Chapter 2

The Importance of Coal in the EAS Region

Study on the Strategic Usage of Coal in the EAS Region Working Group

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CHAPTER 2
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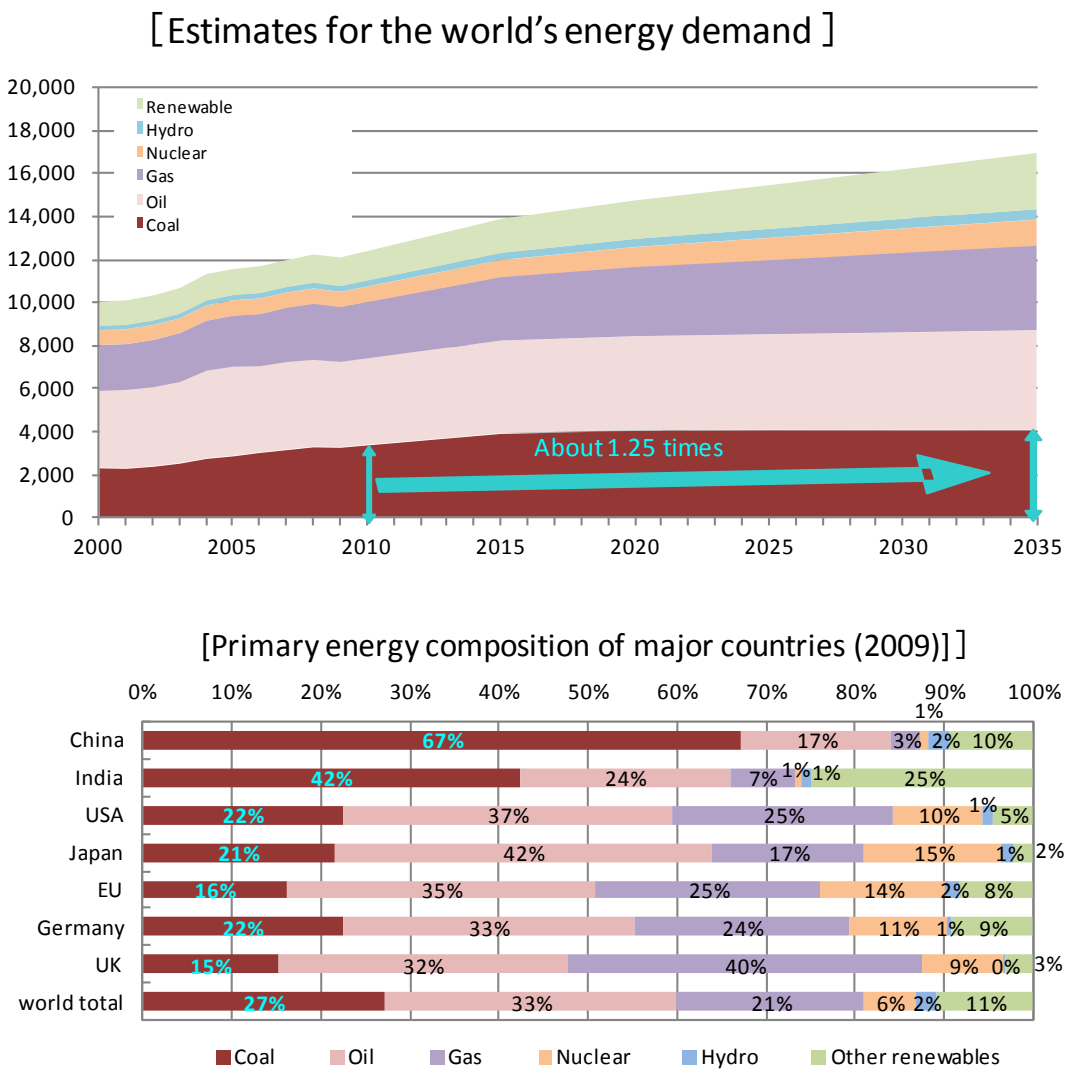
1. The Trends of Energy Demand and the Political Positioning of Coal

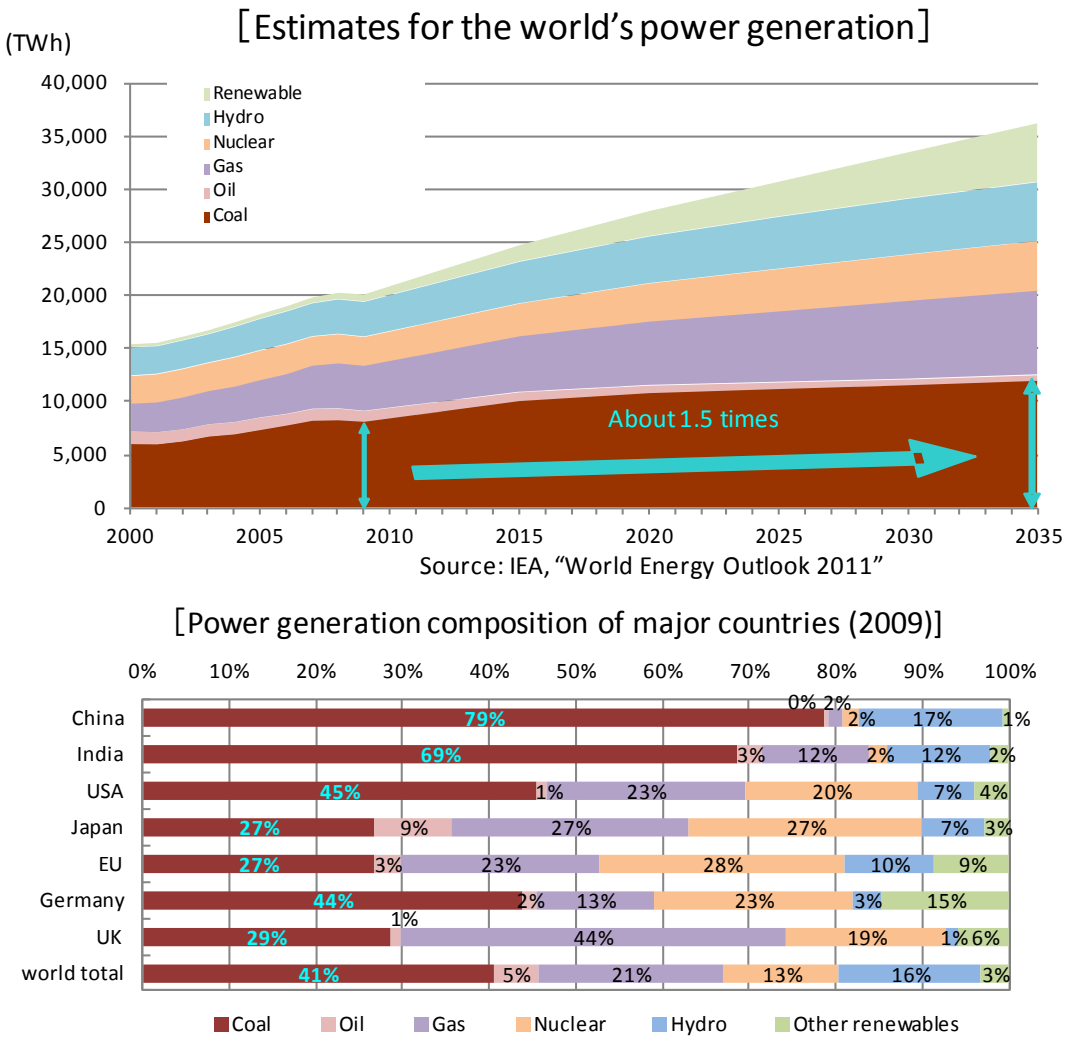
Actual and forecasted global energy demand from the year 2000 to 2035 and the composition of the energy sources in major countries in 2009 are shown in Figure 2-1. Global energy demand is expected to remain increasing steadily in line with continuing economic growth in the future. Under this scenario, coal constitutes about ¼ of the energy demand which is forecasted to increase by about 1.25 times the current level by 2035. Figure2-2 shows the global electricity demand and composition of the electrical power by energy source in the major countries; coal-fired power generation constitutes the largest share or 40% of total electricity generated which is expected to increase to 1.5 times the current level by 2035.

Figure 2-1: World's energy demand and primary energy composition of major countries



Source: IEA, "World Energy Outlook 2011" & "Energy Balances of OECD/non-OECD Countries (2011 Edition)"

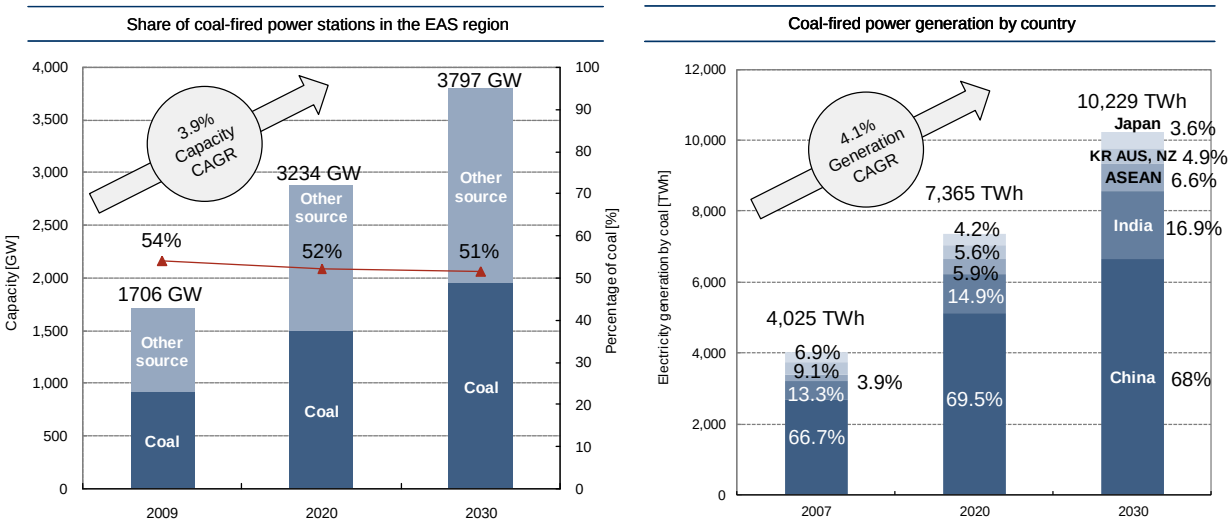
Figure 2-2: World's power generation and power generation composition of major countries



Source: IEA, "World Energy Outlook 2011" & "Energy Balances of OECD/non-OECD Countries (2011 Edition)"

In the EAS region where economic development and growth have been remarkable, demand for electricity is forecasted to increase substantially, half of which will be met by coal-fired power generation as shown in figures 2-3. In particular, coal-fired power generation has vastly increased in China and India, and future increases are also forecasted in the ASEAN region. As coal is lower priced compared to petroleum and natural gas, demand for coal is therefore expected to continue increasing from an economic point of view.

Figure 2-3: Estimate of coal-fired power plant in the ERIA

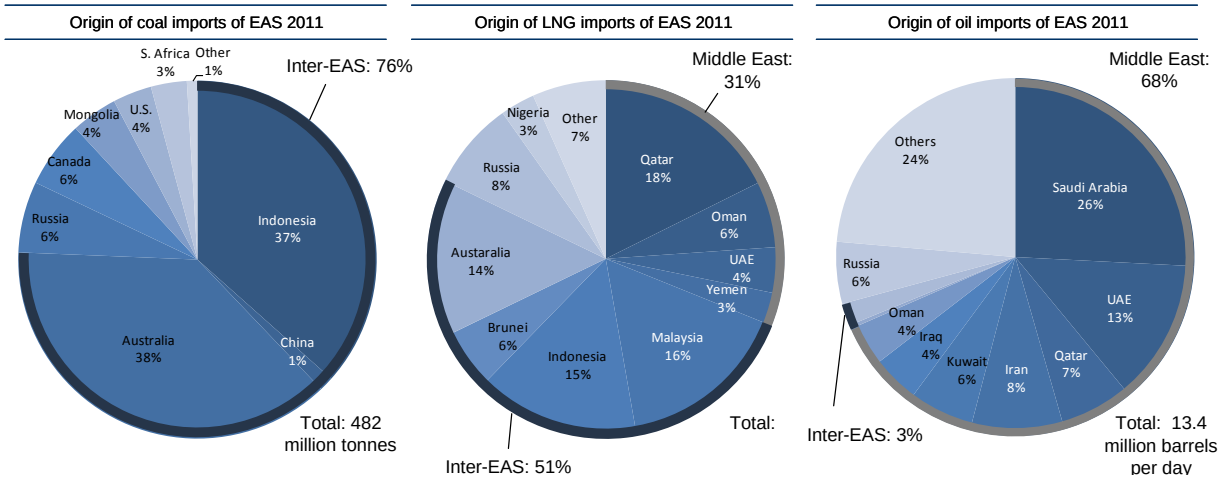


Source: Compled from IEA statistics

As such, coal has become an important energy source in the EAS region. Petroleum and natural gas are also produced in the EAS region and will remain important energy sources in the future. Figure 2-4 shows the origin of primary energy import in EAS region. In the EAS region, about 50% of the natural gas consumed is produced within the region while 31% is being imported from the Middle East. A mere 3% of the petroleum consumed is regionally produced with 68% being imported from the Middle East. In contrast, coal produced in the EAS

region constitutes 76% of the total coal consumption in the region. All this indicates that coal, mainly produced and consumed within the region, does not require dependency on the Middle East as petroleum and natural gas do. In view of the political uncertainty of the Middle East region which may raise concern over transportation security at a strategic pathway such as the Strait of Hormuz, coal will be of further significance in the energy security context as well.

Figure 2-4: Origin of primary energy import in EAS region



Source: Compiled from IEA Natural gas information, Coal information, GTA data, Japan's trade statistics and original estimation

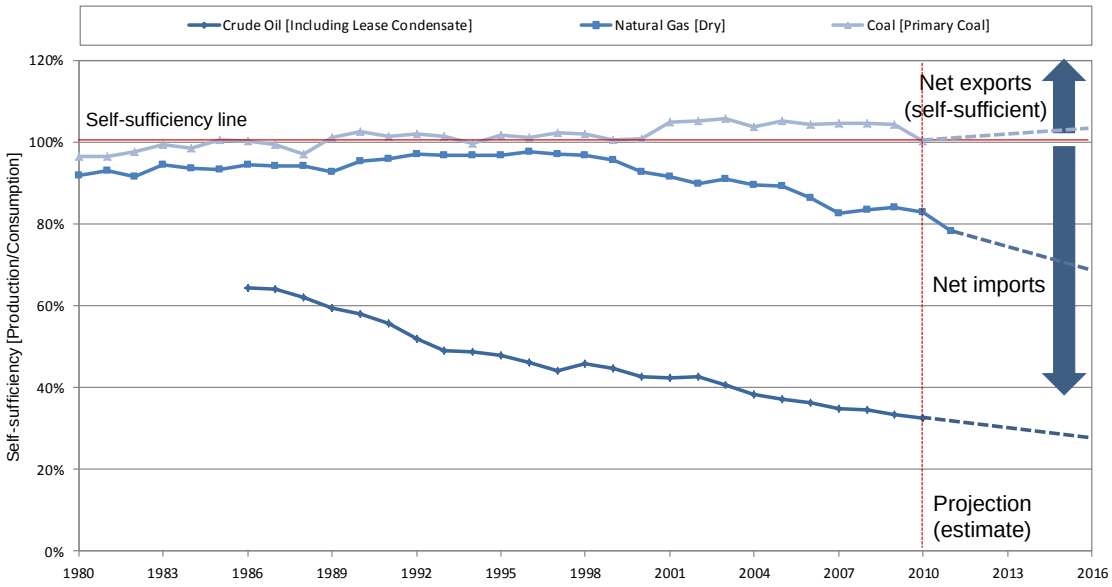
2. Features of Coal Resources and Their Importance

2.1. Coal and Gas Self-sufficiency Rates in East Asia

In order to understand the energy supply security of coal and natural gas, the self-sufficiency rate was used as an indicator. Self-sufficiency in the EAS region can be defined as: the total coal or natural gas production within the EAS region divided by the total demand or consumption of coal or gas in the EAS region. If the ratio is smaller than 100, it implies that imports from outside the EAS region are necessary

to satisfy demand. Figure 2-5 shows the self-sufficiency of coal, natural gas and oil in the EAS region. Coal has historically been self-sufficient in the EAS region and showed the highest self-sufficiency among all fossil fuels, and therefore, the most secure natural resource in the EAS region. Since 2000, coal has been continuously self-sufficient, meaning that there is enough production capacity to supply all coal demand in the EAS region.

Figure 2-5: Self-sufficiency of energy resources in the EAS region



Source: Compiled from EIA International Statistics.

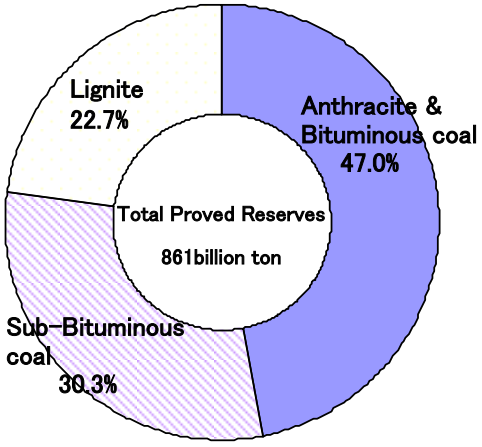
2.2. The Potential for Supply Increases through Expansion of Procured Coal Grades

2.2.1. Coal Resources

Global coal reserves are shown in Figure 2-6. High rank coals such as bituminous coal and anthracite that are used as coking coal and steam coal make up around 47% of the reserves, while low rank coals constitutes about half of the overall coal reserves with 30% being sub-bituminous coal and 23% being lignite. Figure 2-7 shows the world minable coal reserves by region and by coal rank. Unlike other

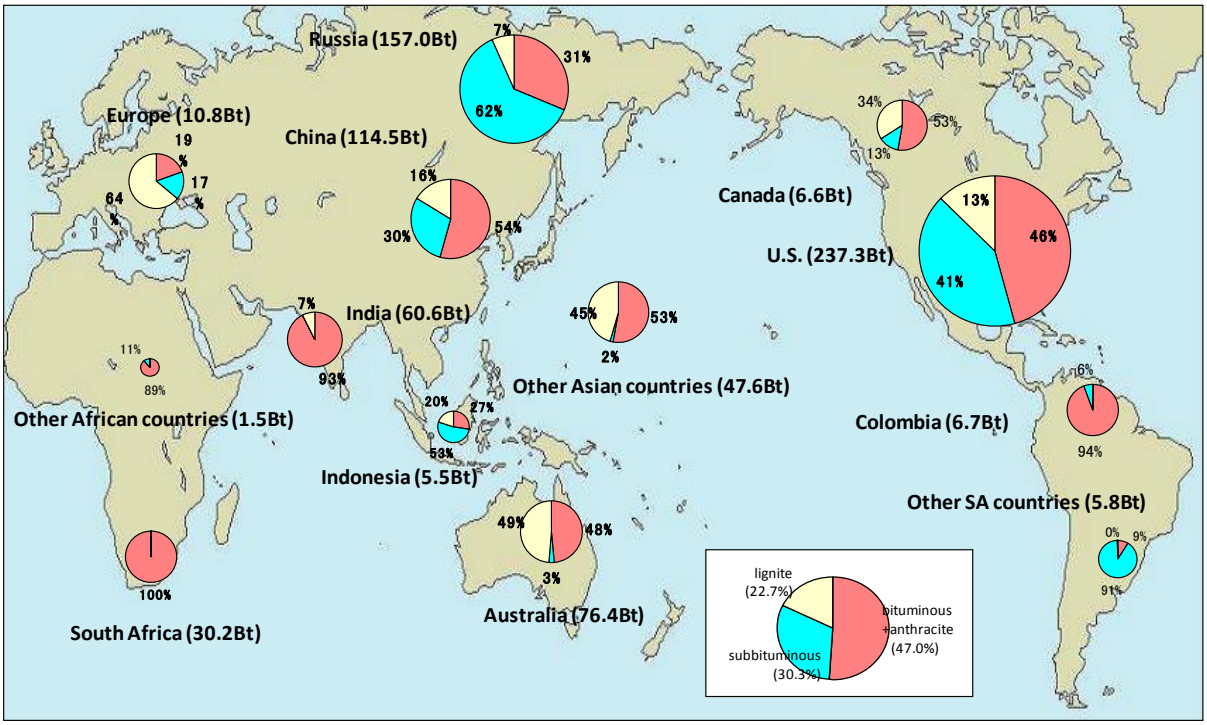
energy sources, coal is distributed widely throughout the world with little uneven distribution. While coal reserves are large in Oceania and the Asia region, the proportion of lignite is high. Even in the world's largest steam coal exporter Indonesia which exports mainly to the Asian countries, the amount of bituminous coal reserves is only 27% of the total reserves and thus exports of sub-bituminous coal are increasing.

Figure 2-6: Proved reserves of coal by rank in the world



Source: BP, Statistical Review of World Energy 2012

Figure 2-7: Recoverable coal reserves in the world (by region and coal rank)



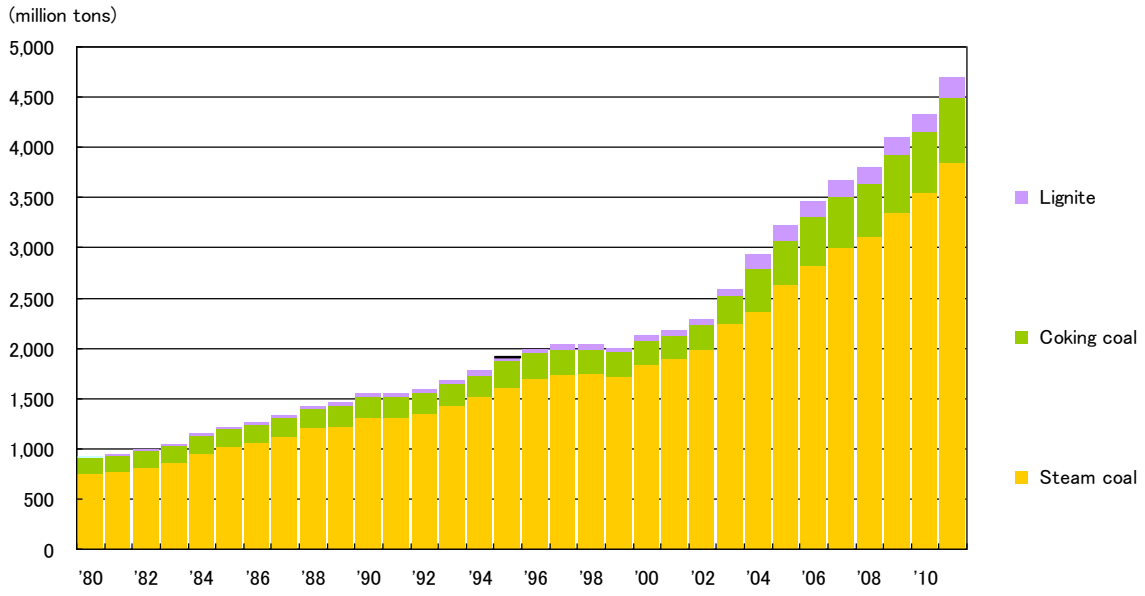
Source: WEC "Survey of Energy Resources 2010," BP Statistics 2010

Source: WEC "Survey of Energy Resources 2010", BP Statistics 2010

2.2.2. Coal Consumption in Asia

The amount of coal consumed in the Asia region reached 4.7 billion tons in 2011. In terms of coal rank, steam coal is dominant with over 80% as shown in Figure 2-8. Likewise, the amount of lignite consumption is increasing year by year. The consumption of steam coal for power generation (including in-house power generation, heat supply) in 1980 only accounted for 25 % of the total consumption of steam coal and it was mainly used for industrial purposes and consumer use. In the 2000s, however, the consumption of steam coal for power generation started to account for over 60% of the total and since 2006 it has accounted for around 70 %.

Figure 2-8: Coal consumption by coal type in Asia



(million tons)

	80	85	90	95	00	05	06	07	08	09	10	11*
Steam coal *(for Power Generation)*	740 *(186)*	1,008 *(297)*	1,304 *(484)*	1,604 *(786)*	1,831 *(1066)*	2,621 *(1738)*	2,816 *(1932)*	2,990 *(2110)*	3,105 *(2176)*	3,336 *(2284)*	3,537 *(2416)*	3,837
Coking coal	162	180	207	262	238	452	486	511	526	576	603	647
Lignite	11	19	34	46	49	150	156	165	168	179	187	206
Total	913	1,207	1,545	1,912	2,118	3,222	3,458	3,666	3,800	4,091	4,327	4,690

Note : 2011* is an estimate and Steam coal includes anthracite.

Source : IEA, "Coal Information 2012" and "Energy Statiscs OECD/non-OECD 2012".

Figure 2-9 shows the flow of steam coal in 2011. Steam coal is mainly exported for Asia by Indonesia and Australia, and is also exported by South Africa, Russia, as well as China, Colombia, the US, and Canada, although the volume is smaller.

Table 2-1 shows the volume of exports by destination of exporting countries which supply the main countries in East, South and Southeast Asia in 2011 with steam coal. Indonesia is the biggest steam coal exporter to China and accounted for 48% of total Chinese imports in 2011. Korea, Taiwan and India import also from Indonesia in the same manner as China. 96% of the nearly 300 million tons in steam coal exports from Indonesia are for Asia. As the column of "others" of the exports from Indonesia exceeds 55 million tons, it is estimated that other countries without adequate data also import big quantities from Indonesia.

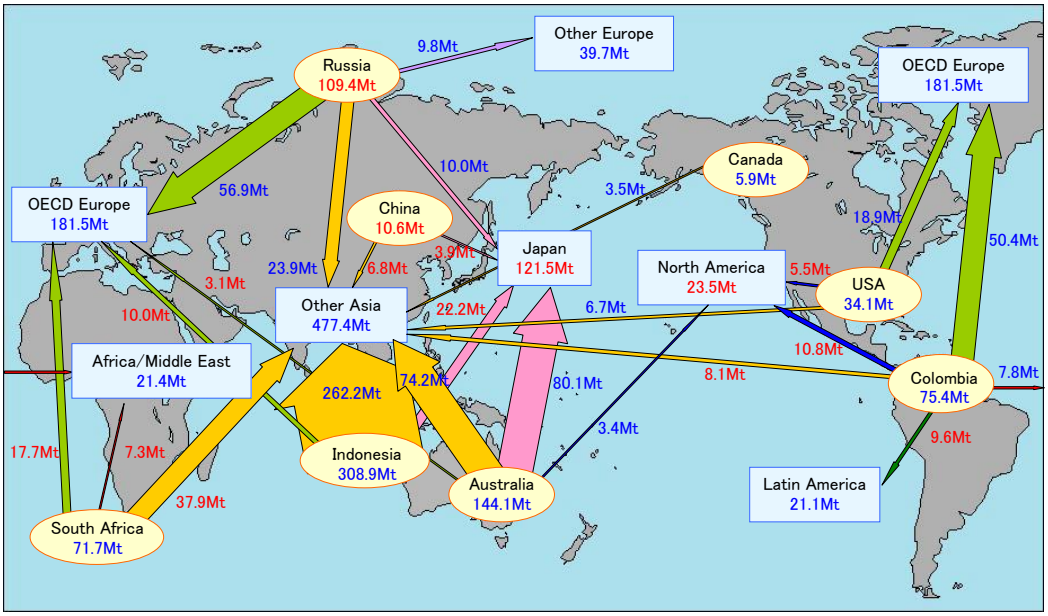
Australia is the second largest steam coal exporter to Asia after Indonesia and 97% of its steam coal is exported to Asia which totaled 140 million tons in 2011. Indonesian and Australian coal exports account for three-fourths of the steam coal imported by Asia. Australia exports the biggest quantity of steam coal to Japan. Its exports to China, Korea and Taiwan exceed 15 million tons, respectively, but its exports to India are smaller. India imports more coal from South Africa which is a shorter distance than Australia.

Russia exports more than 10 million tons of steam coal to Japan and Korea and ranks as the fourth largest exporter to Asia.

Other Asian countries import mostly from Indonesia. According to future coal demand forecasts, demand for energy and in particular electricity is expected to increase substantially as a result of the economic growth in Asia region, and many new coal-fired power plants are being planned. Coal consumption for power generation is forecasted to increase in Asia region. Even in Cambodia which

currently does not have any coal-fired power plants and Myanmar which has only small-scale coal-fired power plants, construction of coal-fired power plants with imported coal from Indonesia are in the planning phase. In Vietnam where anthracite used to be dominant, a plan of a new plant to be fired on blended coal; i.e. anthracite with imported Indonesian coal is in progress.

Figure 2-9: Flow of steam coal (2011 estimate)



Note: The above figure does not show flows of less than 3 million tons. The blue-colored numbers show an increase relative to the previous year and the red-colored numbers a decrease relative to the previous year. The "North America" as an importer includes Mexico.

Source: IEA, "Coal Information 2012".

Table 2-1: Volumes of export of steam coal in the main exporting countries (2011)

(million tons)

Export by destination	Export Countries							
	Indonesia	Australia	South Africa	China	Russia	Colombia	USA	Canada
China	70.98 24%	17.32 12%	12.24 29%	– –	6.23 18%	1.44 55%	0.88 13%	1.31 23%
Japan	29.41 10%	66.96 48%	0.85 2%	4.21 40%	12.12 36%	0.23 9%	0.61 9%	2.04 37%
Korea	39.48 13%	28.27 20%	4.04 10%	4.46 42%	10.72 32%	0.28 11%	4.88 70%	2.23 40%
Taiwan	26.63 9%	20.12 14%	3.86 9%	1.87 18%	3.61 11%	0.66 25%	0.00 0%	0.00 0%
India	73.60 25%	0.50 0%	17.14 41%	– –	1.14 3%	0.01 0%	0.63 9%	0.00 0%
Thailand	Unknown	2.92 2%	Unknown	Unknown	Unknown	–	0.00 0%	0.00 0%
Malaysia	Unknown	3.15 2%	Unknown	Unknown	Unknown	–	0.00 0%	0.00 0%
Vietnam	Unknown	Unknown	Unknown	Unknown	Unknown	–	–	–
Philippines	Unknown	0.28 0%	Unknown	Unknown	Unknown	–	0.00 0%	0.00 0%
Others	55.39 19%	0.56 0%	3.92 9%	0.02 0%	0.05 0%	– –	0.00 0%	0.00 0%
Total of Asia	295.50 96%	140.07 97%	42.03 59%	10.55 100%	33.87 31%	2.26 3%	7.00 21%	5.58 94%
Total export	308.91	144.06	71.70	10.58	109.36	75.41	34.06	5.93

Note: Steam coal includes anthracite. The percentage shows the percentage of the volume of export to the countries surveyed relative to the export volume of steam coal to Asia (total of Asia). The percentage in the total column of Asia represents the percentage of the export volume of steam coal to Asia (total of Asia) relative to the total volume of export of each exporting country. When the volume of export is unknown, this figure is added to the column of "others".

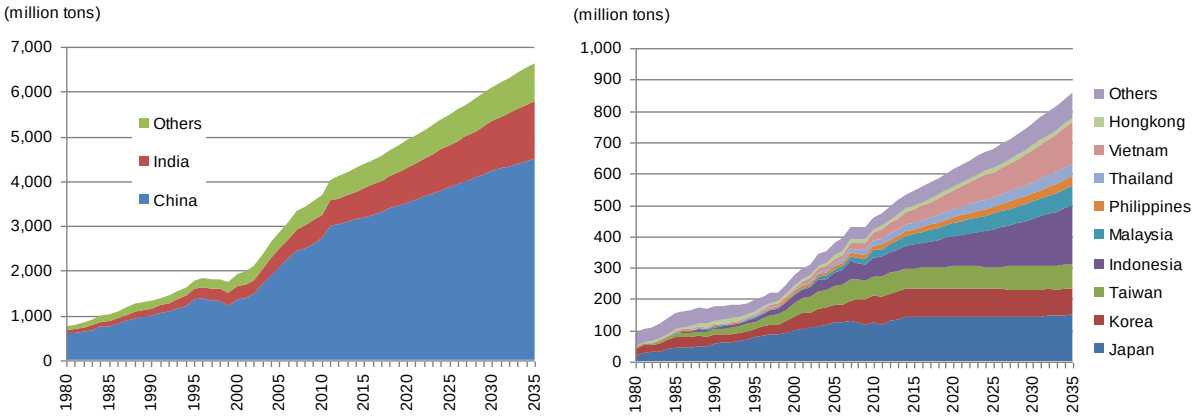
Source: IEA, "Coal Information 2012"

2.2.3. Consideration on Future Coal Demand and Supply

Steam coal demand in Asia will increase from 2010 to 2035 at an annual growth rate of 2.4 %, and will increase by 1.8 times from 3,730 million tons in 2010 to 6,652 million tons by 2035. Figure 2-10 show a steam coal demand forecast in Asia. Steam coal demand in China will not show such a rapid growth as it did during the 2000s, but as demand for electricity is expect to increase with economic growth in

the future, the demand for power generation should increase. The demand in India for steam coal will increase at an annual growth rate of 3.7% to 2035 due to a rapid increase in demand for power generation and India is expected to consume up to 1,297 million tons in 2035, which is a 2.5-fold increase relative to 2010. In ASEAN countries, in order to meet the increasing demand for power generation, it is expected that they will use cheap coal power and that coal demand will increase. Specially, in Indonesia, which is building a coal power generation station using low grade coal produced domestically, steam coal demand will close to 100 million tons in 2020 and increase to 190 million tons in 2035. Steam coal demand in Vietnam will increase to 132 million tons in 2035 by the increment of coal power. The consumption of steam coal in other countries will increase by 2 to 3 times relative to that in 2010. On the contrary, Japan, Korean and Taiwan which have widely used steam coal for power generation will still experience increases in demand, but their growth is expected to slow down.

Figure 2-10: Steam coal demand forecast in Asia

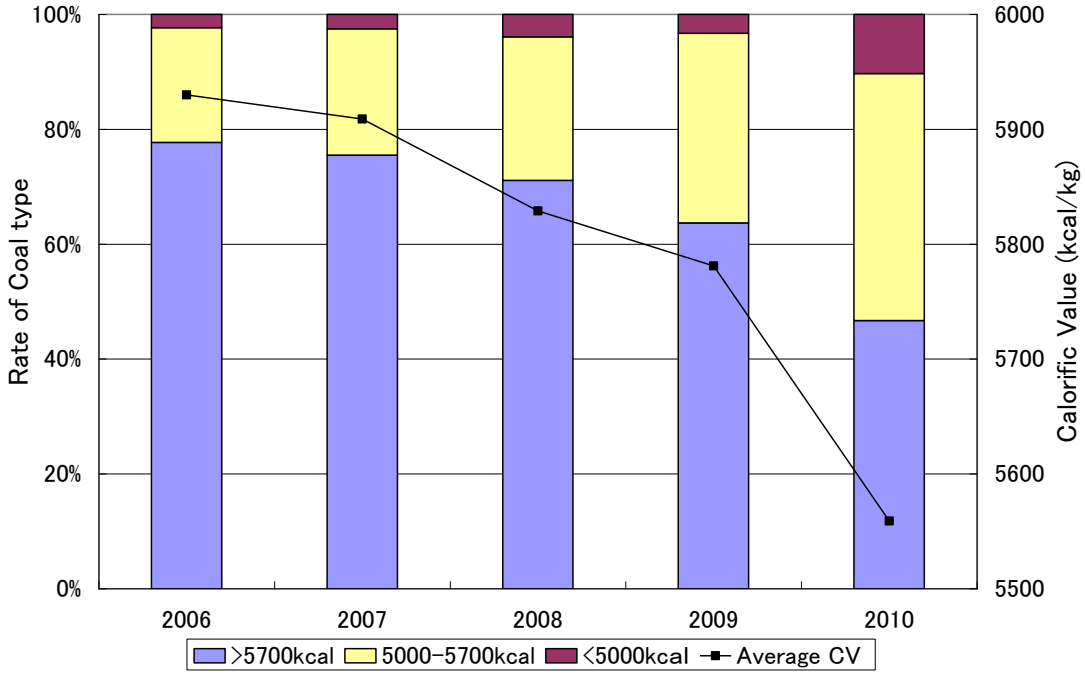


Source: The actual data is from the IEA data and the forecast was made by the JICA.

Most of these increases in coal demand in the region are expected to be addressed by Indonesia. Being abundant with low rank coal of low ash and low sulphur content offering advantages in both price and environmental compliance, Indonesia expects its low rank coal export to further increase toward the future. Such trend has shed light on low rank coals that used to be regarded as non-marketable; China and India have been importing low rank coals of lower than 4,000kcal/kg, which now have come on to the market.

Korea has been expediting low rank coal utilization and expansion. As shown in Figure 2-11, the overall calorific value of the coal used is also on a downward trend as low rank coal utilization is on the increase. Such downward trend has become more conspicuous since 2010. The Government of Korea expedites measures such as combustion improvement through blending with high rank coal and high efficiency CCT such as USC, etc. in consideration of high moisture and low calorific value that low rank coal carries.

Figure 2-11: Coal type and average calorific value used in coal-fired power plant in Korea



Source: Gyun Choi and Jiho Yoo, APEC Clean Fossil Energy Technical and Policy Seminar 2012 (Gold Coast, Australia, February, 2012).

Looking at Indonesia, the major coal supplier for the region, the country in recent years saw steady economic growth after having gone through the impact of the global financial crisis, which has boosted its own energy demand. Once joining OPEC as one of the major oil and gas producer, in view of the gradually depleting oil and gas resources, Indonesia has shifted its energy policy toward effective use of the domestically abundant and available energy source; i.e. coal. In order to meet the increasing demand for electricity, many new large-scale coal-fired power plants are being planned, which requires sustainable coal supply for such new power plants to be ensured. More than 80% of the produced coal is currently exported and the rest is for domestic consumption. It is expected with the surging domestic demand by the

power sector, in the coming years coal export by Indonesia may see sluggish growth as the policy to prioritize domestic supply to meet domestic demand has come into force. It may come up as the common agenda that Asia region need concerted coordination toward balanced regional demand-supply.

2.3. Comparison of Coal and Natural Gas Prices

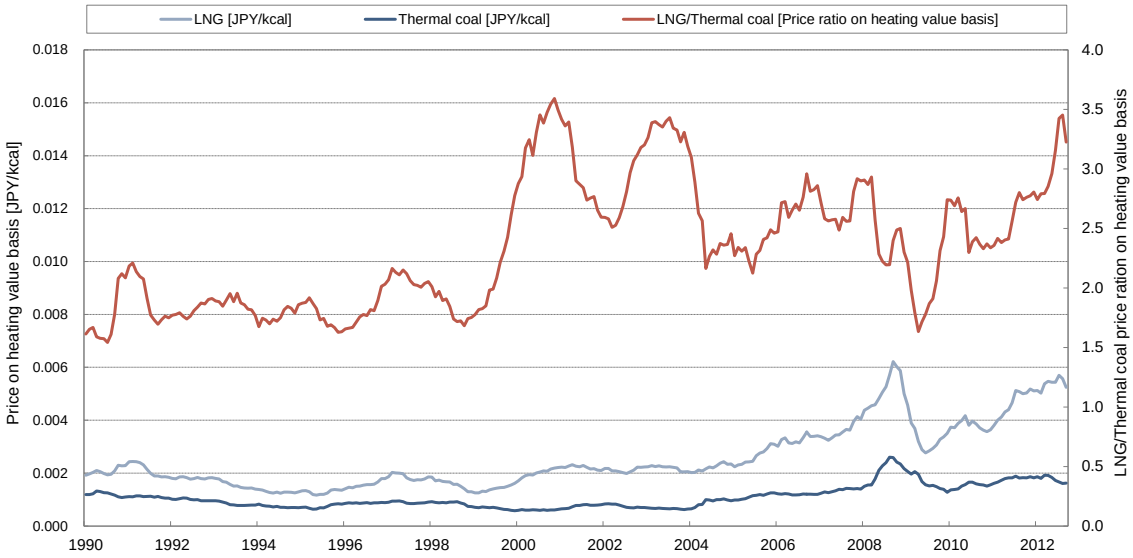
Figure 2-12 shows thermal coal and LNG import prices (CIF price) on heating value basis, as well as the price ratio of LNG/thermal coal for Japan. The price of coal on heating value basis has always been more competitive than natural gas, providing high economic rationale. Historically, the LNG/thermal coal price ratio has been between 1.5 and 3.5. Since 2000, the price ratio has increased and consistently been around 2.3 to 3.5, with the exception of 2009.

In January 2013, prices were 0.0056 JPY/kcal (15.85 USD/MMBtu[1]) for LNG and 0.0017 JPY/kcal (117.57 USD/ton[2]) for thermal coal, putting the LNG/thermal coal price ratio at 3.3.

[1] For the heating value conversion, the IEA energy conversion rate was used at 1 MMBtu = 251,995.79631 kcal. The average exchange rate of the Federal Reserve for January 2013 was used at 1 USD = 89.0581 JPY.

[2] The average heating value of imported thermal coal to Japan was 6,142 kcal/kg. The same exchange rate as for the LNG conversion was used at 1 USD = 89.0581 JPY.

Figure 2-12: Comparison of coal and natural gas prices



Source: Japan import statistics.

2.3.1. Shale Gas Impact

Although the shale gas revolution has had a decreasing effect on natural gas prices in the US, and has therefore allowed for lower export prices from the US, coal is still expected to remain its cost-competitiveness.

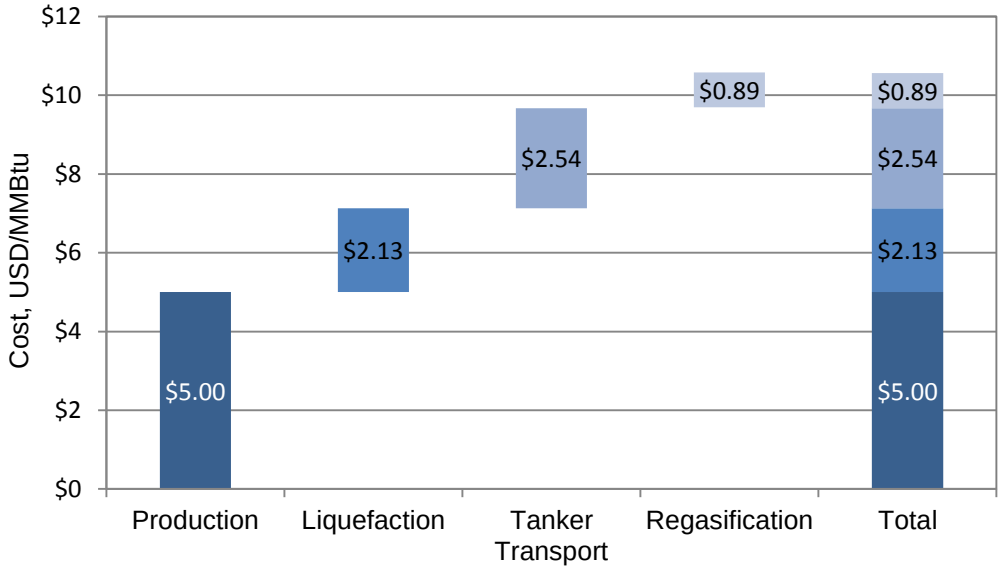
As seen in Figure 2-13, the CIF cost price of LNG to Japan can be potentially reduced to about 10.56 USD/MMBtu, assuming that the input natural gas price in the US is 5 USD/MMBtu [3]. The remaining costs consist of liquefaction (2.13 USD/MMBtu), transportation by tanker (2.54 USD/MMBtu) and regasification (0.89 USD/MMBtu).

As mentioned previously, the January 2013 price of coal imports to Japan was 117.57 USD/ton, with an average heating value of 6,142 kcal/kg. In January 2013, the LNG import price to Japan was around 15.85 USD/MMBtu, which is equivalent

[3] This assumption lies slightly above current prices in the US (around 4 USD/MMBtu), but is not unrealistic when considering that expanding exports will in all likelihood cause domestic prices in the US to rise.

to 386 USD/ton of coal, assuming the heating value of coal is 6,142 kcal/kg. LNG import prices of 10.56 USD/MMBtu would be equal to 257 USD/ton of coal on heating value basis. Therefore, even if LNG import prices are around 10 USD/MMBtu, coal is more than twice as cost-competitive on heating value basis,

Figure 2-13: US LNG import to Japan cost breakdown

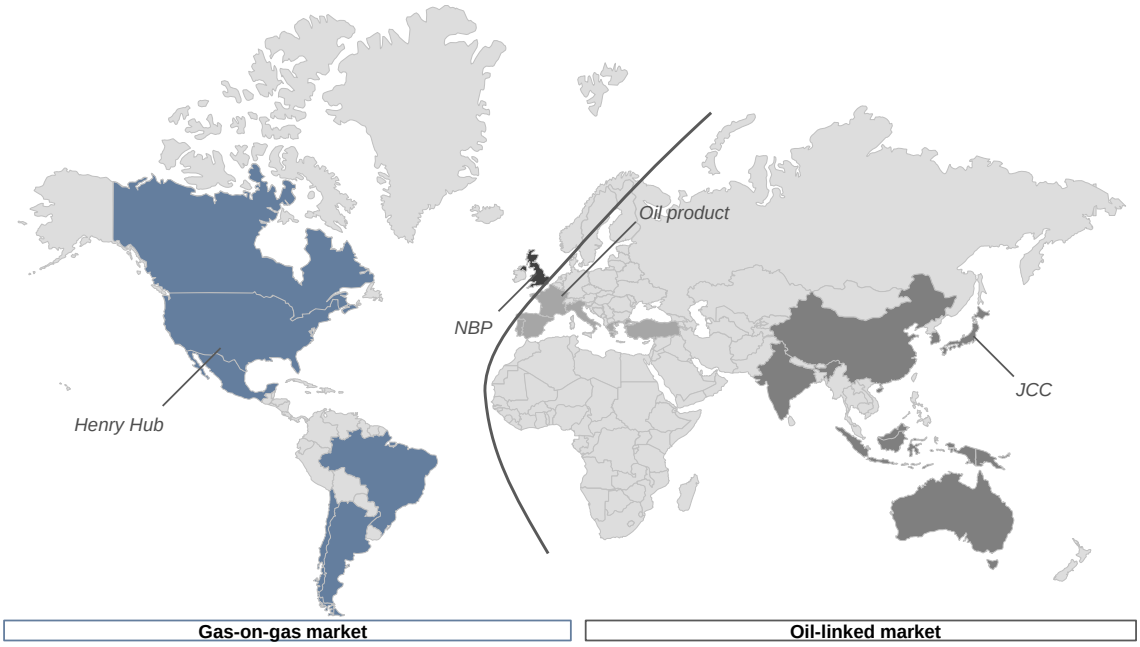


Source: Liquefaction, tanker transport and regasification values were taken from NERA. Production cost is MRI assumption.

Historically there have been 4 price mechanisms for natural gas as seen in Figure 2-14: Henry Hub in the US, National Balancing Point (NPB) in the UK, oil product in continental Europe, and the Japan Customs-cleared crude (JCC) in Asia. However, judging from Japanese participation in newly proposed LNG terminals in the US, it is expected that exports from the US to Japan will increase. This increase may cause the Henry Hub price to have a larger impact on LNG prices in Asia, and weaken the link of the LNG price to the JCC market. As a result, gas prices in Asia

may decline. However, even in this shift from JCC to Henry Hub, coal is expected to remain its competitiveness, as discussed previously and as shown in Figure 2-13.

Figure 2-14: Natural gas price mechanisms



Source: Mitsubishi Research Institute from various resources.

3. The Importance of Coal and CCT for Improving Energy Security

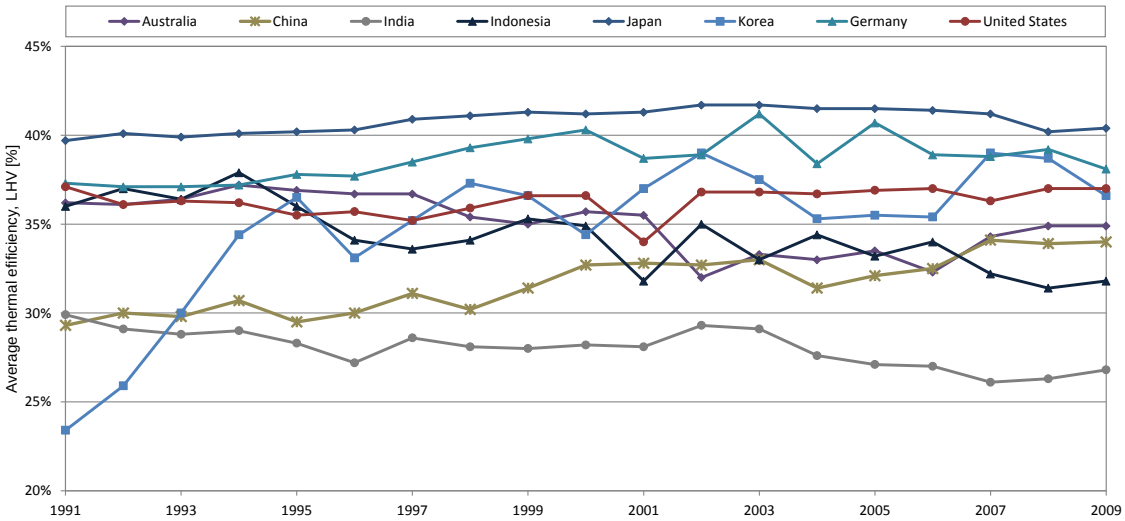
The main features of coal for the EAS region can be summarized as follows:

1. Coal is the primary energy source in the EAS region;
2. Coal is the most secure energy resource in the EAS region;
3. Coal supply potential can be further expanded by developing lower grade coal, and;
4. Coal is more cost-competitive than natural gas.

However, coal is not used efficiently. Although coal is relatively abundant in the EAS region, coal is also an important source of energy, and should be used as

efficiently as possible. Figure 2-15 shows the thermal efficiency in Australia, China, India, Indonesia, Japan and Korea, as well as Germany and the United States as a reference. In some Asian countries, thermal efficiency is still lower than 35%, leaving room for improvement. In order to maximize the potential of coal, CCT should be introduced in the EAS region.

Figure 2-15: Thermal efficiency of coal-fired power stations in Asia, Germany and the US



Source: Energy Balances of OECD/Non-OECD Countries 2011, IEA