Japan's Energy Policy in the Asian Region

Reiji Takeishi
Tokyo International University

Abstract

With encouraged economic activities in the Asian region, energy consumption of Asian countries are substantially increasing. Based on the improved role of Asian countries, the possibility to secure enough energy in the future is becoming a seriously important matter because economic activities basically depend on stable energy supplies.

China is depending on a huge amount of coal supply and the demand is continuously increasing, and whether China can depend on the coal supply in the future or not is important for the Asian region's development and secure security. In Asia, some countries have enough energy resources and some don't. If the Oceania countries are added to Asian countries and Asia Pacific countries are considered, Australia is a very important country because enough energy resources are reserved in Australia. Japan's role for maintaining and contributing to Asian energy security should be based on the concept of "region" and including various types of countries, systems and/or regulations for acquiring stable resource supplies must be prepared.

Key words: energy supply and demand, shale revolution, Asian developing countries, energy strategy
JEL classification: F5, F6, O3, O5, Q4

I. Preface

In the Asian region, depending on the comparatively preferable economic development rather than other regions in the world, energy consumption is expanding outstandingly. The Asian region is called "the Engine for world development" and whether ample supply of energy for the region can be attained or not, it is deciding the trends of world economy. The role of the Asian region is coming very important and situation of Asian industries is attracting more attention. The Asian region is now significantly influencing the price settings of world traded fossil fuels such as oil, natural gas and coal.

The progress of energy trade history and characteristic of the Asian energy market should be intensively analyzed. Especially in a large number of countries in Asia, states themselves are directly participating in the markets and/or state enterprises and state-owned enterprises are controlling the markets. Therefore, the price movements in Asia take different trends from those in Europe and North American markets on occasion. For example crude oil price fluctuations of Dubai crude is different from the other markets in Europe and North America.

The trade practices of energy markets in Asia may force the different movements not only on prices but on demand and supply compared with the ordinal and historical trade practices in Europe and North America.

The possibility of the continuation of a favorable economy and political stability in Asia substantially influences and supports the world economic activity, therefore it is very important to examine Asian energy demand and supply practices.

Especially in the view of energy security, China stands in a very firm position against their requests for the East China Sea and South China Sea areas and also the various territorial requests against neighboring India and Russia are causing worry of conflicts.

For maintaining enough and stable energy supply, arising territorial inconsistency of opinions with neighboring countries causes anxiety. Asian political stability is disturbed by the strong requests by China.

The reason why China mightily insists on the territorial request is related mainly to the necessity to reserve energy resources. From a view to stabilize the energy supply to Asia, the influence of China's actions should be carefully analyzed.

In this paper, how the world-leading research entities are estimating the amount of energy resources and how the process to resolve the inconsistency of opinions are observed.

At first, the increasing trend of Asian energy demand is analyzed and then the effects of the recently appearing "shale revolution" to the Asian countries are evaluated and future prospects of this trend are also studied.

Then the relation with industrial development in Asia and energy demand increase, and the characteristics of each Asian country are considered and evaluated. At last future prospects of the Asian region are examined and Japan's energy policies toward Asia are studied.

II. Energy Situation in Asia

II-1. Research relating to the energy situations in Asia

Recently, due to the comparatively preferable economic conditions in Asia compared with the other regions in the world, energy consumption in Asia expanded steeply. Compared with the other regions in the world energy consumption in Asia is outstanding and still demand increase is expanding. The energy markets in Asia are offering substantial influence on the world trends of energy supply-demand situation and also price fluctuation.

The possibility to acquire enough energy in Asia is becoming much more important than before. Therefore the possibility of maintaining a stable energy supply to Asia must be carefully studied. At first under the present political situation, what types of approaches can be chosen for acquiring a sustainable energy supply which directly connects to the issues of energy security.

In Asia remarkable economic development is arising and newly developed countries are coming to have a stronger voice. World political systems that solely depend on the US are changing, and it becomes impossible to rely only on the US as a hegemonic country. And the

influence from European countries are comparatively declining. Therefore the way to tackle security issues not depending on traditional ways must be considered. In addition to the concept of hub and spoke relations, research to consider multilateral relations which composes the regional architecture are now increased (Jinbo et al. 2011).

Which country and region which must be included inside the regional security institution are discussed depending on the various kinds of opinions.

To start with, the relations or differences of resembling concepts, such as systems, mechanisms, networks, regimes, institutions, complexes, or orders are ordinarily vaguely understood (Jinbo et al. 2011). When energy security issues are considered, the region where it should be included has various choices.

In addition, the areas for regional institutions such as on FTA, EPA, TPP, or AFTA are not demarcated only on economical characteristics, so the diversified concept of drawings of lines will be possible.

II-2. Presence of Asian countries in the energy markets

When we divide the world in six areas, such as in North America, South America, Africa, Asia, the Middle East, and Europe and the Former Soviet Union, there are three strongly energy demanding areas which are North America, Europe and the Former Soviet Union, and Asia in the year around 2000. The energy demand for those three areas are almost same in around 2000.

In the other three areas such as in the Middle East, Africa and South America, energy demand is much less compared with the larger consumer areas such as North America, Europe and the Former Soviet Union, and Asia (See Figure 1).

Although in the 2000s due to steep development in Asian countries especially in China and India, the situation appeared to be that the engines for world economic development were located in Asia, and energy consumption in Asia rapidly increased. Then the Asian energy demand jumped, showed distinction, and this increasing trend continued more rapidly throughout the 2000s.

Figure 1[1] Trends of primary energy consumption in 6 regions of the world (From 1965 to 2011)

(Unit: Million ton oil equivalent)

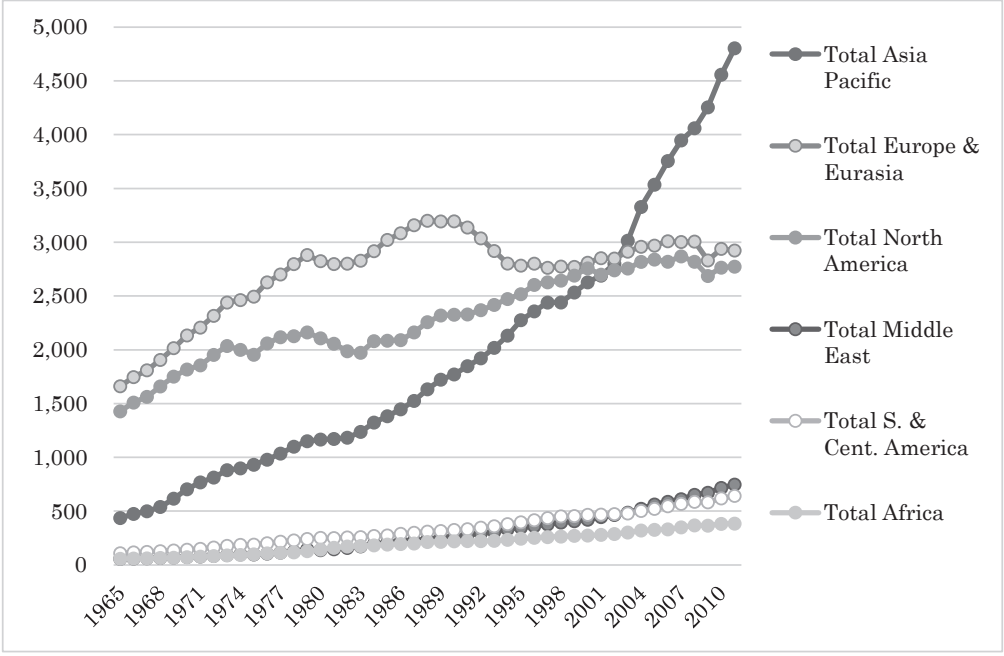


Table 1 shows the production and consumption of oil, gas and coal, in each of the six areas of the world in 2011. The figures of net export are calculated.

The production/consumption total in the world of both oil and gas are almost the same and remain at around 4 billion tons oil equivalent. On the other hand, gas production/consumption is around 3 billion tons. Compared with oil and coal, the amount of gas is less than about a quarter. However, the amount of gas production is increasing due to the effect of the shale revolution, therefore gas supply in the world is expected to increase rapidly. Compared with the prices, coal is ordinarily relatively cheap and then gas production increased substantially, so the price of gas fell. In the near future, in terms of calorific value, gas consumption will surely come to the same amount of oil and coal.

Compared with CO_2 emissions from the combustion of coal, oil and gas, the ratio is 5:4:3, and necessary environmental protection expenses are less in gas. In developing countries, with the increase of individual income, they endure to pay the initial cost for gas distribution lines.

Even in the developing countries, with the increase of income, people can pay the initial cost for utilizing vaporous natural gas, such as pipe laying or combustion appliances, then gas will be preferred more than coal or oil.

[1] Based on BP statistics 2012 data

Utilizing Table 1, whether the utilization of oil, gas and coal is maintained or not in each region is analyzed.

Coal production in the Asia Pacific region is outstandingly high and consumption is also surpassing the other regions. The Asia Pacific is a region heavily relying on coal and it is very important that it is possible for this area to be self-sustained.

In the world, coal is principally consumed inside the area where produced, and as shown in Table 1, the amount of traded coal across the region is not so large compared with oil and even with gas.

As for gas, the Asia Pacific's import amount is the biggest out of the six regions, and the Asia Pacific region can be called the most coal-dependent area in the world. The regions which are depending on the supply of gas from other regions are the Asia Pacific, and Europe and Former Soviet Union. The North, Central, and South American regions are self-sustaining, and the Middle East and Africa are exporting a large amount of gas.

Oil resources are unevenly located and export potential in the world is concentrated in the Middle East. The regions where oil can be exported are in the Middle East, Africa and Central and South America. The Asia Pacific region is where most large amounts of oil are imported and next is North America and the region of Europe and the Former Soviet Union are net importers.

Oil is liquid fuel and very easily transported. But oil is mainly reserved in the Middle East where it is politically unstable, so the price of oil tends to be raised including political risks.

Taking into consideration the above mentioned facts, the Asia Pacific is a region heavily depending on the imports from the Middle East. And this is the area where huge amounts of gas are imported from other regions. Furthermore, the Asia Pacific region is extraordinary dependent on coal, so environmental attention is becoming a big issue.

Table 1[2] Energy production and consumption in six areas of the world in the year 2011

Unit: Million tons oil equivalent per year

	Oil Production	Oil Consumption	Net Oil Export	Gas Production	Gas Consumption	Net Gas Export	Coal Production	Coal Consumption	Net Coal Export
North America	670.0	1,026.4	−356.3	784.0	782.4	1.6	600.0	533.7	66.3
Central & South America	379.9	289.1	90.7	150.9	139.1	11.9	64.8	29.8	35.0
Europe & Forer Soviet Union	838.8	898.2	−59.4	932.7	991.0	−58.2	457.1	499.2	−42.1
Middle East	1,301.4	371.0	930.4	473.5	362.8	110.7	0.7	8.7	−7.9
Africa	417.4	158.3	259.1	182.4	98.8	83.6	146.6	99.8	46.8
Asia Pacific	388.1	1,316.1	−928.0	431.2	531.5	−100.4	2,686.3	2,553.2	133.1

Note 1: Export figures and import figures are not always equal due to statistical discrepancy

Note 2: Positive figures on the column of "Net Export" mean that production surpasses consumption, and minus figures mean that consumption surpasses production

[2] Based on BP statistics 2012 data

II-3. Special Features of energy consumption in the Asia Pacific region

Energy consumption in each Asia Pacific country and the type of fuel are classified as shown in Table 2. China occupies 21.3% of world total energy consumption. India is second in the Asia Pacific but the ratio remains only 4.6%. How much China spends on energy can be understood by this figure. The third is Japan, followed by Korea, Indonesia, Australia and Taiwan.

For maintaining a secure supply of energy in Asia, a stable supply of energy to China is firstly important. According to the data in 2011 of BP statistics, China's coal reserve is third in the world, but production of coal is overwhelmingly world number one and occupies 49% of world production. The reserve production ratio is 33 years.

Before the starting of reform and open-door policy, China's energy dependence to foreign countries is very low. But with the progress of economic development, China's production of oil is increasing, and the import of oil is rapidly expanding. As for natural gas, production is increasing, but consumption is also rising highly, and the import amount of gas is rapidly growing. In China, only coal is in the position of net export if export to Hong Kong is included in the calculation. But the total exporting amount of coal is fluctuating depending on the domestic supply demand situation.

Total energy consumption in the Asia Pacific, but excluding the figure of China, occupies 17.8% of world total and 80% of China. Compared with the figure in China, that is only one country, but the other Asia Pacific countries' total is less. Why China's energy situation, with a background of economic, political, and social situations, is so important will be understood by the above mentioned figures.

As shown in Table 2, there is 1.839 billion tons of coal in China, which occupies 38% of oil equivalent and 4.803 billion tons of total energy consumption in the Asia Pacific region.

Energy issues in the Asia Pacific should be depending on the progress of China's coal production, and as for environmental issues, how China can reduce the burden on the environment under worsening air pollution and to transform from coal to natural gas in city areas, especially in Beijing.

General Secretary of the Chinese Communist Party Xi Jinping, after being elected to his position, first traveled abroad to Russia and concluded with China to import gas from Russia through a pipeline for thirty years. The supply of gas will start from 2018 and the first amount will be 38 billion cubic meters per year and can be expanded to a maximum of 60 billion cubic meters per year. China could be the number one importer of Russian gas, surpassing Germany.

As for oil imports from Russia to China, the 1.5 million tons per year concluded in 2009 will be doubled to 3.1 million tons.

The Chinese government is trying to diversify the countries of energy imports, enhancing imports of natural gas with an environmentally low burden as much as possible, and advancing counter measures to avoid air pollution.

As shown in Table 2, energy consumption in the Asia Pacific by countries and by types of fuels, the largest amount of fuels used is China's coal, and next in the order is China's oil, and following are India's coal, Japan's oil, India's oil, China's hydroelectricity, Japan's coal, China's natural gas, Korea's oil and Japan's natural gas.

China's energy consumption is extremely large, but India, Japan, and Korea are also consuming large volumes of energy. Japan and Korea are both very limited in their reserves of energy within the border, very fragile on energy security, and must rely on the import of energy abroad.

With the economic development of Asia, the amount of energy consumption increased and some countries are changing to net importers of energy, like in Indonesia. Indonesia's oil consumption increased and has the same production as in 2003, and from 2004 Indonesia changed to a net importer of oil, and thereafter the volume of oil imports has been increasing year by year.

Table 2[3] Energy consumption in Asia Pacific countries in 2011

Unit: Million tons oil equivalent per year

		Coal	Oil	Natural Gas	Nuclear	Hydro-electricity	Renewables	Total	Share of Total
1	China	1,839.4	461.8	117.6	19.5	157.0	17.7	2,613.2	21.3%
2	India	295.6	162.3	55.0	7.3	29.8	9.2	559.1	4.6%
3	Japan	117.7	201.4	95.0	36.9	19.2	7.4	477.6	3.9%
4	South Korea	79.4	106.0	41.9	34.0	1.2	0.6	263.0	2.1%
5	Indonesia	44.0	64.4	34.1		3.5	2.1	148.2	1.2%
6	Australia	49.8	45.9	23.0		2.4	2.2	123.3	1.0%
7	Taiwan	41.6	42.8	14.0	9.5	0.9	1.2	109.9	0.9%
8	Thailand	13.9	46.8	41.9		1.8	1.6	106.0	0.9%
9	Singapore		62.5	7.9				70.4	0.6%
10	Malaysia	15.0	26.9	25.7		1.7		69.2	0.6%
11	Pakistan	4.2	20.4	35.2	0.8	6.9		67.6	0.6%
12	Vietnam	15.0	16.5	7.7		6.7		45.9	0.4%
13	China Hong Kong SAR	7.7	18.1	2.7				28.6	0.2%
14	Philippines	8.3	11.8	3.2		2.1	2.3	27.7	0.2%
15	Bangladesh	1.0	5.0	17.9		0.3		24.3	0.2%
16	New Zealand	1.4	6.9	3.5		5.7	2.0	19.4	0.2%
	Other Asia Pacific	19.1	16.7	5.2		8.8	0.1	49.9	0.4%
	Total Asia Pacific	2,553.2	1,316.1	531.5	108.0	248.1	46.4	4,803.3	39.1%
	World Total	3,724.3	4,059.1	2,905.6	599.3	791.5	194.8	12,274.6	100.0%
	USA	6.8	4.2	1.3	-	0.2	1.1	13.6	0.1%
	EU	285.9	645.9	403.1	205.3	69.6	80.9	1,690.7	13.8%
	Former Soviet Union	169.8	190.6	539.6	60.2	54.6	0.4	1,015.1	8.3%

In Table 3, the incremental amounts of energy consumption in the Asia Pacific region in 10 years – from 1980 to 1990, from 1990 to 2000, and from 2000 to 2010 – are mentioned. Minus figures mean the decrease of consumption during the 10 years.

Generally speaking, from 1980 to 1990 and from 1990 to 2000, most of the countries' figures have not drastically changed, but from 2000 to 2010, a lot of countries' figures moved

[3] Based on BP statistics 2012 data

to high growth of energy consumption.

Especially in China, the growth of energy consumption is very high and only one country occupies 53.1% of growth during that period of world energy growth.

Other countries which show high growth of energy consumption during 2000 to 2010 are India, Singapore, Vietnam and Pakistan.

Hong Kong and Bangladesh are countries, compared with the previous period, where the growth is becoming larger.

In Indonesia, Thailand and Malaysia, the growth of energy consumption during 1990 to 2000 is not so different compared with the figures during 2000 to 2010.

On the contrary, in Korea, Taiwan, Australia, the Philippines, New Zealand, and Japan, compared with the figures during 1990 to 2000 and during 2000 to 2010, incremental figures have decreased.

With income rising and industrialization progressing to certain stages, industries of high energy consumption lose competitiveness and some factories start to move to other countries. Growth of energy consumption decreases, and the gross amount of energy increase will remain the same. Furthermore, in Japan compared to 10 years ago, energy consumption is not increasing but decreasing. Therefore Japan's energy situation is advancing more than the other Asia Pacific countries.

As shown in Table 3, energy consumption in the United States, the same as in Japan, decreased during the period from 2000 to 2010. The US is relying not on manufacturing industries but on tertiary industries such as IT-related industries, finance, medical and entertainment, and shifting mainly to service industries and making profits under these economic structures.

Middle income countries, such as in Thailand and other Asia Pacific countries, are targeting to become high income countries with raised industrial competitiveness. But in those middle income countries, energy consumption is not raised much and the entry of factories in their countries is not so high. This situation is called the "Middle Income Trap" (Gill et al. 2007). Middle Income countries which took off, reached middle income countries, but thereafter, the economies stagnated and failed to catch up to the level of advanced countries (Kato et al. 2013, p.238). It cannot be said that those countries thoroughly failed to participate with advanced countries, but under the situation cannot find a way to attain further steps to participate in the next development.

Table 3[4] Incremental amount of energy consumption in the Asia Pacific region in 10 years: from 1980 to 1990, from 1990 to 2000, and from 2000 to 2010

Unit: Million tons oil equivalent per year

	From 1980 to 1990	From 1990 to 2000	From 2000 to 2010	From 2000 to 2010 share of total
China	246.1	348.4	1,392.1	53.1%
India	78.2	115.1	224.7	8.6%
South Korea	51.5	99.5	66.1	2.5%
Indonesia	26.6	46.7	49.7	1.9%
Thailand	18.4	36.0	37.7	1.4%
Singapore	13.8	10.2	34.6	1.3%
Vietnam	1.4	6.7	26.0	1.0%
Pakistan	13.5	16.6	23.5	0.9%
Malaysia	14.7	23.0	23.5	0.9%
Taiwan	22.1	37.8	23.0	0.9%
China Hong Kong SAR	5.3	4.4	11.6	0.4%
Bangladesh	3.6	6.0	11.4	0.4%
Australia	17.9	19.9	8.3	0.3%
Philippines	2.9	10.1	1.5	0.1%
New Zealand	5.1	2.9	1.0	0.0%
Japan	78.5	80.5	−11.7	−0.4%
Other Asia Pacific	5.7	−7.5	7.0	0.3%
Total Asia Pacific	605.2	856.1	1,930.1	73.6%
Total World	1,473.8	1,250.7	2,622.2	100.0%
OECD total	484.0	804.9	137.3	5.2%
Non-OECD total	989.8	445.8	2,484.9	94.8%
USA	155.8	345.3	−35.9	−1.4%
EU total	85.6	71.7	22.9	0.9%
Former Soviet Union	272.3	−497.9	69.1	2.6%

The regions where energy demand growth is high need to install and expand the facilities for energy supply. Energy related investments will concentrate on the areas where energy demand is high. Therefore, in the Asia Pacific region, energy related investment was concentrated. The newest designed facilities are prepared in the Asia Pacific region. The size will become big and the cost competitiveness is strong, then the manufactured goods which conquer the export markets can possibly be produced.

In the Asia Pacific region, the situation is divided into two cases, like in Japan where energy demand has not been growing and new energy related investment has stagnated, and other countries such as in China and India where energy demand has been growing rapidly and new facilities are prepared one after another. Newly constructed refinery facilities in China and India will take superior position due to those facilities' competitiveness being very

[4] Based on BP statistics 2012 data

high.

About the refining capacity in Asia in 2011, the biggest is in China and the capacity is 10.83 million barrels per day. The second is Japan at 4.27 million barrels per day, the third is India at 3.8 million barrels per day, the forth is Korea at 2.78 million barrels per day, the fifth is Singapore at 1.4 million barrels per day, the sixth is Thailand at 1.4 million barrels per day, the seventh is Taiwan at 1.2 million barrels per day, and the eighth is Indonesia at 1.14 million barrels per day (data from BP statistics, 2012).

The country which has the world's largest refining capacity is the US and its capacity is overwhelmingly large at 1.73 million barrels per day. The world's second largest capacity is in China and as mentioned it is at 10.83 million barrels per day. The third is Russia and its capacity is at 5.66 million barrels per day. The refining capacity in Asia has expanded and can compete with the sizes of other regions in the world.

With this comparison using refining facilities, the existence of Asia in the energy sector has been a tremendous expansion in the world.

In the next step, refineries' capacity utilization ratios are calculated dividing the refinery throughput data by capacity of atmospheric distillation data.

In the process industry, the preferable capacity utilization ratio of refineries is over 80%. As shown in Table 4, Japan's ratio is 79.9% and less than 80%. And in Mexico, South and Central America, Europe and Eurasia, and Africa, the ratio is less than 80%.

On the contrary, in China, India, the US, and Canada, the capacity utilization ratio of refineries are well over 80%. The refineries of the oil or specialized companies in those countries can certainly make profit. The huge differences depend on the countries where refineries are locating.

Some parts of the process industry in China and India are surely maintaining competitiveness, but if there are the middle income countries which have several process industries, it is still difficult to surmount the "middle income trap." Both China and India are importing a lot of crude oil and refining them and receiving refinery margins through producing and selling petroleum products. Even the refineries in China and India have competitiveness through the refining process, to catch up to advanced countries by installing process industries in China and India will still not be enough to earn the same level of income as the advanced countries have.

Further steps in the training of manpower, installing of social infrastructure and preparing of essential staff to be able to step into sectors where high added value can be obtained are necessary.

Table 4[5] Refinery capacity of atmospheric distillation, refinery throughput and capacity utilization (%) in the world in 2011

Unit: Thousand barrels per day, %

	Refining Capacity	Refinery Throughput	Capacity Utilization
US	17,730	14,833	83.7%
Canada	2,046	1,733	84.7%
Mexico	1,606	1,167	72.7%
S. & Cent. America	6,590	4,812	73.0%
Europe & Eurasia	24,570	19,544	79.5%
Middle East	8,011	6,505	81.2%
Africa	3,317	2,219	66.9%
Australasia	742	789	106.2%
China	10,834	8,992	83.0%
India	3,804	4,085	107.4%
Japan	4,274	3,406	79.7%
Other Asia Pacific	9,480	7,480	78.9%
Total World	93,004	75,563	81.2%
of which: OECD	45,426	36,931	81.3%
Non-OECD	47,578	38,632	81.2%
European Union	15,234	12,193	80.0%
Former Soviet Union	8,093	6,601	81.6%

II-4. Comparison of Energy consumption of types of fuel in Asia Pacific

In the world of energy consumption, the presence of Asian countries is expanding. The characteristics of energy consumption in Asian countries by types of fuels are analyzed.

Figure 2 shows the ratio of primary energy consumption of Asia Pacific countries including Asian countries, Australia and New Zealand in 2011 divided by types of fuels. The names of countries are listed in the order of high ratio of coal consumption from left to right. China's ratio of coal consumption is 70% and exceptionally high in the Asia Pacific countries. The following high coal consumption ratio countries are India and Australia.

China, India and Australia show a high coal consumption ratio and all three countries hold huge coal reserves. Taiwan shows the fourth highest ratio of coal consumption in Asia and is a country where they must always pay precise attention to energy security in relation to mainland China. Taiwan is composing a system to utilize various kinds of energy and is introducing in addition to coal, oil and gas, nuclear, hydroelectricity and renewables.

The other countries which are trying to take the balances of various kinds of energy and trying to introduce various kinds of energy are Japan and Korea.

The Philippines and New Zealand are showing a high ratio in the introduction of

[5] Based on BP statistics 2012 data

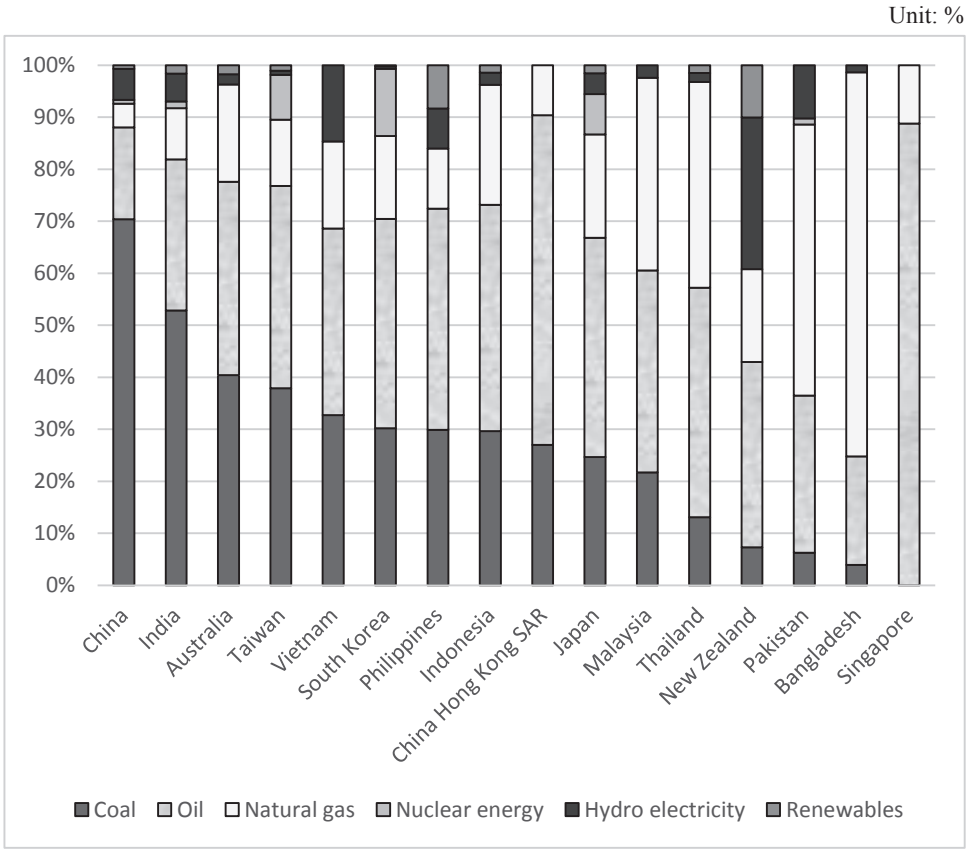
renewable energies compared with the other countries.

Singapore and Hong Kong's ratio of oil are very high among Asia Pacific countries. Both countries are supplying a lot of banker fuels to ships and as a hub airport supplying huge amounts of jet fuel and trying to diversify the power generation from fuel to gas.

The countries where the ratio of gas consumption is high are Bangladesh, Pakistan, Thailand and Malaysia, and all those countries are gas producing countries.

Each country in the Asia Pacific countries should mainly utilize the energy resources which are abundant in the country, and if more cost competitive energy is available, then use such energy, especially coal. Trying to pursue the way of economic development is the right way for keeping energy security. To depend heavily on energy import means high vulnerability.

Figure 2[6] Ratio of primary energy consumption in Asia Pacific countries in 2011



II-5. Fossil fuel reserves in Asia Pacific countries

Whether fossil fuel reserves in the Asia Pacific countries are high or low in the world

[6] Based on BP statistics 2012 data

should be analyzed.

Oil recoverable reserves in Asia Pacific countries as shown on Table 5 occupy only 2.5% of the world total. In the OPEC countries, 72.4% of the world total oil reserves remain. Oil is unevenly distributed in the world. With the economic development in the Asia Pacific region, automobiles become popular, traffic increases further, and then consumption of oil products such as gasoline and gas oil for traffic must increase. More import from the outside of the Asia Pacific region, mainly from Middle East countries, is expected to inevitably increase.

The next analysis is about the reserves-to-production (R/P) ratio of oil at the end of 2011.

The ratio in China is 9.9 years; in Malaysia, 28.0 years; India, 18.2 years; Vietnam, 36.7 years; Indonesia, 11.8 years; Australia, 21.9 years; Brunei, 18.2 years; Thailand, only 3.5 years; and the average of other areas in Asia is 10.4 years; and the total average of the Asia Pacific Region is 14.0 years (data based on BP statistics).

The definition of "proved recoverable reserves of oil" doesn't include not-yet-discovered reserves and reserve growth, which means an incremental amount of production with technological advance. Therefore the present amount of reserves should surely have additions. But it is said that the additional amount of oil reserves should not bring the present oil reserves twice as much (Japan Petroleum Development Association 2012, p.23).

In addition, to calculating the reserve production ratio, the reserve amount is divided by the latest production amount. Even in the case when some reserves are added, Asian countries' oil production, which is the denominator on the R/P calculation, is forced to increase, so the R/P figure will not increase substantially.

For example, in Vietnam the R/P figure of oil in 2011 was 36.7 years. Vietnam is now in the position to come to a turning point to increase oil consumption steeply. Following the expansion of oil consumption, the R/P figures will have to show a rapid decrease.

Malaysia is a country producing oil, but the government is taking the policy to preserve the reserves, keeping the production under a certain level, maintaining the import of oil, and keeping the balance of production and import. It is expected that some oil producing countries will take the policy to increase the amount of oil import and to maintain the upper limit of production levels.

Oil reserves in Asia are expected to come to the upper limit in 20 to 30 years, and after that the production level will remain at a limited amount.

In the world at present, fuels for transportation are largely dependent on oil, but transformation from oil to other fuels will gradually become necessary. In that case, as automobiles are very common in the world and since those cars can be used for more than 10 years, it is not an easy task to make the shift of transportation fuels from oil to others.

In a country where the people's income is high above a certain level, hybrid cars which are expensive but show high fuel efficiency can be sold, but in low income countries hybrid cars can't be popularized. But even in low income countries, people who have automobiles have the opportunity to earn much more income, and actually many people are making money utilizing cars. Then the number of cars will inevitably increase and with the growth of the number of cars, oil consumption will expand.

As is well-known, oil is a depletable resource and the amount of oil reserves of each reservoir will decrease according to the production, and the production ability of each well will naturally decrease. Table 5 shows the oil reserves of Asia Pacific countries at the end of 1991, 2001 and 2011. Oil reserves in China are declining, and in Indonesia and Australia the figures have the tendency to decrease.

In Vietnam, the figures of oil reserves are increasing, and in Malaysia, reserves are slightly and steadily increasing. In India and Brunei, the figures reached a plateau.

The leveling off of oil reserves means that the produced oil amount was substituted by an additional new discovery or a "technologically increased reserve growth" with the efforts of oil exploitation, exploration and development.

The figures of world total oil reserves are increasing and compared with the figures at the end of 1991, at end of 2011 world oil reserves increased to 1.6 times more. Oil production in the world increased from 65.19 million barrels per day in 1991 to 83.576 million barrels per day in 2011, meaning it is 1.28 times more. This means that compared with oil production, oil reserves increased more in the same period.

Table 5[7] Oil recoverable reserves in Asia Pacific countries

Unit: Billion barrels, billion tons, %, years

	End 1991	End 2001	End 2011			
	Billion Barrel	Billion Barrel	Billion Barrel	Billion Ton	Share of Total	R/P
China	15.5	15.4	14.7	2.0	0.9%	9.9
Malaysia	3.7	4.5	5.9	0.8	0.4%	28.0
India	6.1	5.5	5.7	0.8	0.3%	18.2
Vietnam	0.2	2.2	4.4	0.6	0.3%	36.7
Indonesia	5.9	5.1	4.0	0.6	0.2%	11.8
Australia	3.2	5.0	3.9	0.4	0.2%	21.9
Brunei	1.1	1.2	1.1	0.1	0.1%	18.2
Thailand	0.2	0.6	0.4	0.1		3.5
Other Asia Pacific	0.9	1.1	1.1	0.1	0.1%	10.4
Total Asia Pacific	37.0	40.5	41.3	5.5	2.5%	14.0
Total World	1,032.7	1,267.4	1,652.6	234.3	100.0%	54.2
OECD	142.7	254.8	234.7	35.7	14.2%	34.7
Non-OECD	890.1	1,012.6	1,417.9	198.6	85.8%	59.7
OPEC	769.0	855.5	1,196.3	168.4	72.4%	91.5
Non-OPEC	204.7	330.4	329.4	48.7	19.9%	26.3
European Union	8.3	8.8	6.7	0.9	0.4%	10.8
Former Soviet Union	59.0	81.4	126.9	17.2	7.7%	25.8

Note: R/P means Reserves-to-Production Ratio

As for natural gas as shown on Table 6, the R/P, which means reserve production ratio, on natural gas is larger than that of oil in the Asia Pacific region. The Asia Pacific region is relying on the import of natural gas from outside of the area but not totally depending on the

[7] Based on BP statistics 2012 data

import.

Ranked by the volumes of natural gas reserves in the Asia Pacific region, No.1 is Australia, and China, Indonesia, Malaysia, India, Pakistan, Vietnam, Papua New Guinea, Bangladesh, Brunei and Thailand are following.

As for the volume of liquefied natural gas export, Australia is the largest and the next largest are Indonesia, Malaysia, Papua New Guinea and Brunei. Myanmar is exporting natural gas to Thailand and China through pipelines.

Existing export projects of natural gas through a pipeline are from Indonesia to Malaysia and Singapore, from Malaysia to Singapore, from East Timor to Australia and from China to Hong Kong. The gas transported from East Timor to Australia is exported as LNG from Australia.

In addition, outside of the Asia Pacific region, natural gas is imported a long way from Turkmenistan to China.

When importing natural gas by LNG ship, if spot purchase basis LNG is available, the cost of LNG is sometimes very competitive. On the other hand when importing natural gas through a pipeline, generally speaking, the exporter and importer are both restricted. But the exception of this is in the US where the natural gas pipelines are installed in every direction and restriction is very loose. The price of natural gas transported by pipeline is fluctuating, influenced by the world traded gas price and also the world oil prices.

Therefore, mutual dependence of contractors are found on the gas trade through pipelines. Not only the buyers but the sellers will also take perpetual advantages. The sellers of natural gas depend on the buyers of natural gas and when buyers will buy then sellers can get a refund of their investment for facilities. The buyers are also depending on the sellers and a stable supply of natural gas is very important.

Natural gas trade through pipeline sometimes causes confusion within the countries of gas producers/exporters and importers when passing through the pipeline of third countries. A famous example is in the case of the natural gas export from Russia to West Europe through Ukraine. The gas price from Russia to Ukraine caused trouble and Ukraine stopped the transportation of gas in their territory. The situation became serious because Russia couldn't transport gas to West Europe and Russia's gas export to West Europe was expected to drastically decrease. Then Russia was forced to solve the issues of Ukraine for the purpose of transporting natural gas to West Europe.

In the Asian region, especially in Southeast Asia, a lot of trans-boundary pipelines exist and there are more plans of installation so as to enforce the pipelines as regional grids. With the progress of installation of pipelines more export and import of natural gas becomes possible, and the sharing of energy among countries through those installed pipeline-girds becomes possible. Now there is the tendency that Asian countries' mutual dependence will be enhanced.

It is well known that in ASEAN countries, from high ranked government officials to technical staff, they are frequently participating in meetings (Sato 2003). When gas trade through the pipelines increases and becomes popular in the region, differences of industrial

standards in the concerned countries, examination of mutual payment systems, accounting systems, reimbursement of expenses after calorific adjustment of gas trade volume and gas ingredient data analysis must be studied carefully, holding frequent meetings with the staff and engineers in charge in both countries.

Table 6[8] Gas recoverable reserves in Asia Pacific countries

Unit: Trillion cubic meters, 5 years

	End 1991	End 2001	End 2011		
	Trillion Cubic Meter	Trillion Cubic Meter	Trillion Cubic Meter	Share of Total	R/P
Australia	0.9	2.7	3.8	1.8%	83.6
China	1.0	1.4	3.1	1.5%	29.8
Indonesia	1.8	2.6	3.0	1.4%	39.2
Malaysia	1.7	2.5	2.4	1.2%	39.4
India	0.7	0.8	1.2	0.6%	26.9
Pakistan	0.8	0.7	0.8	0.4%	19.9
Vietnam	0.0	0.2	0.6	0.3%	72.3
Papua New Guinea	0.4	0.4	0.4	0.2%	*
Bangladesh	0.7	0.3	0.4	0.2%	17.8
Brunei	0.4	0.4	0.3	0.1%	22.5
Thailand	0.2	0.4	0.3	0.1%	7.6
Myanmar	0.3	0.3	0.2	0.1%	17.8
Other Asia Pacific	0.3	0.4	0.3	0.2%	18.9
Total Asia Pacific	9.3	13.1	16.8	8.0%	35.0
Total World	131.2	168.5	208.4	100.0%	63.6
OECD	15.2	16.1	18.7	9.0%	16.0
Non-OECD	116.1	152.5	189.7	91.0%	90.0
European Union	3.8	3.6	1.8	0.9%	11.8
Former Soviet Union	49.8	50.9	74.7	35.8%	96.3

Note: The * mark in Papua New Guinea means that R/P (reserves-to-production ratio) exceeded 100 years.

As for the coal reserves in the Asia Pacific region, reserves are concentrating on the three countries in the order of China, Australia and India. Coal reserves in the above three countries are one digit larger than the other countries and the country which has the fourth largest reserves is Indonesia, followed by Pakistan and Thailand.

The world share of coal reserves of Asia Pacific countries is 30.9% and compared with the ratio of oil's 2.5% and natural gas' 8%, coal reserves in the Asia Pacific could be said to be affluent.

As for the R/P ratio of coal, China's R/P is 33 remaining years. In the future, with the progress of exploitation, China's coal reserves should have increased, but coal is the main energy source in China and is supporting the Chinese economy. Therefore, the figure of 33 years of coal R/P in China should cause serious anxiety for the Chinese government.

[8] Based on BP statistics 2012 data

R/P figures of coal in Australia, who hold the second largest reserves in the Asia Pacific region, and India who has the third, are exceeding 100 years. Indonesia, who hold the fourth largest coal reserves in the Asia Pacific, is exporting coal to Japan and other countries, but the reserve volume is not large enough, so it may be difficult for Japan and other countries to rely on export from Indonesia in the long term.

Coal has a variety of forms such as anthracite, bituminous, sub-bituminous and lignite. Water content in lignite is high and is not useful and not used much. For purposes of utilization, coal is divided into two kinds, such as raw material coal for steel production and fuel coal for power generation.

Compared with China and Australia, India's coal is occupied mainly by anthracite coal and bituminous coal. But in India, coal's ash ratio is high and in making cokes for steel production, India is importing coal from Australia.

In the world, in Germany, low quality lignite is mainly reserved. But compared with oil which is located mainly in OPEC, coal is reserved in OECD countries such as in the US, Canada, Germany and Australia. So OECD countries have many coal reserves and can compete with the reserve volumes of non-OECD countries.

On the contrary to coal, natural gas is reserved in extremely large amounts in non-OECD countries and the ratio of reserves in OECD countries against non-OECD countries is 1:10. The coal reserve ratio is 44:56 and it is different from natural gas and OECD countries who can compete with non-OECD countries on coal supply. Therefore, OECD countries will surely try to utilize coal in the future.

Table 7[9] Coal recoverable reserves in Asia Pacific countries in 2011

Unit: Million tons, %, years

	Anthracite and bituminus	Sub-bituminous and lignite	Total	Share of Total	R/P
China	62,200	52,300	114,500	13.3%	33
Australia	37,100	39,300	76,400	8.9%	184
India	56,100	4,500	60,600	7.0%	103
Indonesia	1,520	4,009	5,529	0.6%	17
Pakistan	–	2,070	2,070	0.2%	*
Thailand	–	1,239	1,239	0.1%	58
North Korea	300	300	600	0.1%	19
New Zealand	33	538	571	0.1%	115
Japan	340	10	350		275
Vietnam	150	–	150		3
South Korea	–	126	126		60
Other Asia Pacific	1,583	2,125	3,708	0.4%	88
Total Asia Pacific	159,326	106,517	265,843	30.9%	53
Total World	404,762	456,176	860,938	100.0%	112
OECD	155,926	222,603	378,529	44.0%	182
Non-OECD	248,836	233,573	482,409	56.0%	86
European Union	5,101	51,047	56,148	6.5%	97
Former Soviet Union	86,725	141,309	228,034	26.5%	408

Note: * mark at Pakistan means R/P is more than 100 years.

The analyses of fossil fuels such as oil, gas and coal are already mentioned in the above sections, in the Asia Pacific region relatively high reserves of coal in the world exist and those advantages are utilized and the substantial coal reserves are the reason why the Asia Pacific can reach rapid economic development.

On the other hand, natural gas and oil are relatively low in reserves in the Asia Pacific. As for natural gas from areas or countries where there is ability, gas is exported by pipeline or LNG. And where there is a deficiency of supply from inside the Asia Pacific, natural gas is imported by LNG from far away regions such as the Middle East. As in the case of China, natural gas is imported from Turkmenistan by pipeline. China is negotiating with Russia to import gas to compensate for its energy deficit.

III. Shale Revolution and Asia

III-1. Shale Revolution in the US

In the US, technological innovation progressed and shale gas production from shale rocks became possible. Production of natural gas and oil from shale rocks are considered traditionally to be very difficult. Source rocks which are equal to shale rocks, are the original places of oil and gas formation, and after formation, oil and gas partially move to reservoir rocks. It is well

[9] Based on BP statistics 2012 data

known from a long time ago that shale rocks reserve affluent gas and oil.

Even in major oil companies, which tried to produce from shale rocks before, shale gas and shale oil production from shale rocks was considered to be very difficult, not profitable, and that technological breakthroughs could never overcome the difficulties in production, and withdrew from the trial.

George P. Mitchell, a graduate of Texas A&M University and the president of George Mitchell Energy & Development which is based in Texas, enthusiastically tried technological innovation for a long time with the assistance of Section 29 in the US' tax system which allowed federal tax credit for drilling for unconventional natural gas, eventually succeeding in commercial production.

After the other companies pulled out, Mitchell continued his trial at the Barnett Shale located between Dallas and Fort Worth, Texas, and finally succeeded in the production of shale gas utilizing the technologies of hydraulic fracturing.

Utilizing water, sand and small amounts of chemicals, it was highly pressurized and poured in the underground shale reserves, making shale gas production possible (Yergin, 2012).

In 2002, Mitchell Energy & Development was acquired by Devon Energy, located in Oklahoma City. This company had advanced horizontal drilling technology. With the combination of Mitchell Energy & Development's hydraulic fracturing technologies and Devon Energy's horizontal drilling technologies, highly advanced operation technology and shale gas production began to increase. This technology spread over locations in the US where shale reservoirs existed.

The US is the world number one consumer of oil and gas, and in this country, much more gas production becomes possible, exceeding the US' gas consumption, and in addition, unconventional oil, called tight oil, also becomes possible. The results of that innovation have had a huge impact on the world energy supply and demand situation.

The US government was worried about the double deficits of financial and current accounts. In addition, the import of large volumes of natural gas was expected before the increase of shale gas production. But after the shale revolution utilizing affluent unconventional gas reserves, gas production increased and based on the low priced gas, electricity prices were expected to remain low, and industries are starting to return to the US.

The industries in the US are expected to be enhanced and to hold competitiveness, and the possibility of a decrease in both financial and current account deficits as a result of the shale revolution is expected in the US.

In addition, with the increase of natural gas production, the associated production of liquids, which are called condensate or NGL (natural gas liquid) will increase. From the NGL, abundant middle distillate oil can be produced. The utilization of shale gas plans, that large scale fleets and transcontinental trucks can run by natural gas, are already starting in the US.

In 2011, the US' export of oil products surpassed the total of the former USSR's export of oil products and also surpassed the total of the Middle East's export. The US became the

largest exporter of oil products and the volume of export from the US is still increasing. After 2013, it is expected that the US' export of oil products will increase even more.

The production technologies of shale gas can be applied to the production of unconventional oil and, at first, production of tight oil is increasing. In the future, the production of shale oil is expected to increase.

III-2. Spreading the Shale Revolution in the world

The shale revolution, which is the technological innovation to produce unconventional gas and oil, started in the US and is spreading throughout the world and the trial to increase the production of gas and oil in the world is beginning.

In the production of shale oil, the cost of production was expected to be 145 dollars and much higher than the price of crude, but with technological innovation the cost was estimated to be reduced to 64 dollars (Andrews 2011).

The estimation of technologically available natural gas reserves by the OECD IEA is shown on Table 8.

In the area of the Former Soviet Union, including Russia, the reserves of technologically recoverable conventional gas are large and the reserves in the Middle East are following. In the other areas, Africa, North America and the Asia Pacific are the regions where gas reserves are kept at slightly less than 50 trillion cubic meters. The areas which have far less reserves are Central and South America, holding 32 trillion cubic meters, and in OECD Europe, holding 24 trillion cubic meters. The above figures are the estimation of technologically recoverable conventional gases, but the reserve location of unconventional gas is different.

Unconventional gas is divided into three categories such as shale gas, tight gas, which is easily produced compared with shale gas, and CBM (coal bed methane), which is produced from the coal layers. Shale gas in the world is expected to be the largest, at 200 trillion cubic meters; the next is tight gas, expected to be at 81 trillion cubic meters; and the last is CBM, expected to be at 47 trillion cubic meters.

A lot of tight gas is already under production in the US and the Energy Information Administration in the Department of Energy, which is publishing energy statistics, is classifying tight gas as conventional gas in the US statistics.

The reserve amount of tight gas in the Asia Pacific region is estimated at a total of 21 trillion cubic meters.

As for shale gas, the same as in the case of tight gas, the technological recoverable volume is largest in the Asia Pacific region, and 57 trillion cubic meter reserves are expected. Reserves of CBM in the Asia Pacific region, also the largest in the world, reached 16 trillion cubic meters.

On Table 8, the total of unconventional gas reserves, the largest being in the Asia Pacific, is 94 trillion cubic meters. The next is in North America and reserves are at 67 trillion cubic meters.

With the figures of the sum of conventional and unconventional reserves, the largest

reserves are kept in the East Europe and Former Soviet Union region and the reserve amount came up to 187 trillion cubic meters. The second is in the Middle East and also in Asia Pacific regions, each holding 137 trillion cubic meters. In the Asia Pacific region, reserves of conventional gas are relatively smaller but with the addition of reserves of unconventional gas, then the Asia Pacific region can compete with the Middle East in total gas reserves.

In North America with the shale revolution, the revitalization of economies is starting, but the amount of total gas reserves remain the fourth rank in the world.

From now on, the shale gas production in areas other than the US will start and active works of shale gas production are expected. In the future, supply sources of natural gas can be diversified widely.

Expecting the world wide tendency of active utilization of natural gas, some proposals and studies are prepared for comprehensive and efficient use of natural gas (The Japan Institute of Energy, 2006).

But the situation in the US and other areas are completely different. In the US, exploitation and exploration are actively performed and pipeline networks are crisscrossing, and affluent persons are working in the oil business. But in the other countries, the condition to start production of unconventional gas is not well arranged.

In the other countries, to start shale gas production is not a simple task and, especially in China, the depth of shale reserves are at around 4,000 to 5,000 meters. Many faults exist, and to start production is not easy work.

In Europe, at Paris Basin in France, there are large shale gas reserves. But underground, beneath the urbanized areas, citizens are very critical to produce natural gas. But it is expected that shale gas will be produced from those urbanized areas in future.

Table 8[10] Recoverable gas reserves in the world: Conventional, unconventional, tight gas, shale gas and CBM (coal bed methane)

Unit: Trillion cubic meters

	Conventional	Un-conventional				
		Tight Gas	Shale Gas	CBM	Sub Total	Total
East Europe & Former Soviet Union	144	11	12	20	44	187
Middle East	125	9	4		12	137
Asia Pacific	43	21	57	16	94	137
North America	47	11	47	9	67	114
Africa	49	10	30	0	40	88
Central & South America	32	15	33		48	80
OECD Europe	24	4	16	2	22	46
World Total	462	81	200	47	328	790

Note 1: The reserve figures include not-yet-discovered figures.

Note 2: Recoverable gas reserves CBM is the abbreviation of coal bed methane.

Note 3: Due to rounding, the world total will not always be the same as the sum of detailed figures.

[10] Based on OECD IEA, "World Energy Outlook 2012" data

IV. Industrial Development and Energy Demand

The US holds the world's number one reserves of coal, but as for natural gas, until several years ago, production decreased and the import of large volumes of LNG was considered. The candidate countries of LNG import are in Central and South America, Trinidad and Tobago, and Venezuela; and in the Asia Pacific, Australia and Indonesia.

In addition, Sakhalin of the Russian Far East, Africa and the Middle East are all targeted areas of US LNG imports. But a large volume of shale gas production becomes possible in the US, and shale gas production is enough to cover the amount of inland demand.

After the bankruptcy of Lehman Brothers in 2008, the US economy stagnated and took much time to recover, and gas prices in the US came down to the historical low level of 2 to 3 dollars per MMBTU. Since then, with the commencement of high gear production of tight gas, there is the tendency of oversupply in the US gas market. The US gas prices remained at around 3 to 4 dollars per MMBTU until the end of 2013.

Coal has been utilized as the fuel for power generation in the US and the share of coal is around 40-50% in the US' total power generation. Environmentally speaking, natural gas can reduce the burden on the atmosphere compared with coal and the acceleration of production and increasing of natural gas started. As natural gas is really low cost, power suppliers decided to stop the operation of coal power plants and introduced gas power plants as much as possible.

Then, the coal producers in the US started to export surplus coal in the US to Europe. From Canada to the US, huge amounts of natural gas were traditionally exported, but due to the reduced gas prices in the US, demand for Canadian gas in the US decreased, and Canadian companies decided to utilize Canadian natural gas as much as possible to produce steam for oil sand production which is abundantly reserved in Canada.

In Canada, shale gas production started and the projects to export gas to Asian countries were planned. Preparation work for construction of LNG export facilities have already started.

As mentioned above, the effect of the shale revolution which started in US spilled over to Europe and Canada. In Europe, the UK, Germany and other countries, coal power generation utilizing imported low priced US coal outstandingly increased in 2012.

At the conference of COP 18 held in Doha, Qatar, on December 2012, European countries where CO2 emissions increased substantially with rising coal power generation couldn't decide the figures for emission reduction targets within the EU. So EU countries held the meetings within the EU during the COP 18 and therefore, at the COP 18 meetings, no fruitful results were acquired for reducing greenhouse gas emissions.

The above mentioned means the various effects of the shale gas revolution spilled over in the world.

V. Energy Profiles of Asian Countries

At this section IV the profiles of energy consumption of main Asian countries, such as the countries of large energy consumption and/or resource rich, are examined.

V-1. China

After the establishment of China in 1949, the most important targets of energy policy have been self-sufficiency. Based on the policy to improve the domestic energy industry and if possible to earn foreign money by export, crude oil and coal have been exported.

Due to the accelerated economic development during the 90s and introduction of the market economy, supported by the world's third-ranked coal reserves, China enhanced industrialization and if there were deficiency only with the domestic production, then China tried to import energy, and took the policy to obtain the rights and interests for energy production abroad as much as possible.

The swift progress of economies in China is called "China as the experimental field" (Nakagane, 2012), and this phenomenon is a very rare case in the history of human beings.

As shown in Figure 3, when comparing China's energy consumption and production data in 2011, China's coal production and consumption is far above large. In addition, China's coal production is exceeding consumption. China's coal consumption is overwhelmingly large in the world and if there are shortages of coal supply in China, then China must import huge amounts of coal from outside of China and this shortage will have serious effects all over the world. Until now, China's coal production increased steadily and when the coal production at Shanxi Province, China's largest coal production are, came to a plateau, then the production in Inner Mongolia Autonomous Region increased and at present has become the largest production area.

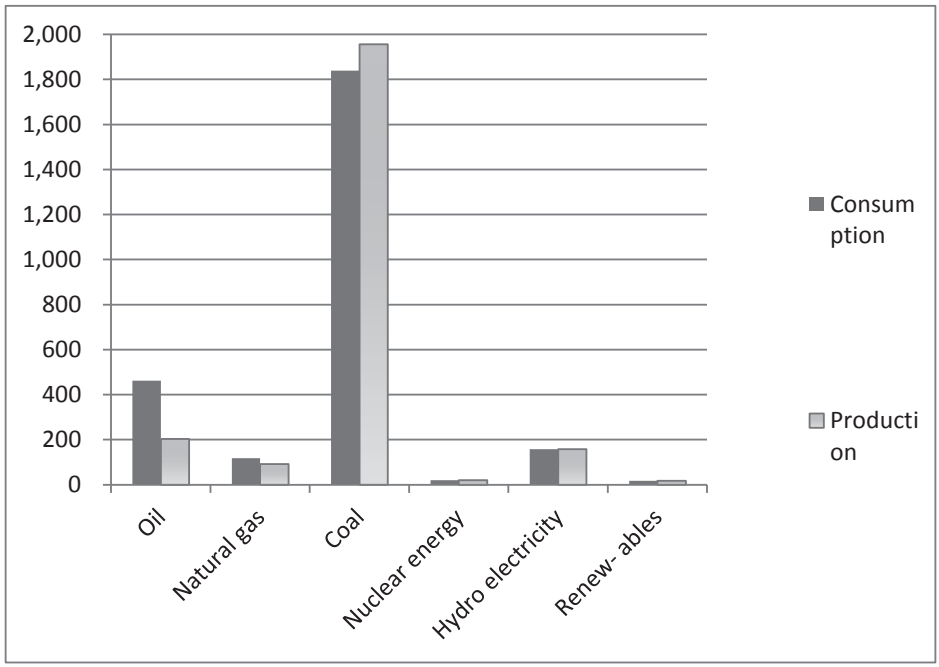
At present, problems in China are on the secure supply of oil. China's remaining domestic supply of oil is half of the domestic consumption. Both maintaining domestic production and the acquiring of oil import are becoming important issues.

The ratio of natural gas production and consumption is occupying the total energy consumption in China, which is still small, but when the ratio comes up then heavy dependence on coal can be reduced and the environmental burden will be reduced. Expectation for the increase of natural gas production is very large in China.

The share of hydroelectric power, nuclear power and renewables are all very small in China, but as for China's energy policy, it is very important to continuously try to increase those supplies and diversify the energy sources step by step.

Figure 3[11] China's energy consumption and production in 2011

(Unit: Million ton oil equivalent)



On the China's 12th five year plan, the government is expecting to raise the share of non-fossil fuel energy to 11.4% in 2015.

According to the OECD IEA report, China's energy consumption will be doubled in 2035 compared with the consumption in 2008.

On the other hand, according to the OECD IEA report, one scenario mentioned there is the possibility that China could reduce the dependency on coal at present by 70% in 2012 to 59% in 2035. In China, the efforts to substantially raise the efficiency of energy use and reduction of CO_2 emissions per GDP are targeted.

But in China, energy consumption will have to increase and there is the estimate that China's coal consumption will be doubled until 2035, and to reduce the total emissions of CO_2 is almost impossible.

In China, natural gas utilization is promoted and there are plans to force the transformation of coal to natural gas. In China, there are gas producing area like Ordos, Sichuan and Tarim, and the Chinese government is expecting that in the East China Sea there are large reserves of natural gas.

According to the figures estimated on the report of the Energy Information Administration, Department of Energy, in the US government (DOE EIA), reserves of oil are at 100 million barrels, and 1 trillion to 2 trillion cubic feet of proven and probable natural gas are estimated

[11] Based on BP statistics 2012 data

to be in the East China Sea (US DOE EIA 2012).

In China, abundant resources are expected and the estimated undiscovered resources on oil are 70 billion barrels to 160 billion barrels, and on natural gas, 250 trillion cubic feet (Ditto EIA 2012).

Depending on those high estimations, and those figures are spreading in China, there may be the possibility that this is why the Chinese government is being active about territorial issues in the East China Sea.

There is a story in China, that Tarim Basin was once considered to be "the second Middle East," with a high possibility of having oil and gas reserves. But after all, the reserves at Tarim Basin are not big enough to compete with the Middle East and production remains relatively small.

Again on the oil development plans at Bohai Bay, the Chinese government estimated huge amounts of oil reserves. After exploration of oil reservoirs at Bohai Bay, they found that it was spread over thinly and covered wide area, but that oil reserves were relatively small compared with the early stage estimation, and the production amount remains relatively small.

In the case of the East China Sea, the Chinese habit to first estimate very large reserve figures is again repeated, and the neighboring countries of China are embarrassed by the Chinese government's active attitude.

Same as in the East China Sea, on the issue of the South China Sea, both the Vietnamese and Philippine governments are facing strong requests and attitudes from China and are perplexed on how to manage the situation.

China's energy policy is under the control of governmental organizations such as at NDRC, and are systematically decided. Energy sectors of oil, natural gas, coal and power are all under the control of national companies and from production to selling are controlled by those national companies.

Oil industries in China were re-organized by government decision to be two main companies, such as CNPC and SINOPEC. Both were in charge of things from the production of oil and gas to the marketing of products in the 1990s. Before, CNPC was the national company mainly in charge of production, and SINOPEC was the company mainly in charge of refining.

In addition, for offshore oil and gas production, CNOOC (China National Oil Corporation) was in charge.

In China, most of the inland oil reservoirs including Daqing Field are starting to deplete due to long-running production. To maintain production, the introduction of EOR (Enhanced Oil Recovery) technologies of secondary and tertiary EOR, such as pouring pressurized water in the underground reservoirs or utilizing chemicals, are becoming necessary.

As for nuclear power stations, new construction works have been enhanced on the target to increase nuclear power generation capacity from 9.1 GW in 2009 to 86 GW in 2020.

V-2. Korea

Korea, as with Japan, is poor in domestic energy resources and almost all fossil fuel energy resources are imported.

But compared to Japan, almost all of Korea's refining facilities hold larger scales[12] and keep competitiveness as export refineries.

Korean government endeavors to coordinate installation and integrate capital intensive industries. In Korea, the coordination works of industries are not so difficult because coordination among the large industrial conglomerates, which are called Chaebols in Korea, are occupying large shares of the economy and if there are some decisions among Chaebols that means the final resolution.

In the case of the gas industry, KOGAS is solely occupying the Korean gas market, and on the power industry, KEPCO is monopolizing the power market. As for oil and gas development, KNOC is the only company. In Korea, the coordination among industries is very simple and the Korean government intensively invested the government's ample money supply which resulted in success.

Based on the Basic Act on Energy, the Korean government is preparing a long term energy strategy called the "National Energy Basic Plan" every five years, and on August 2008, the first National Energy Basic Plan which contains the national targets until 2030 was prepared. Improvement of energy efficiency, promotion of nuclear power plants and renewables and enhancement of oil development by Korean companies are listed as the targets.

The ratio of hydroelectric power generation in Korea remains at 0.4% and renewables are at only 0.2%. In Korea, the government has just introduced policies to enhance renewable energy en masse.

V-3. Indonesia

Indonesia's domestic energy consumption is steeply increasing. Traditionally Indonesia is the exporting country of oil, gas and coal and had been a member of OPEC. But Indonesia has changed as the net importer of oil so Indonesia withdraw from OPEC in 2009. The economic condition of Indonesia is kept very well and the population is still increasing, but supply of domestic energy cannot cover the demand growth. The Indonesian government has been concerned about this situation. In Indonesia, traditionally kerosene and gasoline were subsidized heavily, so how the government can reduce those subsidies have become big issues.

In Indonesia there are many volcanoes and geothermal power generation is ranked at world number three.

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[12] In Korea capacity of five bigger refineries are SK Ulsan 840,000 barrels per day, GS Caltex 760,000 barrels per day, S-Oil 565,000 barrels per day, Hyundai 310,000 barrels per day, SK Inchon 275,000 barrels per day (January 2012).

V-4. Malaysia

In Malaysia domestic production of oil and natural gas is continuing. The Malaysian government is introducing resource conservation policies to maintain the domestic production level of oil and gas and also to maintain the export volume of oil and gas. The government is also trying to maintain the production levels from the existing oil and gas reserves. Field setting and tender for the territorial deep sea zones are continuing. Malaysia is located at one flank which is composed of the Malacca Strait and also facing to the South China Sea where heavy marine transit exists. So Malaysia is trying to utilize their locational advantage as much as possible (DEO EIA 2011).

About the territorial boundary issues in the sea, Malaysia has already settled with Thailand and created a JDA (Joint Development Area) for the development of oil and gas. With Brunei and Vietnam, Malaysia concluded the boundary contracts.

V-5. Thailand

At present, the Thai economy is enjoying good performance and import of energy is rapidly increasing. Production of domestic gas and oil is increasing but compared with the demand growth, domestic supply is very small and import of oil, natural gas and coal is continuously expanding.

Thailand is located in the tropical monsoon and savanna climate and rich in biomass resources, so the utilization of wood and waste is very important, and those biomass resources occupy 16% of total energy consumption (DOE EIA 2011).

Thailand's power consumption is expected to continuously grow and according to the 20-year Power Development Plan published by the Thai government on June 2012, electricity demand will come to 346 TWh in 2036 and this figure is twice as much of the demand in 2010 (Ditto DOE 2011).

V-6. Vietnam

The Vietnamese economy is rapidly developing and energy consumption is sharply increasing. Coal, oil, hydroelectric power generation, natural gas and biomass are basic sources for energy supply in Vietnam. The farming population is large in Vietnam and one-third of energy supply is depending on biomass related materials (DOE EIA 2012).

As for development of oil and gas, the Vietnamese government is introducing foreign companies and national company Petro Vietnam is also holding the rights and participating in the exploration, development and production.

In the South China Sea between Vietnam and China, territorial disputes arose at the Spratly Islands and are causing political instability.

V-7. India

In India, tacit economic development is continuing and the middle classes are gradually increasing. So rapid growth in the sales of automobiles is expected. Energy consumption, especially oil consumption, will have to largely expand.

Energy consumption in 2035 will come to twice as much as compared to the present consumption (DOE EIA 2011).

In India, power shortages constantly happen, so in the five-year plan, the Indian government is planning to take comprehensive measures including strengthening power lines, securing coal, oil and gas supply, maintaining effective energy utilization, energy saving, technological development and environmental measures. Nuclear energy will also be extended but the growth of India's energy consumption is enormous so the dependence on coal in the power sector will have to continue.

V-8. Japan

Japan's energy consumption showed its peak in the middle of the 2000s and after that the energy consumption has not been increasing. The period with the highest oil consumption in Japan was during the 1970s, and then the oil consumption came to decrease. Coal consumption is still gradually increasing and natural gas consumption took the trend of steadily increasing, but after March 11, 2011, substituting the deficit of energy supply from nuclear power plants, gas consumption has been rapidly increasing.

From the view of energy security, it is very important to keep a variety of energy sources.

Especially after the disaster of the March 11 accident in Japan, it is said that the era of "unrest of grounds" started and that there is the possibility of another earthquake, tsunami or other disaster occurring, especially in the western area of Japan. So the people have to prepare for those disasters.

At times of normal conditions, people have to prepare and consider how safe and peaceful lives can be maintained (Takeishi 2011a). For the introduction of renewable energy, preparatory work and tacit installation considering the times of critical situations are necessary (Takeishi 2011b).

As for Japan's energy policy, the latest energy basic plan was established in 2010 based on the Basic Act on Energy Policy. But after the March 11 disaster and the accident at Fukushima Daiichi Nuclear Power Plant, revisions must be made.

Recently, the government has been stressing the deregulation of power sectors, strengthening of natural gas related infrastructures, and as for oil, institutional preparation for the time of disaster such as the amendment of the petroleum stockpiling law and establishment of a collaboration system for oil companies.

VI. Future Prospects of Energy in Asia

The OECD IEA mentioned in "World Energy Outlook 2012" that the world energy situation has changed and stressed the necessity to tackle various energy related issues such as the shale gas revolution, high efficiency energy utilization, production increase in Iraq, and golden age of natural gas.

The above mentioned OECD IEA report is expecting China and India to occupy more than half of the energy demand increment until 2035. Therefore the oil ratio of transit volumes which pass through the Malacca Strait will increase to 45% in 2035 from 32% in 2010. As for gas transit, 11% in 2035 is expected from 8% in 2010.

At the Strait of Hormuz, the ratio of oil transit volume is expected to increase to 50% in 2035 from 42% in 2010. However, as for natural gas the ratio of transit is expected to be 8% in 2035 compared with the ratio of 14% in 2010.

The above expectation is largely depending on the economic conditions of China, India and other developing countries (OECD 2012 p.79).

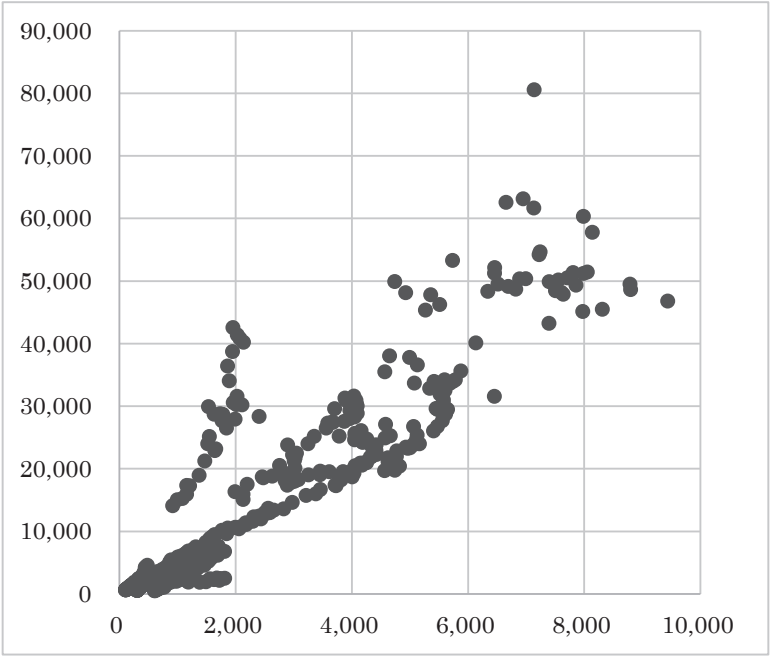
The new concept of a possible shortage of water is very important and this deficit may cause big bottlenecks for the economy of developing countries. For example in India, at power generation plants, a large amount of water is necessary for cooling, but there is an expected water supply shortage in India and there may be problems in the operation of power plants (OECD ditto).

Is it possible to depend totally on the improvement of energy efficiency, energy savings, and resolution of energy issues in the world in the future?

Figure 4 shows real GDP per capita in the vertical axis and energy consumption per capita in the transverse axis in 16 Asian countries from the data of 1980 to 2011.

Figure 4[13] GDP in Asian countries in vertical axis and energy consumption in transverse axis

Unit: Vertical axis: US dollars per person, real GDP in the year 2005, PPP: purchasing power parity figures, transverse axis: kg oil equivalent per person, energy consumption per person



Note: Data from the year 1980 to 2011, from 16 countries in Asia Pacific, totally 596 data

In Figure 4, the linear approximate value can be calculated as $y = 6.5664x - 456.82$ and adjusted R-squared coefficient of determination is high enough to $R^2 = 0.8485$.

In almost all countries there are tendencies that when income increases then energy consumption will follow and grow. The rare exceptional case is in the Philippines, not showing the tendency of steady growth due to the continuous slum periods of the economy.

It is very important that generally speaking on the results in every country, economic growth means an increase of energy consumption. It is very hard to conserve energy, to decrease energy consumption, and to maintain economic growth. A recommendable policy for each government may come to the acquisition of certain amounts of incremental energy every year and trying to accomplish economic development and income growth.

[13] Based on World Bank data

VII. Japan's Energy Policy in Asia

Japan's energy policy should consider to include the concept of areas not only in Asia but also in the Asia Pacific, to be set up as one big issue for the possibility of a secure, stable supply and demand of energy in the region.

The importance of Asia in the world energy supply and demand should increase further in the future. How Japan will keep relations with the Asia Pacific region is very important for the Japanese economy and it can be said that the relation with the Asia Pacific region will decide Japan's future.

ASEAN+6 is one of the concepts to consider in Japan's relation with the Asia Pacific, but there are a lot of countries not included in the ASEAN+6. How to establish mutual consent, including the countries not included in ASEAN+6, is a very important issue.

First of all, it is said that "the variety of motivations caused regarding FTA in a large county has close relations with the small country's strategy concerning FTA" (Solis et al. 2010).

As shown in the precedent, such as the Energy Charter in Europe, a declaration on energy will also be prepared in Asia and by including various countries it is expected to be signed and ratified.

ASEAN is progressing in economic integration, connecting the cross border gas pipelines, composing mutual export and import relations, connecting high voltage power lines, and starting mutual supply. In the future, the grids crossing the borders are expected to be strengthened in Northeast Asia.

Multiple, bilateral and trilateral combinations have to be prepared depending on the kinds of issues. Especially on the energy issues, securing a stable supply is very important, and preparing for times of emergency or disaster, bringing about mutual supply systems, is very useful, and during ordinary times the persons in charge must gather, discuss and prepare the systems.

Both in the regions of Europe and ASEAN, discussion on energy issues preceded. After that the establishment of the EEC and ASEAN were accomplished. Technological and institutional discussions in the related countries regarded energy as essential.

It is very important that technological standards and specifications of products and/or commodities must be understood, recognizing the accounting and charging systems, and if necessary some modifications should be prepared for the systems.

It is very useful for the engineers of electricity to hold meetings from various countries and to have discussions with each other.

To start the efforts on the issues of energy in East Asia is very useful, because in East Asia, networks of production are already composed like a mesh and vertically integrated networks are already in existence, so for the introduction of new growth, the possibility of regional integration is very important (Kousaka 2008).

In the case of oil and gas production, if there are resources crossing the border, the persons in the industry will take priority over the development and production, and apply world

popular systems such as “unitization or pooling” and divide the earned profit.

Escaping from political intervention, if discussions among engineers can be started then there may be the possibility to make sure of reserve volumes in the earlier stage. There may also be times to control selfish attitudes, such as when one puts priority on their own country like in China where the government is expecting exceptionally high reserves of oil and gas.

At the end of 2013, China still insists on the territorial requests in the East China Sea and in the South China Sea and their demand is very strong. The Japanese government is struggling with how to compromise with them. The estimated reserve figures, which is spreading in China, are too big, and compared with the figures which the US Geological Survey announced, two digits or even three digits larger on China’s estimation. It is necessary to analyze within the geological areas and with other engineers of concerned countries, and with the progress of exploitation and exploration, it is considered that the estimated figures will obviously come down to their certain figures, and realistic and cool measures can be introduced.

In the Asia Pacific region, China has outstanding energy consumption and the amount of consumption is continuously increasing. The most important issue regarding energy in Asia is that China can manage to increase the supply of energy to cover for increasing demand.

In this paper’s analysis, it becomes clear that how long China can continue with their domestic coal supply is a very anxious question and there are not enough coal reserves in China.

Considering the environmental issues and increase in natural gas supply, an increase of twice or three times as much of the natural gas supply, environmentally speaking, has a slight impact on China. Ten or 20 times more of the gas supply will be more meaningful as on the environment (Refer to Figure 3).

In addition China is already the world’s largest automobile market and the rapid introduction of automobiles is estimated to continue.

The serious worries which the Chinese government officials are considered to be sharing are an energy supply shortage and disruption of energy supply. It may be necessary for all people in the Asia Pacific to consider the common troubles, the same that are in China, and should consider counter measures. For this purpose, various energy resources such as oil, natural gas, coal and electricity must be utilized in order to prepare for possible ways to supply energy mutually.

The concept of ASEAN+6 and the Asia Pacific region are both very important which connect the countries of geological vicinity, but further introduction of countries such as the US, Russia, the Middle East, Europe and so on must be introduced and welcomed to participate in individual issues like with gas pipelines, oil and gas development, electricity export and import as participants and/or investors.

On the Japanese side, deregulation and structural reforms are necessary so as to allow for the mutual participation in the energy sectors in Asia. Depending on the rapid advancement of ICT, big data can be immediately analyzed and it becomes possible to introduce new types of markets such as on electricity trade.

The energy basic plan was established in 2010 based on the Basic Act on Energy Policy.

But after March 11, a revision of the energy basic plan became necessary. The role of the government must be discussed and a lot of issues necessary for discussion are arising.

China succeeded in economic development based on the reform and open door model, so at present there are the opinions that Japan should introduce the state capitalistic policies as countermeasures against China, and as for nuclear power, power stations and those operations should be concentrated on the state owned company and concerned risks should be owned by the government. But as for Japan it may be preferable to utilize the vitality of private sectors as much as possible and to promote originality and ingenuity of the people, and to urge various new forms of participation so as to revitalize the local community. On the other hand, in the present systems in Japan, there are still a lot of possibilities for revision so as to force various new forms of participation. Where only one company is occupying the market, introducing competition and revitalizing services will be necessary.

For example, on the supporting system for the private sector of oil and gas exploration and development, it is considered that risk is high on the stage of exploration, so an investment system through the governmental organization JOGMEC was prepared. But as for oil and gas development, lending systems from private financial institutions and JOGMEC's debt guarantee system are utilized.

But at the phase of development there is the possibility of high risk appearance. The strictly dividing system between exploration and development is causing difficulty that private sectors cannot introduce the farm-out method, which is a very common measure in world exploration and production (E&P industry). Japan's present systems and regulations should be reexamined.

As for the power sectors in Japan re-regulation should be necessary. The Electricity Systems Reform Subcommittee of the Advisory Committee for Natural Resources and Energy published a report, and following this report, the Japanese government is taking the policy of total deregulation of the retail sector and legal unbundling of the power transmission and distribution sectors. After the deregulation of the power sector it is expected that the companies of communication, IT, electrical machinery, heavy industry, engineering, super market, convenience stores and so on can participate in the power retail sector, power trading. Japan made new business models that can be created and spread over those models in the world.

With the progress of globalization, at present, China and Korea's business models which concentrate investment and can get the market, are considered to become gradually less effective. The business models composed by reconciliation of various kinds of sectors and offered as systems are considered to give a more comfortable environment.

Within Japan, flexible combinations of various technologies, various goods and also already-existing systems are becoming necessary. If there are new business models which are adopted and succeed in Japan, then there is the possibility that not only the hardware but the service business can be exported.

It is true that in Japan there remains the concept of respecting vertical integration (Takeishi 2010, 2007, 2006), but as in the case of the shale revolution, there are enormous possibilities

of breakthrough. Existing systems should always be overhauled, and the construction of markets in Japan which can be utilized for the inspection of performances so as to be able to contribute to the Asian markets becomes necessary. In the energy sector deregulation for promoting new participation is necessary and acquisition of businesses abroad is expected. As for Japan's energy policy, installing the cooperation frameworks in Asia and also in the Asia Pacific and deepening those relations are extremely important.

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