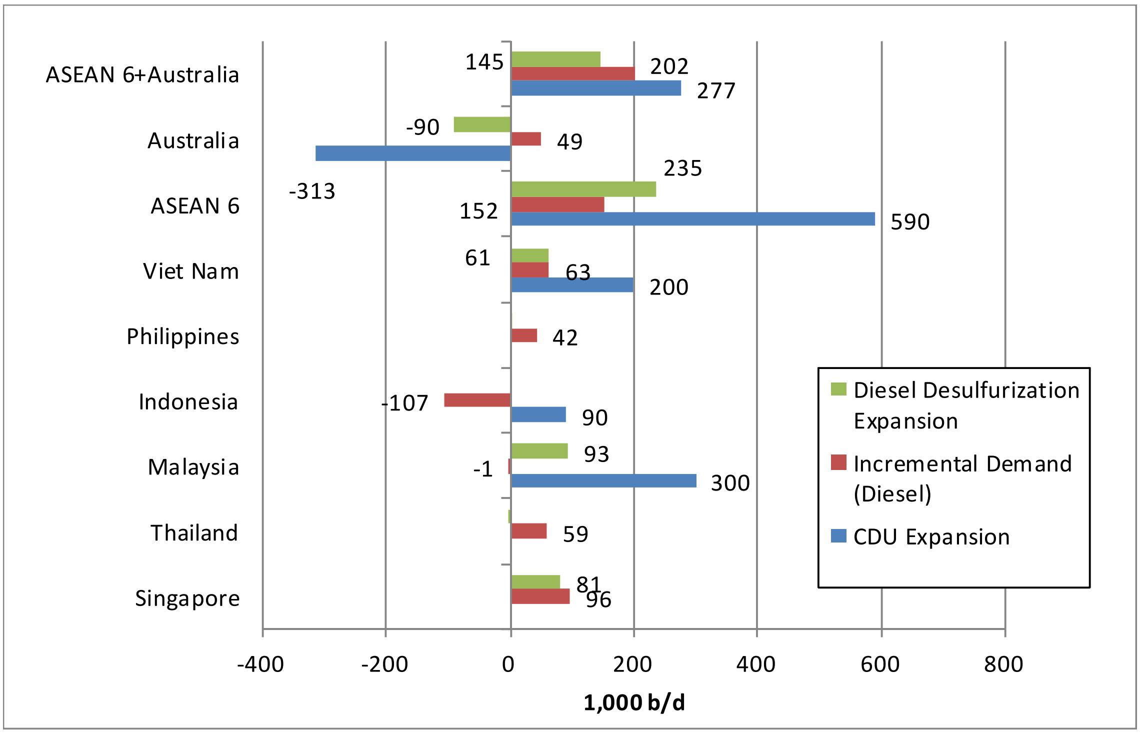


Figure 2.3-3: Estimates of the capacity expansion of crude distillation unit (CDU) and diesel fuel desulfurization and changes in petroleum product demand in major ASEAN countries (2011–2020)

(2) Expansion of major facilities in neighboring countries

Table 2.3-5 shows the expansion of major facilities in neighboring economies from 2011 to 2020. While the capacity of these facilities will slightly increase in Korea, that in Japan and Chinese Taipei will decrease. Therefore, the future capacity of major facilities in neighboring economies will be determined by how much the facilities in China will be expanded.

It is expected that while China's overall petroleum product demand (excluding LPG) will increase by about 2.650 million b/d, gasoline demand will increase by about 1.250 million b/d and diesel fuel only by 250,000 b/d. The capacity of crude distillation units (CDU) will be expanded by about 4.350 million b/d, making the operating rate of crude distillation unit (CDU) lower than now. On the other hand, the capacity of cracking units will be expanded by about 2.650 million b/d and that of reforming units for upgrading gasoline quality will be expanded by about 500,000 b/d. Moreover, since the capacity of desulfurization units for diesel fuel is expected to be expanded by about 2.500 million b/d (total of gasoline and diesel fuel), the sulfur content of 10 ppm could be achieved for both gasoline and diesel fuel if these expansion plans are realized.

Figures 2.3-4 and 2.3-5 show the summary of the aforementioned points by country and by region.

Table 2.3-5: Estimates of the capacity expansion of major refining facilities in neighboring economies (2011–2020)

(1,000b/d)

	Japan	Korea	Chinese Taipei	JST	China	JST+China
CDU	-838	124	-205	-918	4,337	3,419
Cracking Unit	-93	136	37	80	2,604	2,684
Diesel Desulfurization	-108	4	-3	-107	2,502	2,395
Up-grading Unit (Gasoline)	-96	171	-10	65	512	578
Breakdown:Diesel Desulfurization						0
(Diesel<10ppm)	-108	4	237	133	613	747
(Diesel <50ppm)	0	0	-240	-240	4,794	4,554
(Diesel >50ppm)	0	0	0	0	-2,906	-2,906
Between 2011 and 2020				0		0
Dammed Increase (Total)	-478	370	49	-59	2,638	2,579
Demand Increase (Gasoline)	-120	25	4	-91	1,252	1,161
Demand Increase (Gas Oil)	-17	29	-2	10	247	257

(Source) Appendix: Estimates of the capacity expansion of major refining facilities in major ASEAN countries and neighboring economies

(Note) Definition of secondary facility rates

Cracking Rate: FCC +Coker +Hydrocracker, Up-grading Unit (Gasoline) = (Reformer +Isomerization +Alkylation

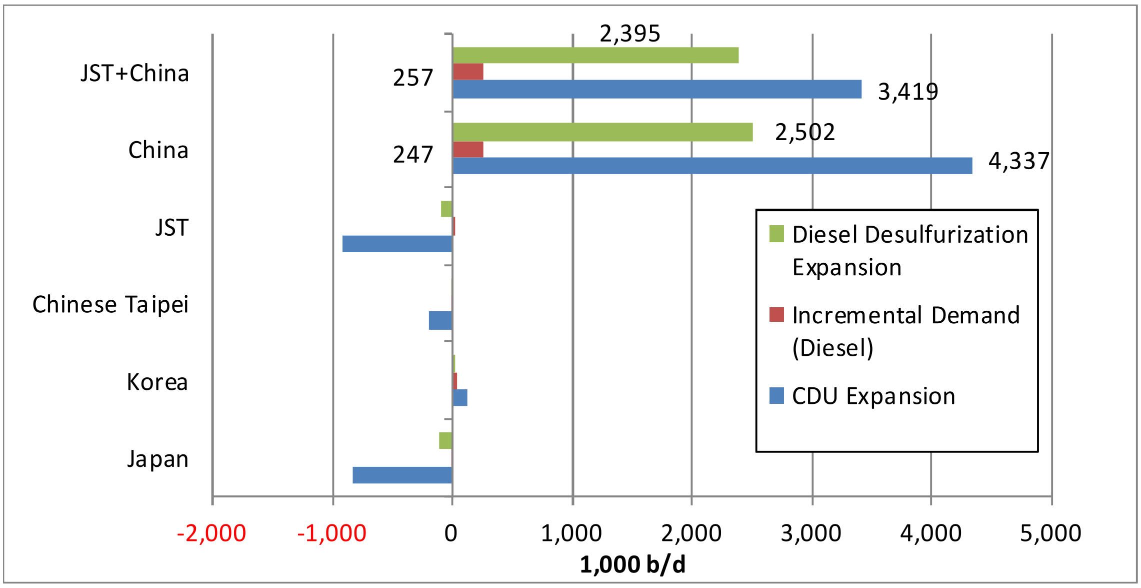


Figure 2.3-4: Comparison between the expansion of diesel fuel desulfurization capacity and an increase in demand in neighboring economies (2011–2020)

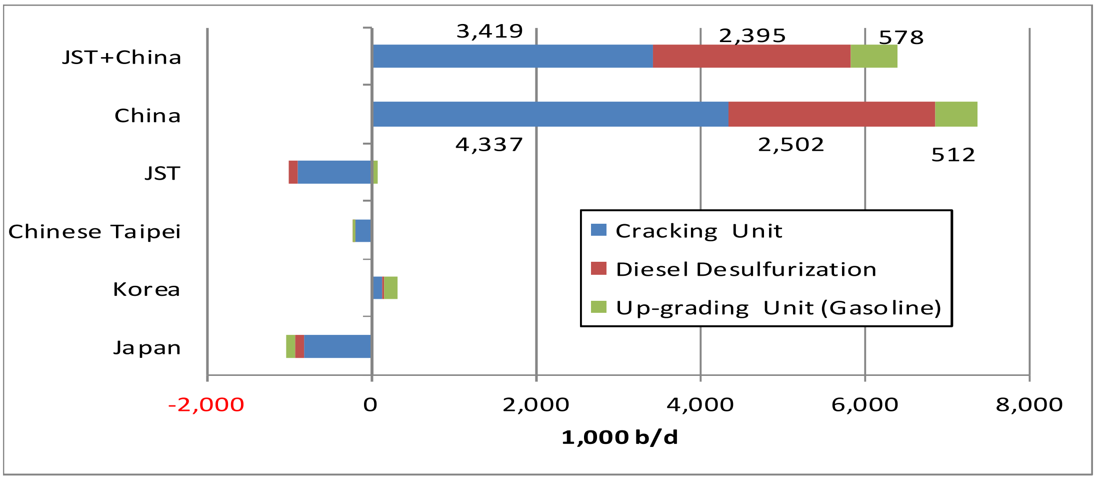


Figure 2.3-5: Estimates of the capacity expansion of secondary facilities in neighboring economies (2011–2020)

(3) Summary

Figures 2.3-6 and 2.3-7 show the indexing results of the cracking rate, gasoline upgrading rate, and diesel fuel desulfurization rate with the crude distillation unit (CDU) capacity as a denominator in order to compare secondary facility rates by country in major ASEAN and neighboring economies. However, since Viet Nam had only one refinery in operation in 2009 and later added cracking units, the result is represented in a rather exaggerated form. On the other hand, China's CDU capacity is too high (low operating rate), leading to underrepresentation of each index. Corrections should be made in the future by using appropriate capacity.

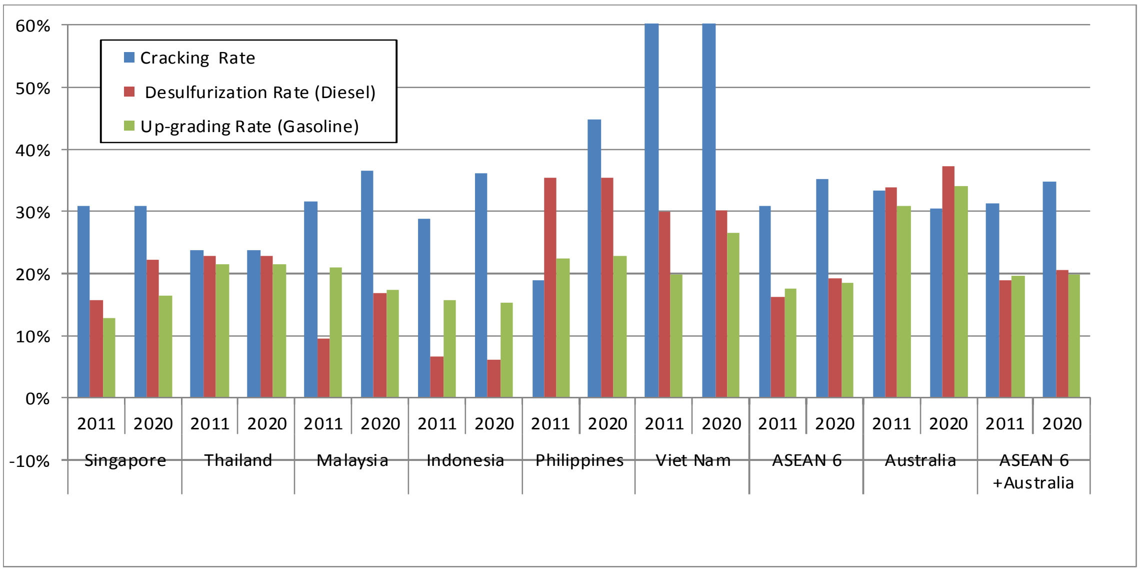


Figure 2.3-6: Estimates of secondary facility installation rates in major ASEAN countries (2011–2020)

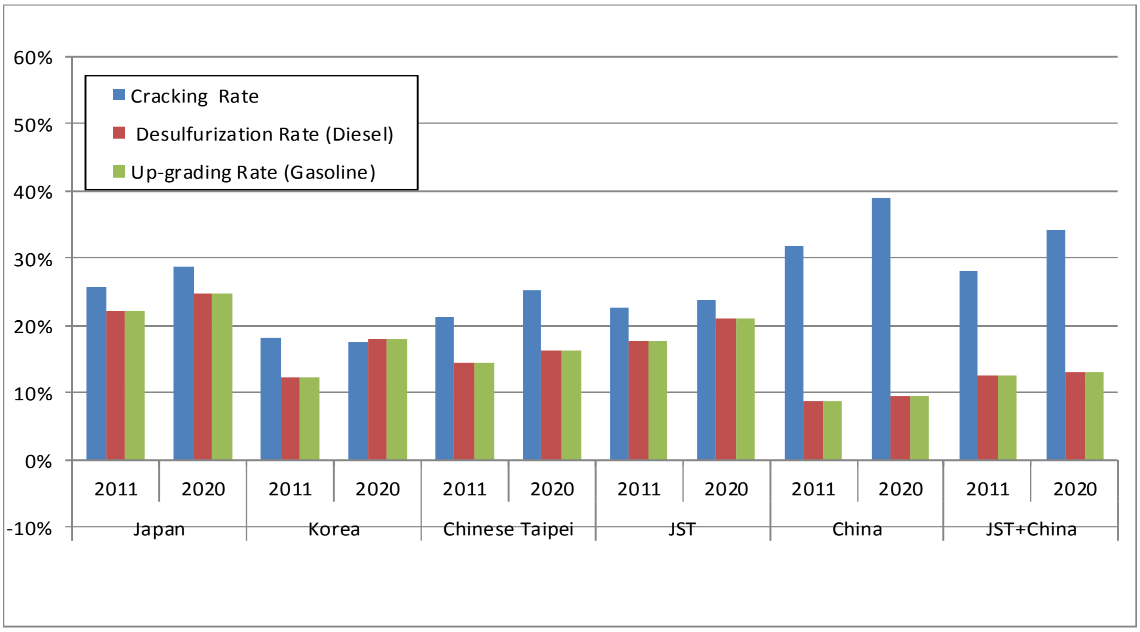


Figure 2.3-7: Estimates of secondary facility installation rates in neighboring economies (2011–2020)

(Note) Definition of secondary facility rates

Cracking Rate = (FCC +Coker +Hydrocracker: Capacity)/CDU Capacity

Desulfurization Rate (Diesel) = Desulfurization (Diesel) Capacity/ CDU Capacity

Up-grading Rate (Gasoline) = (Reformer +Isomerization +Alkylation) Capacity/ CDU Capacity

Appendix: Estimates of the capacity of major refining facilities in major ASEAN countries and neighboring economies (2011 and 2020)

(Major ASEAN Countries)

(1,000b/d)

	Singapore		Thailand		Malaysia		Australia	
	2011	2020	2011	2020	2011	2020	2011	2020
CDU	1,257	1,257	1,146	1,146	588	888	757	444
Condensate Splitter	100	210	135	135	74	74	0	0
Diesel Desulfurization	197	278	262	262	56	149	256	166
(Diesel<10ppm)	0	278	0	262	0	0	256	166
(Diesel <50ppm)	197	0	0	0	0	149	0	0
(Diesel >50ppm)	0	0	262	0	56	0	0	0
VDS/HDS	78	78	53	53	0	160	10	10
Coker/Visbreaker	204	204	40	40	33	33	0	0
FCC	46	46	68	68	0	0	195	95
RFCC	34	34	43	43	43	183	40	40
Hydrocracking	105	103	122	122	110	110	18	0
Reforming	146	193	215	215	109	139	171	106
Alkylation	9	9	0	0	0	0	25	16
Isomer	5	5	32	32	15	15	39	30
	160	207	247	247	124	154	235	152

(1,000b/d)

	Indonesia		Philippines		Viet Nam		ASEAN 6		ASEAN 6+Australia	
	2011	2020	2011	2020	2011	2020	2011	2020	2011	2020
CDU	1,012	1,102	273	273	140	340	4,416	5,006	5,173	5,449
Condensate Splitter	100	100	0	0	11	11	420	530	420	530
Diesel Desulfurization	67	67	97	97	42	103	721	956	976	931
(Diesel<10ppm)	0	0	0	0	0	0	0	540	256	706
(Diesel <50ppm)	0	0	0	10	0	0	197	159	197	159
(Diesel >50ppm)	67	67	97	87	42	103	524	257	524	67
VDS/HDS	0	0	0	0	0	105	131	396	141	406
Coker/Visbreaker	91	106	33	71	0	0	401	454	401	454
FCC	18	18	19	36	0	0	151	168	346	263
RFCC	83	145	0	0	65	145	268	550	308	590
Hydrocracking	100	129	0	16	110	110	546	590	564	590
Reforming	143	151	51	53	21	51	685	802	856	908
Alkylation	16	16	0	0	0	12	25	37	50	53
Isomer	0	0	10	10	7	27	69	89	108	119

(Neighboring Economies)

	Japan		Korea		Chinese Taipei		JST		China		JST+China	
	2011	2020	2011	2020	2011	2020	2011	2020	2011	2020	2011	2020
CDU	4,240	3,403	2,633	2,757	1,245	1,041	8,118	7,200	11,376	15,713	19,493	22,913
Condensate Splitter	129	129	169	509	70	70	368	708	105	105	473	813
Diesel Desulfurization	1,090	982	478	482	266	263	1,834	1,727	3,632	6,134	5,466	7,861
(Diesel<10ppm)	1,090	982	478	482	26	263	1,594	1,727	0	613	1,594	2,341
(Diesel <50ppm)	0	0	0	0	240	0	240	0	726	5,521	966	5,521
(Diesel >50ppm)	0	0	0	0	0	0	0	0	2,906	0	2,906	0
VDS/HDS	1,637	1,470	356	473	390	415	2,382	2,357	273	1,551	2,655	3,908
Coker/Visbreaker	120	120	34	34	48	34	202	188	1,693	2,130	1,895	2,318
FCC	671	599	167	127	250	301	1,088	1,027	1,871	2,835	2,959	3,862
RFCC	312	312	191	346	0	0	503	657	801	1,215	1,304	1,872
Hydrocracking	152	130	247	267	23	23	422	421	1,151	1,941	1,573	2,361
Reforming	812	722	279	429	131	117	1,221	1,268	943	1,435	2,164	2,703
Alkylation	97	97	45	65	27	40	168	202	37	45	205	246
Isomer	31	25	0	0	24	15	56	40	11	24	67	64

(Source) Estimated by IEEJ based on NEXANT and FACTS (autumn 2014) data

3. Current Situation and Future Outlook of the Supply-Demand Balance in the ASEAN Region

3.1 Changes in supply-demand balance based on the petroleum-refining model (LP)

3.1.1 Overview of the petroleum-refining model

A petroleum refinery is a system of units that produce a variety of petroleum products as co-products. Each unit in the petroleum refining process, in particular Fluid catalytic cracking (FCC), a core unit for the production of gasoline blending stock, and the catalytic reforming unit (RF or CCR) play an important role in producing basic petrochemicals. Catalytic reformed gasoline (reformate) is a gasoline blending stock with a high research octane number and at the same time are aromatic petrochemicals (BTX: benzene, toluene, xylene) and forms trade-off relationships with gasoline blending stocks. On the other hand, a propylene-oriented process that suppresses the yield ratio of catalytically cracked gasoline (FCC gasoline), one of the main products, and raises the yield ratio of propylene, a by-product, is beginning to be widely used. Thus, as Figure 3.1-1 shows, the deepening of the petroleum refining process and its integration with petrochemicals have been gaining impetus, making it difficult to strike a self-contained production balance by petroleum refining alone.

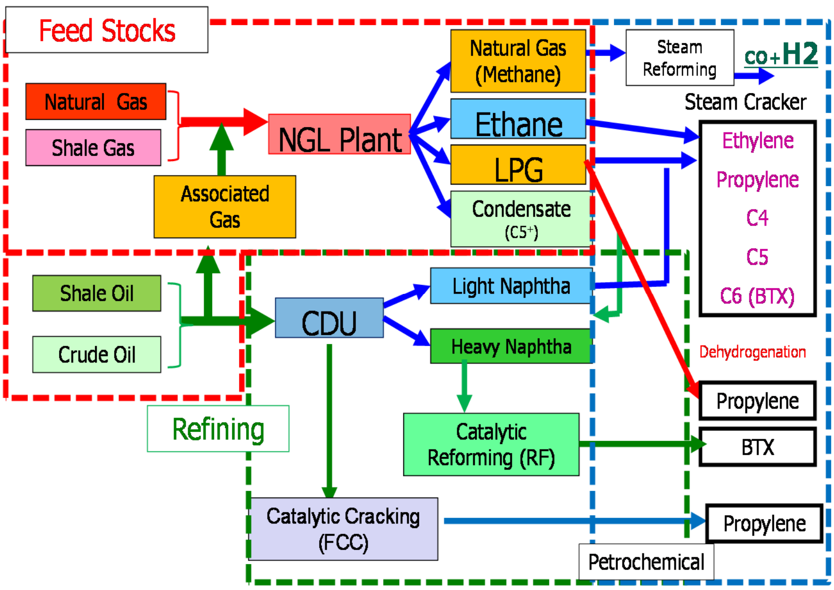


Figure 3.1-1: Deepening of the petroleum refining process and its integration with petrochemicals (conceptual diagram)

The world integrated model developed by IEEJ is an all-in-one model that combines the NGL plant, petroleum refining, and petrochemicals (upstream) as shown in Figure 3.1-1 and has a world trade model (Figure 3.1-2) as a module. However, since it can also be used as a stand-alone petroleum-refining model by separating the NGL plant and petrochemicals, it is used in this study focusing on the supply-demand balance centering on traditional petroleum products. Therefore, the supply of raw materials to petrochemicals is set as an exogenous variable. Figure 3.1-3 shows the configuration of major petroleum refining facilities and a petroleum refining flow for reference.

: Structure of World Trade Model - Prototype -

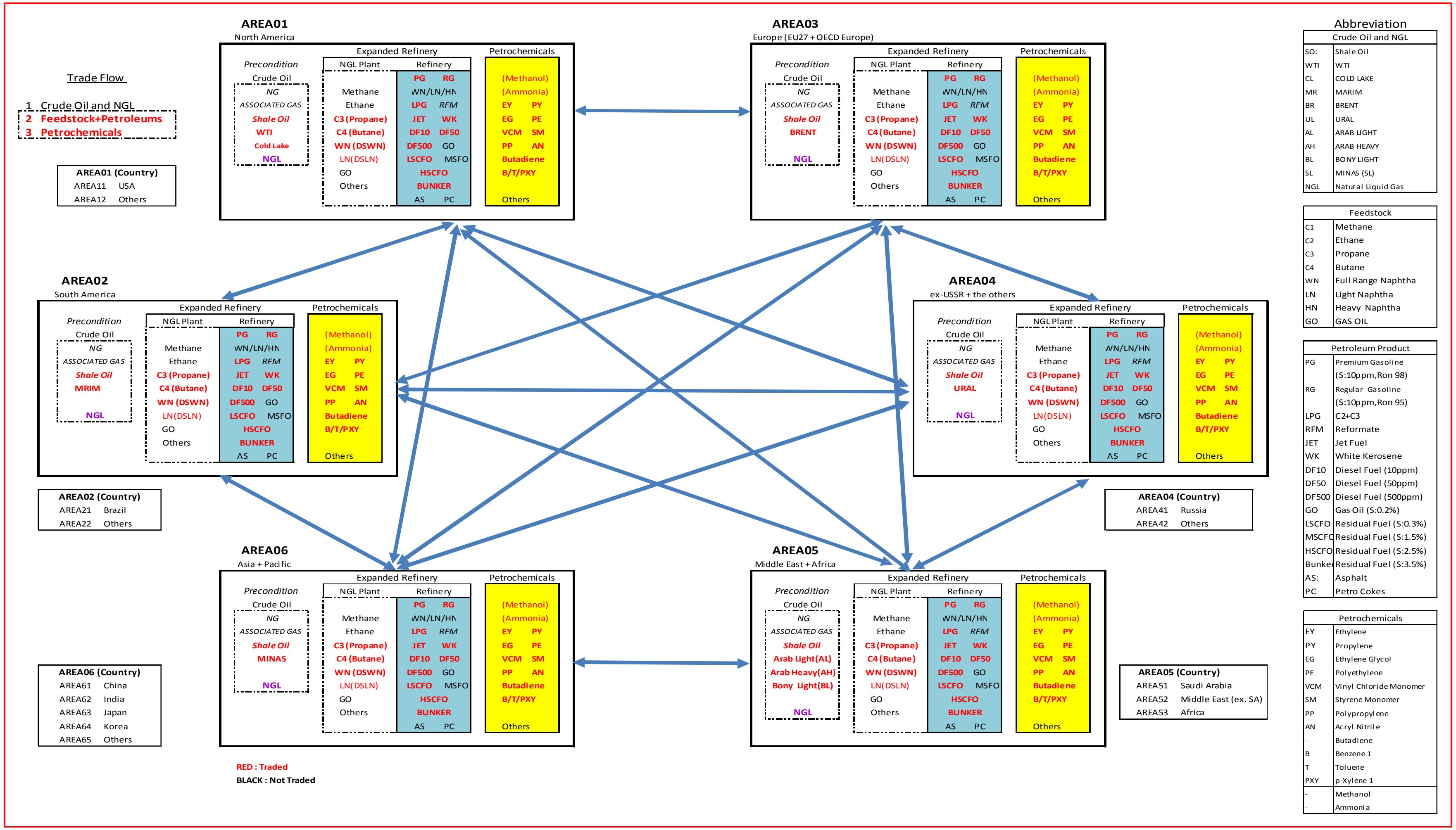


Figure 3.1-2: Trade Structure (IEEJ model) for Crude Oil, Raw Materials, and Petroleum Refined and Petrochemical Products (upstream)

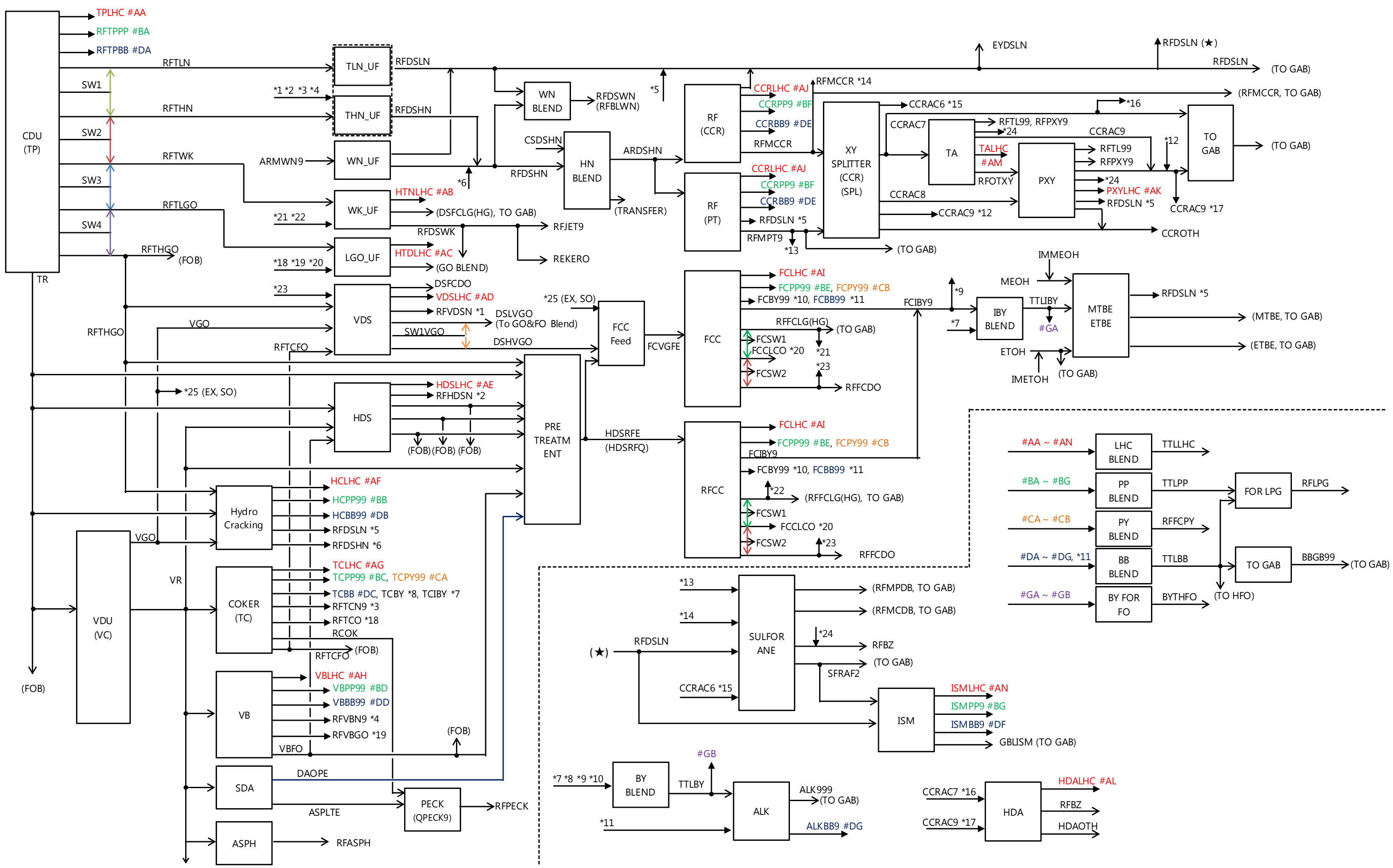


Figure 3.1-3: Petroleum Refining Flow (IEEJ model: Petroleum Refining Division)

3.1.2 Preconditions and Examination Method

(1) Preconditions

Optimization was conducted based on the following conditions:

a. Target regions

Considering the supply and demand structure described in 2.1 of chapter 2, the supply-demand balance was estimated in the six major ASEAN countries and Australia (ASEAN 6 + Australia) and the four neighboring economies of Japan, Korea, Chinese Taipei, and China.

b. Target years

2011 and 2020

c. Types and demand/production volume of each petroleum product

While the values obtained in 2.2 of chapter 2 were used for product demand, product items were further broken down based on Table 3.1-1. Upper limits for demand were not set for LPG and residues of the petroleum refining process, such as HSC heavy oil, asphalt, and petroleum coke, which production are not determined automatically until the production of main petroleum products are decided through overall optimization.

Table 3.1-1: List of Petroleum Products (IEEJ model)

Premium Gasoline	Regular Gasoline			Naphtha	LPG
PG98	RG95	RG92	RG90	Feed Steam Cracker	Propane
(ROM 98)	(ROM 95)	(ROM 92)	(ROM 90)	Aromatics	Butane

Basic Chemicals			
Benzen	Toulene	para-Xylene	Propylne

Jet Fuel	Kerosene	Diesel Fuel (Gas Oil)			
		DF 10	DF 50	DF 500	DF 2000
		(Sulfur 10ppm)	(Sulfur 50ppm)	(Sulfur 500ppm)	(Sulfur 0.2%)

Fuel Oil				Others	
Low Sulfur Fuel Oil	Middle Sulfur Fuel Oil	High Sulfur Fuel Oil	Bunker Oil	Asphalt	Petrocokes
(Sulfur 0.3%)	(Sulfur 1.5%)	(Sulfur 2.5%)	(Sulfur 3.5%)		

(Note) Semi-finished products, blending stocks, and raw materials are not included in the above list.

d. Capacity of refining facilities

The refining capacity and standards for gasoline and diesel fuel were set based on 2.3 of chapter 2.

Table 3.1-2: List of major facilities for petroleum refining (IEEJ model)

Crude Oil Distillation	
CDU	VDU

Desulfurization									
Naphtha	FCC gasoline	Kerosene	Diesel				Vacuum Gas Oil	Residual Fuel
		Jet Fuel	10ppm	50ppm	500ppm	2,000ppm		
NP-HTR	FG-HTR	WK-HTR	GO-HTR				VDS	HDS

Cracking				
Hydrocracking	Delayed Coker	Visbreaker	Solvent Deasphalt	Fuluid Catalytic Cracking
HC	DC	VB	SDA	FCC

Reforming				BTX		
Catalytic Reforming	Isomerization	MTBE	Alkylate	Metathesis	Hydrogenated Dealkylation	para-Xylene
RF(CCR)	ISM	MTBE	ALK	TA	HDA	PXY

Table 3.1-3: List of crude oils processed in petroleum refining (IEEJ model)

Region	North America				South America		EU27+OECD Europe	Ex-USSR		
Sub-region	USA		Canada		Brazil	Others		Russia		Others
Crude Name	West Texas	Shale Oil (Bukken)	Syncrude Sweet	Cold Lake	Marlim	Tia Juana Light	Brent Blend	Urals	ESPO	Azeri (BTC)

Region	Middle East						Africa		
Sub-region	Saudi Arabia			Others					
Crude Name	Arab Extra Light	Arab Light	Arab Heavy	Iran Light	Iran Heavy	Dubai	Saharan Blend	Bonny Light	Algeria Condensat

Region	Asia +Pacific				
Sub-region	China	India	Asean		Oceania
Crude Name	Daqing	Bombay Hi	Minas	Duri	North West Condensat

e. Types and prices of crude oils/product prices

As shown in Table 3.1-3, 24 types in 16 regions were set as crude oils. For crude oil prices, spot prices plus freight costs were set as prices accepted by refineries. For product prices, refinery gate prices, which were set based on spot market prices across the world, were used.

(2) Examination Procedures

It was decided to examine changes in the future petroleum product supply-demand balance centering on gasoline and diesel fuel in the ASEAN region by IEEJ model. As described below, the 2011 supply-demand balance performance was examined and used to estimate the supply-demand balance for 2020.

a. 2011

For the six major ASEAN countries, Australia, and the four neighboring countries (Japan, Korea, Chinese Taipei, and China), the optimal supply-demand balance was estimated by conducting IEEJ model i. The results were compared with the actual supply-demand balance, which was created based on the energy balance of IEA. In addition, the scale of the product supply-demand gap that exists in the ASEAN region and the amount of product supply from neighboring countries were examined, and the consistency between actual balance and optimal balace obtained from the model was checked.

b. 2020

The following were examined: If the petroleum product demand, quality improvement schedule, and the expansion of refining facilities in 2020, which were discussed in chapter 2, are achieved, how much it would improve the supply-demand gap that exists in the six major ASEAN countries and Australia (ASEAN 6 + Australia) and how much product supply the neighboring countries of Japan, Korea, Chinese Taipei, and China could provide to help fill the gap.

3.2 Examination Results and Discussion

3.2-1 Supply-demand balance in the ASEAN region

(1) Changes in supply-demand balance in the ASEAN region

Table 2.2-1 shows petroleum product demand (gasoline + diesel fuel) in the six major ASEAN countries and Australia (ASEAN 6 + Australia) from 2011 to 2020. Gasoline is expected to increase by about 250,000 b/d (270,000 b/d only by ASEAN six majors) while diesel fuel is expected to increase by about 200,000 b/d (150,000 b/d only by ASEAN six majors). In total, petroleum product demand is expected to increase by about 450,000 b/d (about 420,000 b/d only by ASEAN six majors). The capacity of crude distillation units (CDUs) and secondary facilities will also be expanded. The results are shown in Figures 3.2-1, 3.2-2, and 3.2-3. Listed below is the summary of these changes:

(i) Crude oil throughput (2011 to 2020)

Crude oil throughput is expected to increase from about 4.680 million b/d to about 5.340 million b/d, and the operating rate will also increase from 90% to 98%.

(ii) Gasoline supply-demand balance

Net imports are expected to decrease by about 40% (about 100,000 b/d), from about 270,000 b/d to about 170,000 b/d.

(iii) Diesel fuel supply-demand balance

Net imports are expected to decrease by about 70% (about 200,000 b/d), from about 280,000 b/d to about 80,000 b/d.

Since the optimal production balance was calculated by viewing the entire ASEAN region as one refinery, the results tend to be closer to the ideal balance than the calculation results by country (i.e., the trade scale tends to be smaller). However, the overall results showed that it is possible to reduce imports (gasoline and diesel fuel) from outside the region by about 300,000 b/d. It can be said that most of the results are feasible, provided that preconditions given below are fulfilled. In other words, if the preconditions are not met, the results will be different.

(2) Demand-side issues

Since a cap is put on retail prices of gasoline and diesel fuel via the provision of subsidies in the ASEAN region except some areas, prices are lower than international market prices, causing an excess demand (including low energy saving awareness and smuggling to other regions) that greatly exceeds demand associated with economic growth. As discussed in 2.2, chapter 2, the success of subsidy reforms in Indonesia (discontinuation of subsidies to gasoline and diesel fuel by 2020, which was declared by President Joko Widodo who assumed the presidency in October 2014), is crucial at the present and in the future to the realization of proper supply-demand balance not only for Indonesia, but also for other countries within the ASEAN region. Therefore, since the demand for diesel fuel presented in 2.2 of chapter 2 presupposes the discontinuation of subsidies (= coming closer to the international market price) to some extent, if the subsidy reforms fail, the supply-demand balance may not be achieved despite efforts to expand facilities.

(3) Supply-side issues

Among the estimates of the capacity expansion of major facilities by 2020, which was discussed in 2.3, chapter 2, the construction of new refineries (crude distillation capacity of 500,000 b/d in two refineries) was assumed for Malaysia and Viet Nam. For other countries, upgrading via the capacity expansion of secondary facilities (including new construction) and capacity building via de-bottlenecking were assumed. Most countries in the region are forced to give priority to the improvement of fuel quality to comply with increasingly severe international environmental restrictions and production increase (to the extent it does not negatively affect the supply-demand balance) to respond to an imminent increase in petroleum product demand, and postpone the construction of new refineries, which requires huge investment, due to financial and temporal restrictions. In the midst of such conditions, however, Malaysia and Viet Nam have been making investments actively.

(Malaysia)

The Refinery and Petrochemical Integrated Development (RAPID) Project aims to construct a crude oil, petroleum product, and LNG in Pengerang located in the southeastern part of Johor State on Peninsular Malaysia. The main facilities of the project are a refinery with a capacity of 300,000 b/d and a petrochemical plant with a combined production capacity of 7.700 million tons/year. FID was in 2014 and operation is expected to begin in the first half of 2019 at the earliest. While it can be further delayed into after 2020, if the project is completed, Malaysia will have the third largest petrochemical facilities after Singapore and Thailand and become a net exporter of petroleum products.

(Viet Nam)

The first modern refinery was built in Dung Quat in the central part of Viet Nam in 2009. The second refinery with the CDU capacity of 200,000 b/d is under construction in Nghi Son located in the northern part of the country, which is expected to be put into operation around 2018.

If the construction of refineries in both countries is further delayed for some reason and the operation starts after 2020, the estimated supply-demand balance for 2020 can significantly change.

3.2-2 Supply-demand balance in neighboring economies

(1) Changes in supply-demand balance in Japan, Korea, and Chinese Taipei

For the period from 2011 to 2020, gasoline demand in Japan is expected to decrease by about 120,000 b/d and diesel fuel demand is expected to decrease by 20,000 b/d, leading to a total decrease of about 140,000 b/d. In Chinese Taipei, demand for both gasoline and diesel fuel is expected to remain unchanged, whereas in Korea, gasoline demand is expected to increase by about 30,000 b/d and diesel fuel demand by about 30,000 b/d. Together, a slight increase by 60,000 b/d in demand is expected, although the rate of growth would be extremely low. When demand in the three economies of Japan, Korea, and Chinese Taipei is combined, gasoline demand decreases by about

90,000 b/d and diesel fuel demand remains the same. In such countries which first experienced high economic growth among Asian region and then, have already become mature for economy the growth rate of domestic demand will rapidly decelerate, or demand will continuously decrease.

In the midst of that context, Japan has been promoting the reduction of refining capacity, and crude distillation capacity is expected to be reduced by about 840,000 b/d during this period. Chinese Taipei will also reduce its crude distillation capacity by about 210,000 b/d. On the other hand, Korea plans to expand the refining capacity by about 120,000 b/d. When the three economies are viewed as one entity, the total capacity will decrease by about 920,000 b/d. Figures 3.2-1, 3.2-2, and 3.2-3 show the supply-demand balance estimated by IEEJ model. Listed below are key changes in the supply-demand balance of neighboring economies:

(i) Crude oil throughput (2011 to 2020)

While crude throughput will decrease from about 6.590 million b/d to about 6.180 million b/d, the operating rate will increase from 81% to 86%.

(ii) Gasoline supply-demand balance

Net exports will increase by about 30,000 b/d, from about 180,000 b/d to about 210,000 b/d.

(iii) Diesel fuel supply-demand balance

Net exports will decrease by about 200,000 b/d, from about 710,000 b/d to about 510,000 b/d.

Estimation is made on the assumption that the supply and demand balance for petrochemical materials, such as BTX, is not particularly tight. It should be noted that if the balance is very tight, gasoline supply capabilities will decrease significantly, leading to a worse balance between supply and demand for gasoline (net export capacity) than the estimated balance.

(2) Changes in China's supply-demand balance

Due to the deceleration of economic growth, the growth rate of diesel fuel demand will decline significantly and remain at the annual rate of less than 1% (about 250,000 b/d). On the other hand, while its growth rate will decline compared to the previous period (2005 to 2010), gasoline demand is expected to increase by the annual rate of 6% (about 1.250 million b/d) as the ownership of private cars increases due to improved income levels. On the supply side, however, the crude distillation capacity (CDU capacity) will be expanded by about no less than 4.340 million b/d and the capacity of secondary facilities is also expected to be expanded significantly. The estimation results of supply-demand balance by IEEJ model are shown in Figures 3.2-1, 3.2-2, and 3.2-3. Listed below are the key points of changes in China's supply-demand balance:

(i) Petroleum throughput (2011 to 2020)

Petroleum throughput increases from about 8.592 million b/d to about 6.181 million b/d and the operating rate will increase from 76% to 79%.

(ii) Gasoline supply-demand balance

Net exports increase by about 70,000 b/d, from about 90,000 b/d to about 160,000 b/d.

(iii) Diesel fuel supply-demand balance

Net exports increase by about 620,000 b/d, from about 10,000 b/d to about 630,000 b/d.

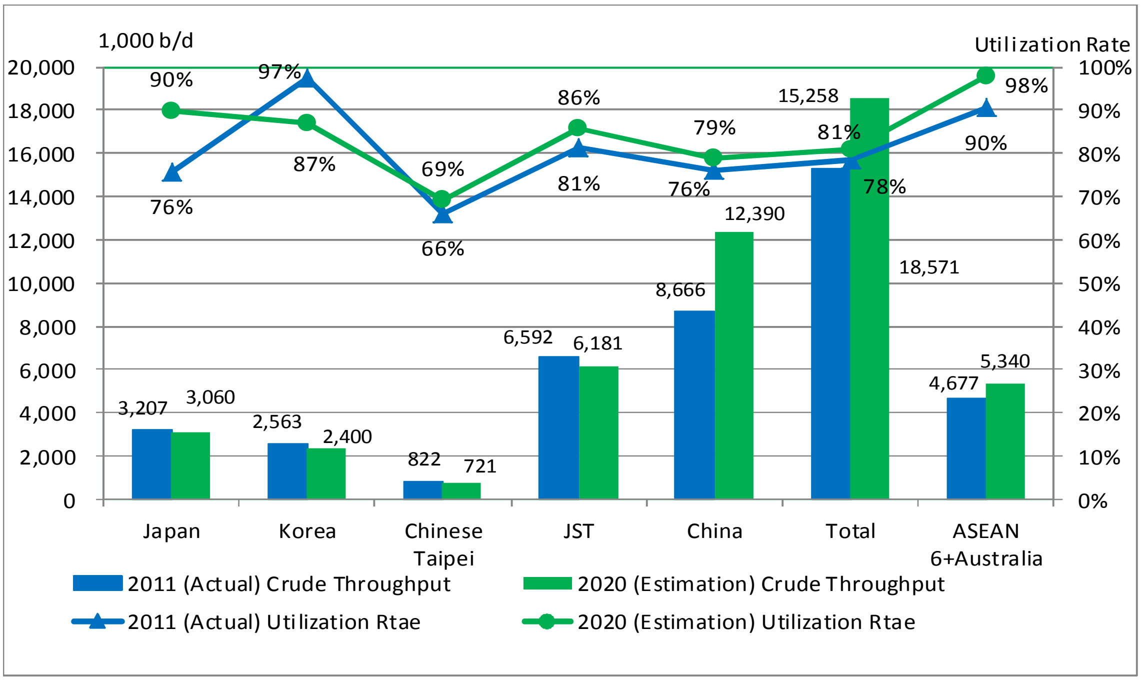


Figure 3.2-1: Comparison of CDU operating rates among the ASEAN region and neighboring economies

(Comparison between 2011 and 2020)

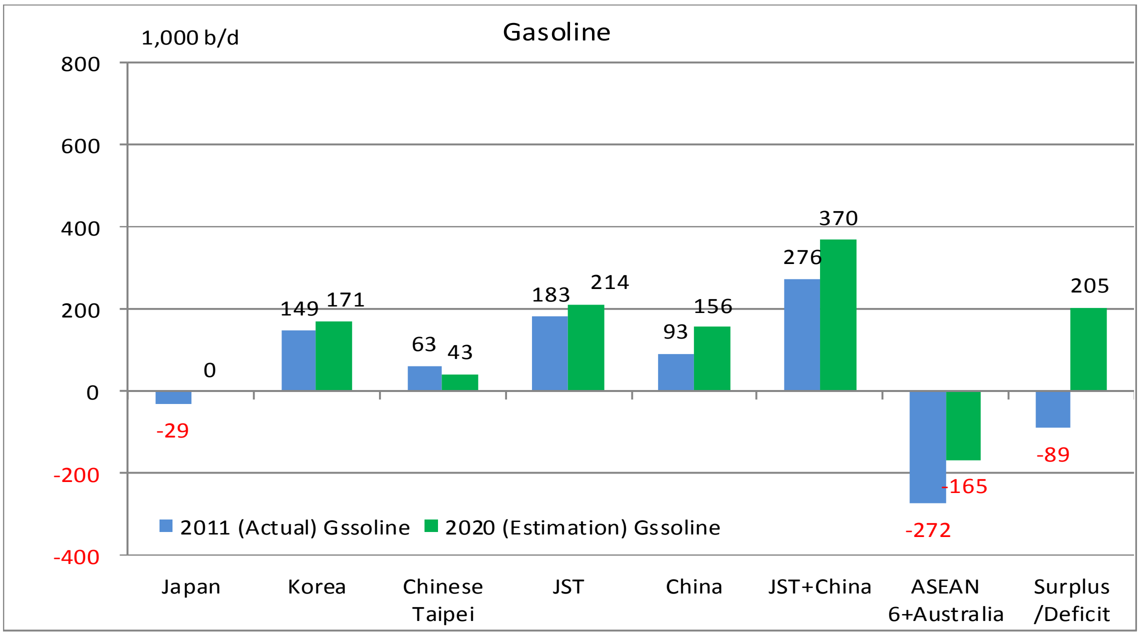


Figure 3.2-2: Changes in gasoline supply-demand balance in the ASEAN region and neighboring economies (net exports)
(Comparison between 2011 and 2020)

(Note) Net exports = exports - imports (excluding changes in inventory)

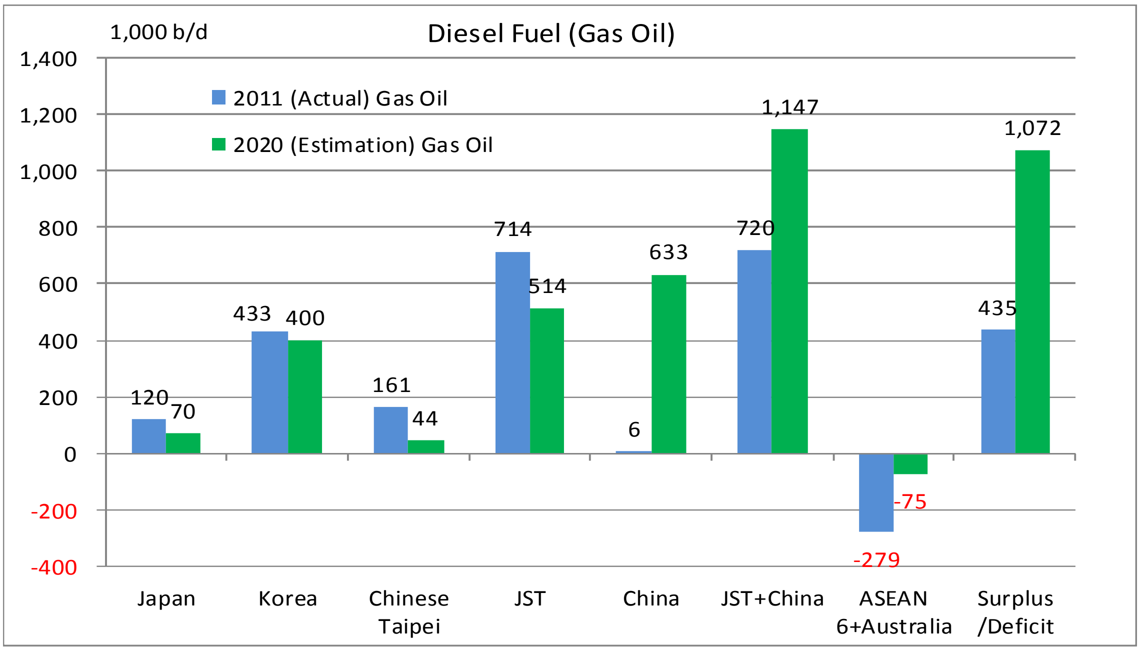


Figure 3.2-3: Changes in diesel fuel supply-demand balance in the ASEAN region and neighboring economies (net exports)
(Comparison between 2011 and 2020)

(Note) Net exports = exports - imports (excluding changes in inventory)

4. Conclusion and Future Challenges

4.1 Conclusion

Diesel fuel, which has increased in quantity in close association with economic growth, is used for various purposes, such as truck transport, railroads, power generation (including private power generation), and industrial fuel. Along with the recent progress in fuel substitution and energy saving, reforms toward the reduction or discontinuation of subsidies are making headway. For gasoline, on the other hand, a standard of living of each person has improved, and people in the middle-income group have become eager to own private cars. As is the case with diesel fuel, the retail prices of gasoline are controlled to remains below the international market through providing subsidies. Even if prices rise due to the discontinuation of subsidies, it will have little impact on gasoline demand as people's motive to buy private cars as a status symbol is strong. On the other hand, since the price elasticity of diesel fuel demand is relatively great, the growth rate in diesel fuel demand is expected to decline. Consequently, the present demand structure of petroleum products, which is extremely skewed toward diesel fuel, will gradually change to a more balanced one as the ratio of gasoline increases and that of diesel fuel decreases. In light of this, closer attention should be paid to the success or failure of the subsidy reforms in Indonesia that has the largest petroleum demand in the region.

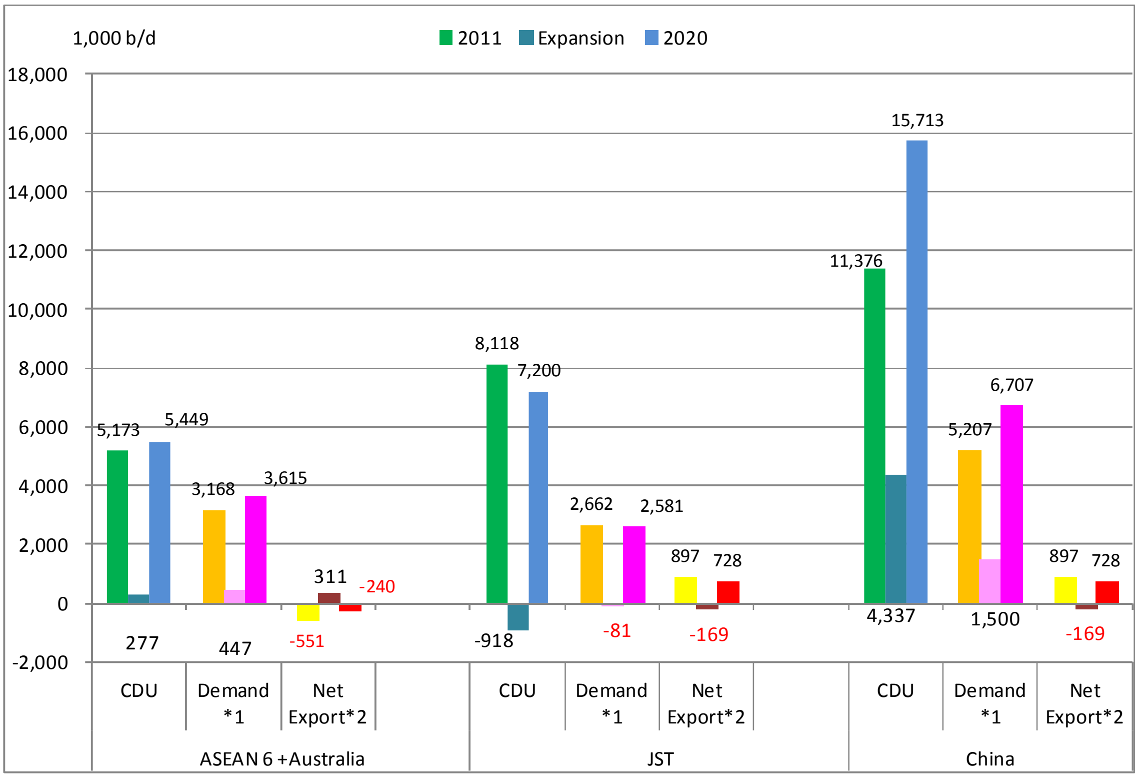


Figure 4.1-1: Comparison of CDU operating rates in the ASEAN region and neighboring economies

(Note)*1: Demand (Gasoline +Diesel) *2: Net Exports (Gasoline +Diesel)

On the other hand, environmental issues and fuel quality improvement have become matters requiring urgent attention. While progress in efforts toward the quality improvement (standards) of gasoline and diesel fuel varies from country to country, most countries aim to shift from standards equivalent to EURO III to those equivalent to EURO IV in the 2010s (some countries aim to shift to standards equivalent to EURO V). While such a goal requires a considerable investment in the construction and expansion of secondary facilities, most countries, except Indonesia, will achieve it, although there may be some delay.

Based on these conditions, the supply-demand balance from 2011 to 2020 was estimated. As shown in Figure 2.4-1, the supply-demand balance for gasoline and diesel fuel will be confirmedly improved on the ground that efforts to improve fuel quality will continue and that imports from outside the region (supply-demand gaps) will shrink significantly. Numerically, it was confirmed that these gaps could be fully filled by exports from Japan, Korea, and Chinese Taipei (actually, exports from China are also great in volume).

4.2 Future Challenges

While the ASEAN region as a whole is heading toward improvement and seems to have no problems, when viewed individually, there are countries that have many problems. In Indonesia, which has the largest petroleum demand in the region, the supply-demand gap in gasoline and diesel fuel reached no less than 520,000 b/d in 2011, and fuel quality has been slow to improve. In order to solve this gap all at once, three to four 200,000 b/d-class refineries must be built, which is difficult to achieve due to a considerable investment required for it. While it is already being implemented, it is essential to make an effort to prevent the aggravation of the current supply-demand balance by creating more additional production capacity than incremental demand through de-bottlenecking of existing refineries. In this respect, the aforementioned demand control via reduction or discontinuation of subsidies will also play a key role.

For the solutions to the current significant supply-demand gaps, it seems effective to create a framework that achieves not exports on an as-needed basis, but long-term exports[7], that is, stable exports for a long period of time, such as about 10 years, through cooperation with Japan, Korea, and Chinese Taipei. The establishment of a stable supply system will enable these ASEAN countries to concentrate on solving domestic problems. On the other hand, it is very likely that petroleum demand will further decline in Japan after the 2020 Olympics. Therefore, the establishment of win-win relationships between the ASEAN region and Japan, Korea, and Chinese Taipei seems to serve as one of various useful approaches toward a good supply-demand balance, including efforts to reduce facilities to realize supply commensurate with domestic demand.

As discussed so far, the supply-demand balance in the ASEAN region, its member states, and neighboring economies was examined and analysed in this article. In the future, it is planned to examine more specifically the development of mutual trading flows with a focus on Indonesia, Singapore, Japan, Korea, and Chinese Taipei while giving due consideration to long-term contract refining (exports).

[7] Contract refining is the way the payment (lease fees and refining direct costs) is implemented in the form of leasing a refinery or refining facilities instead of trading products..

Accompanying Tables

Balance between the Supply and Demand for Petroleum in ASEAN and Neighboring Economies (2011)

*** Created by IEEJ based on the IEA Energy Balance Tables.**

2011	Singapore

NG/CR/NGL BALANCE

	Natural gas (Bcm)	Crude oil (1,000b/d)	NGL (1,000b/d)	Refinery (1,000b/d)	Additive/ (1,000b/d)	Other (1,000b/d)
Production	0	0	0	0	0	0
Imports	8	995	0	0	0	0
Exports	0	-10	0	0	0	0
Stock changes	0	6	0	0	0	0
Domestic Supply	8	991	0	0	0	0

INPUT TO REFINERY & NGL PLANT (1,000 b/d)

		Crude oil	NGL	Total	Refinery	Blending	Other	Total	Grand
1	NGL Plant		0	0	139	0	0	139	139
2	Refinery	-991	0	-991	-139	0	0	-139	-1,130
	Total	-991	0	-991	0	0	0	0	-991

PETROLEUM DEMAND SUPPLY (1,000 b/d)

	Output =Supply					Import	Export	Stock changes	Total (a)	Domestic Demand						Total (b)	Difference (a)-(b)
	NGL Plant	Refinery	Own Use	Refinery	Total					Feedstock	Road	Aviation	Power	Fuel	Other non-		
Ethane	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Refinery Gas	0	65	-30	35	35	0	0	0	35	0	0	0	6	29	0	35	0
LPG	0	9	0	9	9	0	-6	0	4	0	0	0	0	4	0	4	0
Naphtha	0	40	0	40	40	138	-24	0	154	104	0	0	0	0	0	104	50
Gasoline	0	243	0	243	243	331	-549	-5	20	0	20	0	0	0	0	20	0
Jet Fuel	0	214	0	214	214	47	-130	0	131	0	0	131	0	0	0	131	0
Kerosene	0	16	0	16	16	1	-20	4	0	0	0	0	0	0	0	0	0
Diesel / Gas Oil	0	285	0	285	285	393	-568	10	120	0	24	37	2	10	0	74	47
Fuel oil	0	134	-10	124	124	1,194	-492	7	834	0	0	748	34	12	0	793	40
Bitumen	0	32	0	32	32	0	-31	0	2	0	0	0	0	0	2	2	0
Petroleum cokes	0	1	0	1	1	0	0	0	1	0	0	0	0	1	0	1	0
Others	0	97	0	97	97	39	-107	0	28	0	0	0	0	1	27	28	0
Total	0	1,136	-40	1,096	1,096	2,143	-1,927	17	1,329	104	44	917	42	56	29	1,192	137

	Production	Import	Export	Stock	D.Supply
Biogasoline	0	0	0	0	0
Biodiesel	0	0	0	0	0
Other liquid	0	0	0	0	0
Total	0	0	0	0	0

2011	Thailand

NG/CR/NGL BALANCE

	Natural gas (Bcm)	Crude oil (1,000b/d)	NGL (1,000b/d)	Refinery (1,000b/d)	Additive/ (1,000b/d)	Other (1,000b/d)
Production	24	232	142	0	0	0
Imports	10	838	0	0	0	0
Exports	0	-33	-3	0	0	0
Stock changes	0	24	0	0	0	0
Domestic Supply	34	1,060	139	0	0	0

INPUT TO REFINERY & NGL PLANT (1,000 b/d)

		Crude oil	NGL	Total	Refinery	Blending	Other	Total	Grand
1	NGL Plant		-129	-129	0	0	0	0	-129
2	Refinery	-1,056	0	-1,056	0	0	0	0	-1,057
	Total	-1,056	-129	-1,186	0	0	0	0	-1,186

PETROLEUM DEMAND SUPPLY (1,000 b/d)

	Output =Supply					Import	Export	Stock changes	Total (a)	Domestic Demand						Total (b)	Difference (a)-(b)
	NGL Plant	Refinery	Own Use	Refinery	Total					Feedstock	Road	Aviation	Power	Fuel	Other non-		
Ethane	38	0	0	0	38	0	0	0	38	38	0	0	0	0	0	38	0
Refinery Gas	0	10	-10	0	0	0	0	0	0	0	0	0	0	0	0	0	0
LPG	116	67	0	67	183	48	-1	2	233	71	31	0	0	114	12	228	4
Naphtha	0	251	0	251	251	0	-17	0	234	234	0	0	0	0	0	234	0
Gasoline	0	133	0	133	133	1	-16	-1	116	0	114	0	0	1	0	116	0
Jet Fuel	0	107	0	107	107	0	-20	0	86	0	0	86	0	0	0	86	0
Kerosene	0	3	0	3	3	0	-2	-1	0	0	0	0	0	0	0	0	0
Diesel / Gas Oil	0	407	0	407	407	1	-72	13	349	0	236	3	0	99	0	338	11
Fuel oil	0	104	0	104	104	6	-62	-4	44	0	0	19	8	17	0	44	0
Bitumen	0	19	0	19	19	0	-8	0	12	0	0	0	0	0	12	12	0
Petroleum cokes	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Others	0	36	0	36	36	0	-8	0	28	0	0	0	0	0	28	28	0
Total	154	1,137	-10	1,127	1,280	56	-206	10	1,140	343	381	109	8	231	52	1,124	16

	Production	Import	Export	Stock	D.Supply
Biogasoline	6	0	-2	1	5
Biodiesel	9	0	0	0	10
Other liquid	0	0	0	0	0
Total	16	0	-2	1	15

2011	Malaysia

NG/CR/NGL BALANCE

	Natural gas (Bcm)	Crude oil (1,000b/d)	NGL (1,000b/d)	Refinery (1,000b/d)	Additive/ (1,000b/d)	Other (1,000b/d)
Production	59	568	52	0	0	0
Imports	8	182	0	4	0	0
Exports	-31	-229	0	-2	0	0
Stock changes	0	-34	0	0	0	0
Domestic Supply	35	487	52	2	0	0

INPUT TO REFINERY & NGL PLANT

(1,000 b/d)

		Crude oil	NGL	Total	Refinery	Blending	Other	Total	Grand
1	NGL Plant		-52	-52	0	0	-13	-13	-65
2	Refinery	-495	0	-495	-2	0	0	-2	-496
	Total	-495	-52	-547	-2	0	-13	-15	-561

PETROLEUM DEMAND SUPPLY

(1,000 b/d)

	Output =Supply					Import	Export	Stock changes	Total (a)	Domestic Demand						Total (b)	Difference (a)-(b)
	NGL Plant	Refinery	Own Use	Refinery	Total					Feedstock	Road	Aviation	Power	Fuel	Other non-		
Ethane	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Refinery Gas	0	33	-32	1	1	0	0	0	1	0	0	0	0	0	0	0	1
LPG	76	19	0	19	95	15	-28	0	82	37	0	0	0	46	0	83	-1
Naphtha	0	82	0	82	82	50	-58	0	73	73	0	0	0	0	0	73	0
Gasoline	0	82	0	82	82	95	0	0	177	0	179	0	0	4	0	183	-5
Jet Fuel	0	74	0	74	74	11	-15	-18	52	0	0	54	0	0	0	54	-2
Kerosene	1	9	0	9	10	3	-15	0	-2	0	0	0	0	0	0	0	-2
Diesel / Gas Oil	2	181	0	181	182	76	-90	31	200	0	125	0	22	52	0	199	1
Fuel oil	0	11	0	11	11	28	-6	0	32	0	0	4	21	7	0	32	0
Bitumen	0	11	0	11	11	2	0	0	13	0	0	0	0	0	17	17	-3
Petroleum cokes	0	1	0	1	1	0	-2	1	0	0	0	0	0	0	0	0	0
Others	5	12	0	12	17	12	-4	-10	15	0	0	0	0	0	22	22	-7
Total	83	514	-32	482	565	293	-219	5	643	111	304	59	43	108	38	663	-20

	Production	Import	Export	Stock	D.Supply
Biogasoline	0	0	0	0	0
Biodiesel	4	0	-1	-2	0
Other liquid	0	0	0	0	0
Total	4	0	-1	-2	0

2011 Indonesia

NG/CR/NGL BALANCE

	Natural gas (Bcm)	Crude oil (1,000b/d)	NGL (1,000b/d)	Refinery (1,000b/d)	Additive/ (1,000b/d)	Other (1,000b/d)
Production	79	892	36	0	0	0
Imports	0	269	0	121	0	0
Exports	-39	-305	0	0	0	0
Stock changes	0	2	0	0	0	0
Domestic Supply	40	858	36	121	0	0

INPUT TO REFINERY & NGL PLANT (1,000 b/d)

		Crude oil	NGL	Total	Refinery	Blending	Other	Total	Grand
1	NGL Plant		-36	-36	0	0	0	0	-36
2	Refinery	-878	0	-878	-130	0	0	-130	-1,007
	Total	-878	-36	-913	-130	0	0	-130	-1,043

PETROLEUM DEMAND SUPPLY (1,000 b/d)

	Output =Supply					Import	Export	Stock changes	Total (a)	Domestic Demand						Total (b)	Difference (a)-(b)
	NGL Plant	Refinery	Own Use	Refinery	Total					Feedstock	Road	Aviation	Power	Fuel	Other non-		
Ethane	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Refinery Gas	0	14	-14	0	0	0	0	0	0	0	0	0	0	0	0	0	0
LPG	51	23	0	23	74	65	0	2	141	0	0	0	0	141	0	141	0
Naphtha	0	83	-1	82	82	0	-4	0	78	78	0	0	0	0	0	78	0
Gasoline	0	223	0	223	223	276	0	0	499	0	500	0	0	0	0	500	-1
Jet Fuel	0	49	0	49	49	15	0	0	63	0	0	64	0	0	0	64	-1
Kerosene	0	41	0	41	41	0	-8	0	34	0	0	0	0	34	0	34	0
Diesel / Gas Oil	0	332	-1	331	331	251	0	0	581	0	245	45	164	166	0	620	-39
Fuel oil	0	159	-27	132	132	17	-81	0	68	0	0	2	43	23	0	68	0
Bitumen	0	6	0	6	6	0	0	0	6	0	0	0	0	0	6	6	0
Petroleum cokes	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Others	0	61	0	61	61	0	0	0	61	0	0	0	0	48	13	61	0
Total	51	992	-44	948	1,000	622	-93	-139	1,390	1,873	10,246	2,242	715	1,924	1,052	18,052	101

	Production	Import	Export	tock changes	D.Supply
Biogasoline	0	0	0	0	0
Biodiesel	25	0	-19	0	6
Other liquid	0	0	0	0	0
Total	25	0	-19	0	6

2011	Philippines

NG/CR/NGL BALANCE

	Natural gas (Bcm)	Crude oil (1,000b/d)	NGL (1,000b/d)	Refinery (1,000b/d)	Additive/ (1,000b/d)	Other (1,000b/d)
Production	4	18	0	0	0	0
Imports	0	180	0	0	0	0
Exports	0	-18	0	0	0	0
Stock changes	0	-2	0	0	0	0
Domestic Supply	4	178	0	0	0	0

INPUT TO REFINERY & NGL PLANT (1,000 b/d)

		Crude oil	NGL	Total	Refinery	Blending	Other	Total	Grand
1	NGL Plant		0	0	0	0	0	0	0
2	Refinery	-181	0	-181	0	0	0	0	-181
	Total	-181	0	-181	0	0	0	0	-181

PETROLEUM DEMAND SUPPLY (1,000 b/d)

	Output =Supply					Import	Export	Stock changes	Total (a)	Domestic Demand						Total (b)	Difference (a)-(b)
	NGL Plant	Refinery	Own Use	Refinery	Total					Feedstock	Road	Aviation	Power	Fuel	Other non-		
Ethane	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Refinery Gas	0	2	-2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
LPG	0	12	0	12	12	22	0	1	35	0	1	0	0	32	0	33	1
Naphtha	0	13	0	13	13	1	-11	0	3	1	0	0	0	0	0	1	2
Gasoline	0	36	0	36	36	31	-1	0	66	0	64	1	0	0	0	65	1
Jet Fuel	0	16	0	16	16	13	0	0	30	0	0	29	0	0	0	29	0
Kerosene	0	2	0	2	2	1	0	0	3	0	0	0	0	3	0	3	0
Diesel / Gas Oil	0	69	0	69	69	50	-1	3	122	0	79	8	4	28	0	119	3
Fuel oil	0	36	0	36	36	6	-10	0	32	0	0	8	12	14	0	34	-2
Bitumen	0	0	0	0	0	1	0	0	1	0	0	0	0	0	1	1	0
Petroleum cokes	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Others	0	0	0	0	0	1	0	0	1	0	0	0	0	0	1	1	0
Total	0	186	-2	184	184	127	-23	4	292	1	144	47	15	77	3	287	5

	Production	Import	Export	Stock	D.Supply
Biogasoline	0	3	0	0	3
Biodiesel	2	0	0	0	2
Other liquid	0	0	0	0	0
Total	2	3	0	0	5

2011 Viet Nam

NG/CR/NGL BALANCE

	Natural gas (Bcm)	Crude oil (1,000b/d)	NGL (1,000b/d)	Refinery (1,000b/d)	Additive/ (1,000b/d)	Other (1,000b/d)
Production	8	320	7	0	0	0
Imports	0	0	0	0	0	0
Exports	0	-168	0	0	0	0
Stock changes	0	-14	0	0	0	0
Domestic Supply	8	137	7	0	0	0

INPUT TO REFINERY & NGL PLANT (1,000 b/d)

		Crude oil	NGL	Total	Refinery	Blending	Other	Total	Grand
1	NGL Plant		-7	-7	0	0	0	0	-7
2	Refinery	-118	0	-118	0	0	0	0	-118
	Total	-118	-7	-125	0	0	0	0	-125

PETROLEUM DEMAND SUPPLY (1,000 b/d)

	Output =Supply					Import	Export	Stock changes	Total (a)	Domestic Demand						Total (b)	Difference (a)-(b)
	NGL Plant	Refinery	Own Use	Refinery	Total					Feedstock	Road	Aviation	Power	Fuel	Other non-		
Ethane	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Refinery Gas	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
LPG	8	11	0	11	19	23	0	0	42	0	0	0	0	43	0	43	-1
Naphtha	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gasoline	0	55	0	55	55	68	-6	-5	112	0	109	0	0	3	0	112	0
Jet Fuel	0	1	0	1	1	21	-1	-2	19	0	0	19	0	0	0	19	0
Kerosene	0	0	0	0	0	0	-1	2	2	0	0	0	0	2	0	2	0
Diesel / Gas Oil	0	56	0	56	56	109	-21	13	157	0	114	0	3	40	0	157	0
Fuel oil	0	3	0	3	3	27	-4	15	41	0	0	8	18	15	0	41	0
Bitumen	0	0	0	0	0	18	0	0	18	0	0	0	0	0	18	18	0
Petroleum cokes	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Others	1	3	0	3	4	35	0	0	40	0	0	0	0	0	40	40	0
Total	9	129	0	129	138	303	-33	23	431	0	223	27	21	103	57	431	-1

	Production	Import	Export	Stock	D.Supply
Biogasoline	0	0	0	0	0
Biodiesel	0	0	0	0	0
Other liquid	0	0	0	0	0
Total	0	0	0	0	0

2011 Australia

NG/CR/NGL BALANCE

	Natural gas (Bcm)	Crude oil (1,000b/d)	NGL (1,000b/d)	Refinery (1,000b/d)	Additive/ (1,000b/d)	Other (1,000b/d)
Production	50	416	51	0	0	0
Imports	6	511	0	9	0	0
Exports	-26	-312	0	-18	0	0
Stock changes	0	3	0	2	0	0
Domestic Supply	30	618	51	-7	0	0

INPUT TO REFINERY & NGL PLANT (1,000 b/d)

		Crude oil	NGL	Total	Refinery	Blending	Other	Total	Grand
1	NGL Plant		-51	-51	47	0	0	47	-4
2	Refinery	-614	0	-614	-61	0	0	-61	-676
	Total	-614	-51	-666	-14	0	0	-14	-680

PETROLEUM DEMAND SUPPLY (1,000 b/d)

	Output =Supply					Import	Export	Stock changes	Total (a)	Domestic Demand						Total (b)	Difference (a)-(b)
	NGL Plant	Refinery	Own Use	Refinery	Total					Feedstock	Road	Aviation	Power	Fuel	Other non-		
Ethane	7	0	0	0	7	0	0	0	7	7	0	0	0	0	0	7	0
Refinery Gas	0	17	-17	0	0	0	0	0	0	0	0	0	0	1	0	1	-1
LPG	60	25	0	25	85	15	-44	2	57	8	36	0	0	18	0	62	-5
Naphtha	0	4	0	4	4	0	0	0	4	0	0	0	0	0	0	0	4
Gasoline	0	293	0	293	293	46	-3	-2	334	0	309	1	0	4	0	314	20
Jet Fuel	0	98	0	98	98	37	0	-1	134	0	0	127	0	0	0	127	7
Kerosene	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Diesel / Gas Oil	0	223	0	223	223	153	-2	-1	372	0	191	12	12	113	0	328	44
Fuel oil	0	18	-1	17	17	27	-4	0	41	0	0	13	3	14	0	30	11
Bitumen	0	8	0	8	8	6	0	0	14	0	0	0	0	0	13	13	2
Petroleum cokes	0	9	-9	0	0	13	0	0	13	2	0	0	0	0	13	15	-2
Others	34	26	-9	17	52	28	-4	2	77	28	0	0	1	5	41	74	3
Total	101	722	-36	686	787	325	-57	0	1,054	45	536	154	16	154	67	970	84

	Production	Import	Export	Stock	D.Supply
Biogasoline	6	0	0	0	6
Biodiesel	2	0	0	0	2
Other liquid	0	0	0	0	0
Total	8	0	0	0	8

2011 Japan

NG/CR/NGL BALANCE

	Natural gas (Bcm)	Crude oil (1,000b/d)	NGL (1,000b/d)	Refinery (1,000b/d)	Additive/ (1,000b/d)	Other (1,000b/d)
Production	4	5	9	0	0	0
Imports	108	3,419	212	0	0	0
Exports	0	0	0	0	0	0
Stock changes	-1	-9	0	-1	0	0
Domestic Supply	111	3,415	222	-1	0	0

INPUT TO REFINERY & NGL PLANT (1,000 b/d)

		Crude oil	NGL	Total	Refinery	Blending	Other	Total	Grand
1	NGL Plant		0	0	0	0	0	0	0
2	Refinery	-3,207	-213	-3,420	-83	0	0	-83	-3,502
	Total	-3,207	-213	-3,420	-83	0	0	-83	-3,502

PETROLEUM DEMAND SUPPLY (1,000 b/d)

	Output =Supply					Import	Export	Stock changes	Total (a)	Domestic Demand						Total (b)	Difference (a)-(b)
	NGL Plant	Refinery	Own Use	Refinery	Total					Feedstock	Road	Aviation	Power	Fuel	Other non-		
Ethane	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Refinery Gas	0	156	-125	31	31	0	0	0	31	0	0	0	26	0	0	26	5
LPG	0	129	-3	126	126	415	-3	1	540	107	35	0	39	270	0	452	88
Naphtha	25	323	-1	322	347	429	-1	9	784	563	0	0	0	98	0	661	123
Gasoline	0	956	0	956	956	51	-22	-3	982	0	1,003	0	0	-0	0	1,003	-20
Jet Fuel	0	227	0	227	227	23	-45	2	206	0	0	196	0	10	0	206	0
Kerosene	0	340	0	340	340	26	-11	-1	355	17	0	0	1	332	0	350	5
Diesel / Gas Oil	0	951	0	950	950	17	-137	-1	829	4	441	21	11	356	0	833	-4
Fuel oil	0	428	-18	411	411	131	-49	0	492	9	0	118	283	82	0	491	1
Bitumen	0	67	0	67	67	4	0	0	71	4	0	0	22	31	33	90	-19
Petroleum cokes	0	19	0	19	19	71	-1	0	89	7	0	0	15	65	1	88	1
Others	0	84	-2	82	82	2	-14	1	71	0	0	0	0	1	74	76	-5
Total	25	3,680	-149	3,531	3,556	1,169	-282	9	4,451	710	1,478	335	397	1,246	109	4,275	175

	Production	Import	Export	Stock	D.Supply
Biogasoline	0	0	0	0	0
Biodiesel	0	0	0	0	0
Other liquid	0	0	0	0	0
Total	0	0	0	0	0

2011 Korea

NG/CR/NGL BALANCE

	Natural gas (Bcm)	Crude oil (1,000b/d)	NGL (1,000b/d)	Refinery (1,000b/d)	Additive/ (1,000b/d)	Other (1,000b/d)
Production	0	1	0	0	15	0
Imports	47	2,558	0	1	4	0
Exports	0	0	0	-12	0	0
Stock changes	-1	2	0	-2	0	0
Domestic Supply	46	2,561	0	-12	18	0

INPUT TO REFINERY & NGL PLANT (1,000 b/d)

		Crude oil	NGL	Total	Refinery	Blending	Other	Total	Grand
1	NGL Plant		0	0	-43	-18	0	-61	-61
2	Refinery	-2,563	0	-2,563	-113	0	0	-113	-2,677
	Total	-2,563	0	-2,563	-157	-18	0	-175	-2,738

PETROLEUM DEMAND SUPPLY (1,000 b/d)

	Output =Supply					Import	Export	Stock changes	Total (a)	Domestic Demand						Total (b)	Difference (a)-(b)
	NGL Plant	Refinery	Own Use	Refinery	Total					Feedstock	Road	Aviation	Power	Fuel	Other non-		
Ethane	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Refinery Gas	10	58	-68	-10	0	0	0	0	0	0	0	0	0	0	0	0	0
LPG	26	52	-1	51	77	210	-3	-2	282	54	130	0	0	76	0	260	22
Naphtha	17	537	0	537	554	519	-97	0	976	767	0	0	40	0	0	807	169
Gasoline	19	326	0	326	345	0	-149	2	197	0	194	0	0	0	0	194	3
Jet Fuel	3	337	0	337	340	0	-232	-1	107	0	0	96	0	10	0	107	0
Kerosene	0	101	0	101	101	1	-25	1	78	1	0	0	2	72	0	75	4
Diesel / Gas Oil	4	817	0	817	821	7	-440	-2	386	0	278	21	2	89	0	390	-4
Fuel oil	3	352	-29	323	326	44	-99	-3	268	0	0	149	43	65	0	258	10
Bitumen	0	51	0	51	51	0	-30	1	22	0	0	0	0	0	22	22	0
Petroleum cokes	0	4	-1	3	3	0	0	0	4	0	0	0	1	3	0	4	-1
Others	0	103	0	103	103	0	-47	0	56	35	0	0	2	0	17	54	3
Total	80	2,739	-99	2,639	2,720	781	-1,122	-3	2,376	856	603	267	89	317	39	2,171	205

	Production	Import	Export	Stock	D.Supply
Biogasoline	0	0	0	0	0
Biodiesel	6	0	0	0	6
Other liquid	0	0	0	0	0
Total	6	0	0	0	6

2011 Chinese Taipei

NG/CR/NGL BALANCE

	Natural gas (Bcm)	Crude oil (1,000b/d)	NGL (1,000b/d)	Refinery (1,000b/d)	Additive/ (1,000b/d)	Other (1,000b/d)
Production	0	0	0	0	0	0
Imports	16	808	0	0	9	0
Exports	0	0	0	0	0	0
Stock changes	-1	14	0	0	0	0
Domestic Supply	16	823	0	0	9	0

INPUT TO REFINERY & NGL PLANT (1,000 b/d)

		Crude oil	NGL	Total	Refinery	Blending	Other	Total	Grand
1	NGL Plant		0	0	26	0	0	26	26
2	Refinery	-822	0	-822	-26	-9	0	-35	-857
	Total	-822	0	-822	0	-9	0	-9	-831

PETROLEUM DEMAND SUPPLY (1,000 b/d)

	Output =Supply					Import	Export	Stock changes	Total (a)	Domestic Demand						Total (b)	Difference (a)-(b)
	NGL Plant	Refinery	Own Use	Refinery	Total					Feedstock	Road	Aviation	Power	Fuel	Other non-		
Ethane	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Refinery Gas	0	24	-24	0	0	0	0	0	0	0	0	0	0	0	0	0	0
LPG	3	34	-1	33	36	36	-1	-1	70	25	2	0	0	43	0	70	0
Naphtha	0	173	0	173	173	243	0	-1	415	334	0	0	0	0	0	334	81
Gasoline	86	147	0	146	233	1	-64	3	173	0	174	0	0	1	0	176	-3
Jet Fuel	0	77	0	77	77	1	-25	1	53	0	0	47	0	3	0	50	3
Kerosene	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Diesel / Gas Oil	3	262	-1	261	265	0	-161	-1	103	0	79	5	1	16	0	101	1
Fuel oil	0	149	-4	145	145	24	-17	4	157	0	0	29	39	59	0	128	29
Bitumen	0	11	0	11	11	0	-4	0	7	0	0	0	0	0	7	7	0
Petroleum cokes	0	9	0	9	9	1	-3	0	6	0	0	0	6	0	0	6	0
Others	0	40	0	40	40	27	-12	2	57	0	0	0	5	0	47	53	4
Total	93	925	-30	895	988	334	-288	7	1,042	359	256	81	51	123	55	925	117

	Production	Import	Export	Stock	D.Supply
Biogasoline	1	0	0	0	1
Biodiesel	0	0	0	0	0
Other liquid	2	0	0	0	2
Total	3	0	0	0	3

2011 China

NG/CR/NGL BALANCE

	Natural gas (Bcm)	Crude oil (1,000b/d)	NGL (1,000b/d)	Refinery (1,000b/d)	Additive/ (1,000b/d)	Other (1,000b/d)
Production	95	4,065	3	0	0	0
Imports	27	5,085	0	0	0	0
Exports	-3	-50	0	0	0	0
Stock changes	0	-291	0	0	0	0
Domestic Supply	120	8,809	3	0	0	0

INPUT TO REFINERY & NGL PLANT (1,000 b/d)

		Crude oil	NGL	Total	Refinery	Blending	Other	Total	Grand
1	NGL Plant		-3	-3	9	0	0	9	6
2	Refinery	-8,666	0	-8,666	-9	0	-32	-41	-8,707
	Total	-8,666	-3	-8,670	0	0	-32	-32	-8,702

PETROLEUM DEMAND SUPPLY (1,000 b/d)

	Output =Supply					Import	Export	Stock changes	Total (a)	Domestic Demand						Total (b)	Difference (a)-(b)
	NGL Plant	Refinery	Own Use	Refinery	Total					Feedstock	Road	Aviation	Power	Fuel	Other non-		
Ethane	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Refinery Gas	0	303	-229	74	74	0	0	0	74	3	0	0	43	27	0	73	1
LPG	5	733	-56	677	682	120	-41	1	763	20	21	0	0	703	0	744	19
Naphtha	0	983	0	983	983	0	0	0	983	983	0	0	0	0	0	983	0
Gasoline	0	1,871	0	1,871	1,871	1	-94	-27	1,751	4	1,695	8	0	43	0	1,751	0
Jet Fuel	0	271	0	271	271	90	0	0	361	0	0	361	0	0	0	361	0
Kerosene	0	153	-1	152	152	45	-144	-2	52	0	0	0	0	36	0	36	16
Diesel / Gas Oil	0	3,448	-5	3,443	3,443	48	-42	-16	3,434	0	1,666	268	9	1,395	0	3,338	95
Fuel oil	0	209	-24	185	185	503	-230	-5	452	0	0	238	46	150	0	434	19
Bitumen	0	181	0	181	181	0	0	0	181	0	0	0	0	0	181	181	0
Petroleum cokes	0	193	0	193	193	0	0	0	193	0	0	0	0	0	193	193	0
Others	0	623	0	623	623	278	-77	-72	752	16	0	0	0	435	301	752	0
Total	5	8,968	-315	8,653	8,658	1,085	-627	-121	8,996	1,027	3,382	875	98	2,788	675	8,846	150

	Production	Import	Export	Stock	D.Supply
Biogasoline	25	0	0	0	25
Biodiesel	2	0	0	0	2
Other liquid	0	0	0	0	0
Total	27	0	0	0	27