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Coal Trends

Trends in coal supply, demand and prices as seen in statistics

— Decline in coal-fired power seen in U.S. DOE reports and insight into the future of coal in Japan read from METI council data

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The website of the United States Department of Energy (DOE) Energy Information Agency (EIA) is a well-known information source among those related to the energy sector.

The "TODAY IN ENERGY" section on its default homepage is updated each day to feature the latest news on the global energy industry, particularly focusing on news in the United States.

Although some articles published this year reported on current trends in U.S. coal, none of them suggested bright prospects for the coal industry.

On the contrary, in Japan, expectations for the future role of coal-fired power sources are generally high, as seen in the discussions held at various councils sponsored by the Ministry of Economy, Trade and Industry (METI). One such example is the "Long-term Energy Supply and Demand Outlook," published in July 2015 by the Advisory Committee for Natural Resources and Energy. It projects that coal-fired power will grow to account for approximately 26% of the total power generation in the power source mix in Japan, even in 2030.

This column will discuss the U.S. DOE EIA reports, followed by METI council materials, with a brief comparison of both countries in conclusion. We hope this article helps our readers to see the clear differences between the coal sector climate in Japan and the United States.

1. A decline in coal-fired power seen in the U.S. DOE reports

Five reports on coal have been featured in the "TODAY IN ENERGY" section this year, as shown below (as of the end of April 2016).

- January 8, 2016: Coal production and prices decline in 2015
- March 7, 2016: U.S. coal exports declined 23% in 2015, as coal imports remained steady
- March 8, 2016: Coal made up more than 80% of retired electricity generating capacity in 2015
- March 16, 2016: Natural gas expected to surpass coal in mix of fuel used for U.S. power generation in 2016
- March 21, 2016: As coal stockpiles at power plants rise, shippers are reducing coal railcar loadings

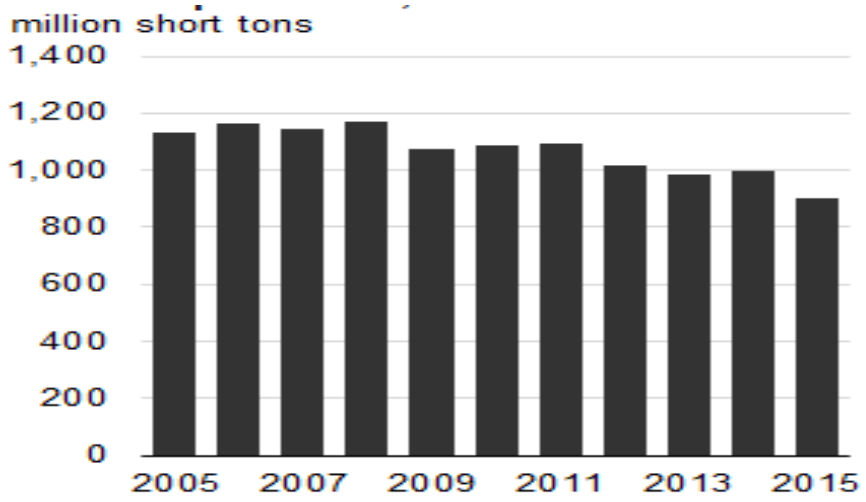
Abridged translations of these reports are as follows.

The articles clearly show the struggles that the coal industry is experiencing in the United States.

(1) “Coal production and prices decline in 2015”

After peaking in 2008, coal production in the United States continues to decline. The production drop was particularly significant in 2015 with a 10% decline from the production in 2014, expected to be around 900 million short tons. This is the lowest level since 1986.

Figure 1: Changes in coal production in the U.S. (2005–2015)



Source: EIA
Note: December 2015 data are projections

Nearly all coal in the United States is used for power generation. In recent years, the share of coal in the power source mix has been declining as natural gas and renewable energy sources are expanding.

It has been pointed out that one of factors influencing this coal share drop is an increase in natural-gas-powered generation, mainly due to tighter environmental regulations and declining natural gas prices.

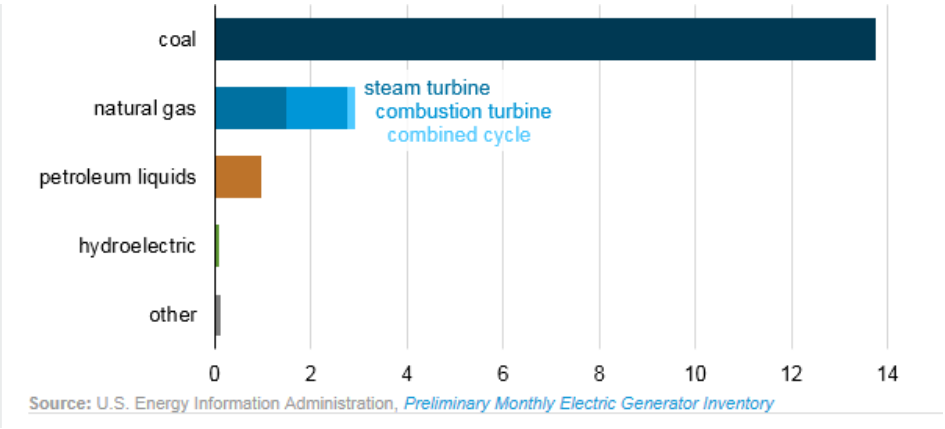
(2) “Coal made up more than 80% of retired electricity generating capacity in 2015”

In the United States, facilities for approximately 18 GW (18 GW)[1] of generating capacity have been suspended and retired during 2015. Out of this significantly large figure, 80% constituted conventional coal-fired power generation facilities. The remaining 20% was shared by approximately 2.5 GW from natural gas and 1 GW from fossil oil fuels.

[1] (Reference) The installed capacity of coal-fired power in Japan was 39.96 GW (2014, total of 10 power companies, Source: Federation of Electric Power Companies (FEPC))

30% of the coal-fired power capacity retired in 2015 ended operations in April. This was prompted by the enforcement of "Mercury and Air Toxic Standards (MATS)" by the DOE in the same month.

Figure 2: Electricity generating capacity retired in 2015 by fuel and technology



We have observed that many of the coal-fired power generating facilities which suspended their operations in 2015 tended to be either older or smaller than those that are continuously operating and have not been selected for retirement.

Most of the coal-fired power facilities retired in 2015 began operation between 1950 and 1970, having 54 years of the average number of years in operation. The facilities which will continue their operation are relatively new, with the average operating years of 38.

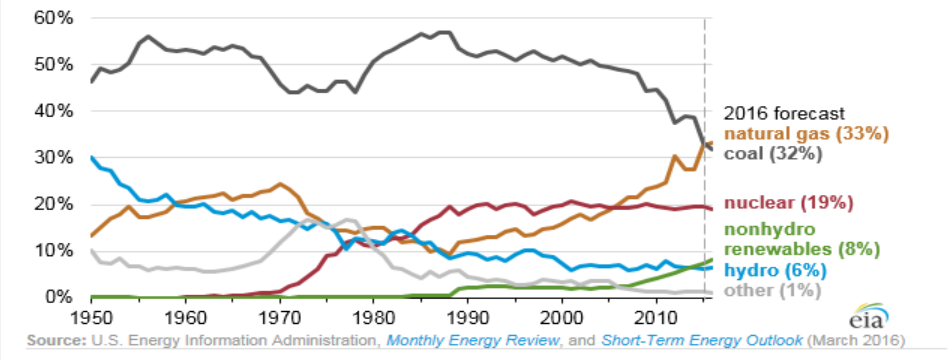
Another characteristic observed was that the 2015 retired coal-fired power facilities were smaller in scale than those in operation. The average size of retired plants was 133 MW, in comparison with 278 MW for that of the currently operating plants.

(3) "Natural gas expected to surpass coal in mix of fuel used for U.S. power generation in 2016"

Over the past several decades, coal has consistently been the largest source of power generation in the United States. However, the latest EIA/STEO (Short Term Energy Outlook) published in March 2016 projected that annual power generation from natural gas would exceed that of coal for the first time in 2016.

There have been no years recorded in the past in which natural gas surpassed coal throughout the year. The first monthly-based reversal in placing occurred in April 2015. During 2015, shares of both natural gas and coal remained at a similar level, around 1/3, as shown in the figure below.

Figure 3: Annual share of total U.S. electricity generation by source (1950–2016)



With regard to 2016 figures, the STEO, mentioned earlier, forecasts that natural-gas-fired power supplies 33% of the total power generation, as coal is to lose its share down to 32%.

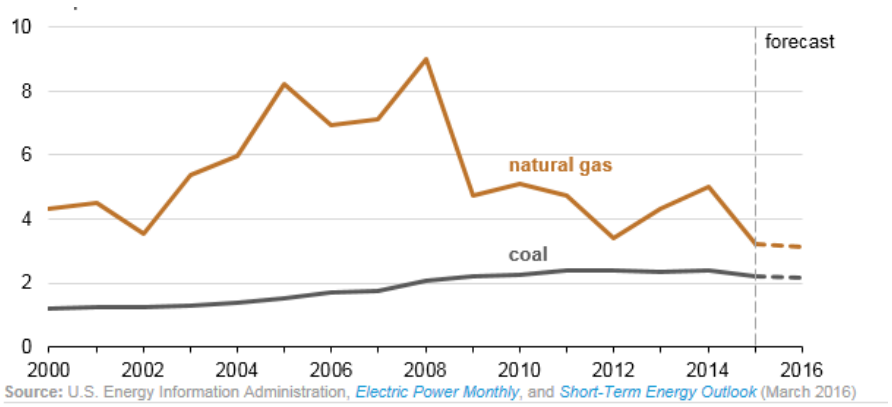
The EIA attributes changes in the power source mix seen in Figure 3, a sharp drop in coal share and a rapid increase in natural gas, to the change in relative economic advantages of both sources.

Fuel price has been a factor to which shares of coal and natural gas in power generation responded sensitively over the past ten years. Figure 4 illustrates changes in the cost of natural gas and coal at power plants.

Between 2000 and 2008, coal had an overwhelming advantage in price over natural gas, accounting for 50% of power generation during this period as shown in Figure 4.

In 2009, however, natural gas production derived from shale advanced, which caused a sharp drop in gas price. Meanwhile, the price of coal showed a slow, yet upward trend, resulting in a rapidly shrinking relative price ratio between natural gas and coal. This led to the sudden drop in coal-fired power generation and sharp spike in natural-gas-fired power.

Figure 4: Annual fuel receipt costs at electric generating plants (2000–2016)



(4) "As coal stockpiles at power plants rise, shippers are reducing coal railcar loadings"

The amount of coal stored at coal storage facilities in generating plants piled up to 197 million tons at the end of 2015. This is the highest amount recorded since June 2012, and the largest-ever year-end coal stockpile in the past 25 years. In the short period between September and December 2015, the stored coal increased by 40 million tons. It was also the largest stockpile accumulation for the same period in the past 15 years.

Figure 5: Monthly coal stockpiles at electric generating facilities
(Jan 2010 – Dec 2015)

2. Insight into the future of coal in Japan read from METI council data

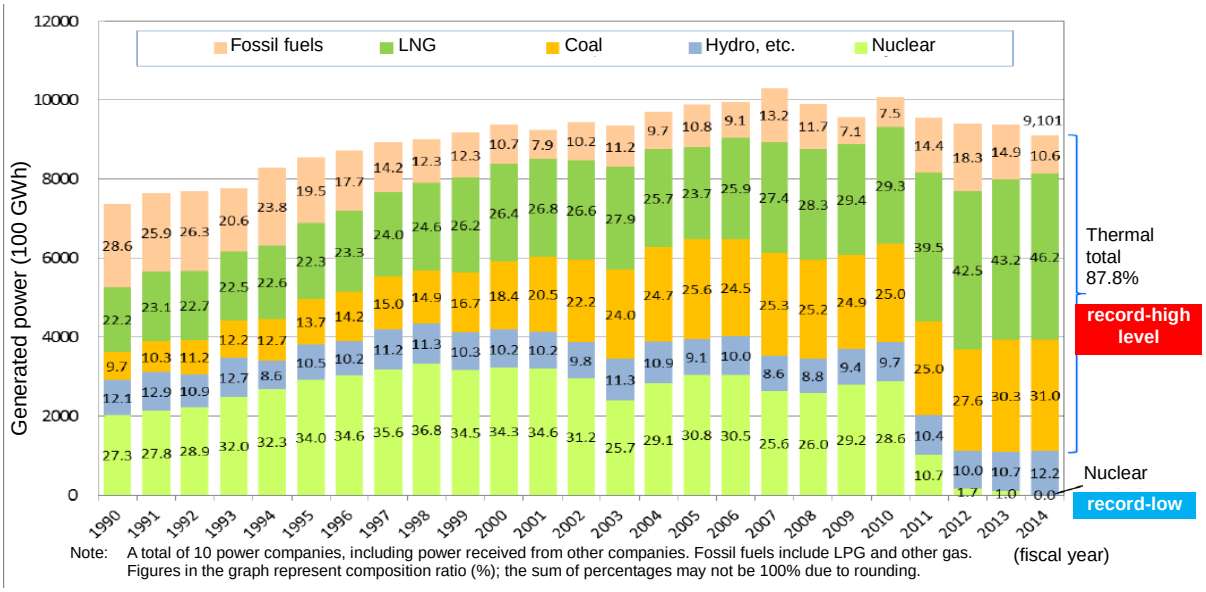
We will now take an opportunity to glimpse at the future prospects of coal-fired power in Japan, based on reference materials provided by various councils including the METI-sponsored Advisory Committee for Natural Resources and Energy.

(1) Changes in and forecast for coal-fired power generation

We will first review the record that coal-fired power has had in the history of power generation.

The figure below (Figure 6) illustrates changes in the power source mix in Japan since 1990.

Figure 6: Changes in power source mix in Japan



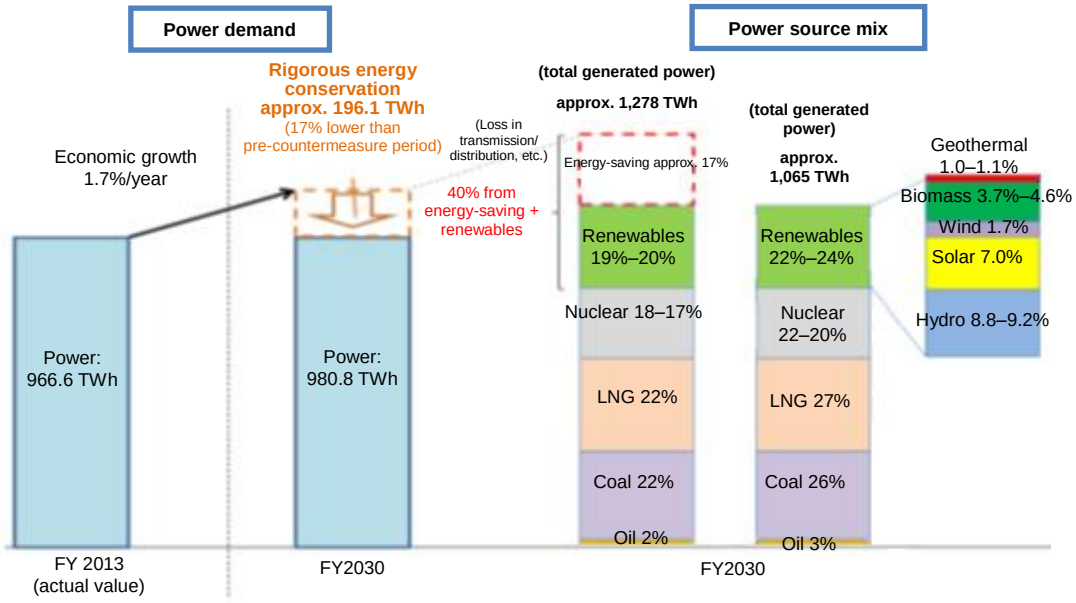
Source: Federation of Electric Power Companies (FEPC) (Advisory Committee for Natural Resources and Energy, Committee on Energy Efficiency and Renewable Energy, Energy Efficiency and Conservation Subcommittee, WG on Tendering Systems of Thermal Power Supply (second meeting) - distributed material)

Since 1990s, coal steadily expanded its share in the power source mix (generated power), with 250 TWh generated in FY2010 prior to the Great East Japan Earthquake. It accounted for 25% of the total power generation. Both LNG and nuclear power have grown to constitute an important part of the best mix of power sources.

After the earthquake, power generated by coal expanded to compensate for the loss in nuclear power. In 2014, 31% of the total generated power, 280 TWh, was supplied by coal-fired generation.

For a future projection, it was stated in the "Long-term Energy Supply and Demand Outlook" published by the Advisory Committee for Natural Resources and Energy in July 2015 that efforts would be made to "realize higher efficiency of coal-fired and LNG-fired thermal power generation, and promote their effective utilization, while ensuring a reduction of an environmental load at the same time." It also stated that "the expectation is to provide 277 TWh, approximately 26% of the projected total generated power of 1,065 TWh for 2030," in terms of quantity.

Figure 7: Power demand and power source mix (values are approximate) in FY2030



Source: "Long-term Energy Supply and Demand Outlook" by Advisory Committee for Natural Resources and Energy (July 2015)

In Japan, coal-fired power has steadily expanded its role in the power source mix, as it took up the heavy load of compensating power from nuclear power generation lost after the Great East Japan Earthquake. The future prospects for coal-fired power from the standpoint of policy goals remain bright, with the anticipated power generation for FY2030 being at the same level as 2014, when it accounted for 31% of the total generated power. This is also to be achieved along with steady progress in efficiency improvements and a reduction in environmental impact.

(2) New construction plan for thermal power plants

As shown earlier, we can expect coal-fired power to play an important role in policy measures in the future.

Figure 8, which was distributed at a meeting of WG on Tendering Systems of Thermal Power Supply, confirms 17.75 GW of new coal-fired power plant construction for FY2013 and later, including those at the planning phase. It may be safe to interpret that coal-fired power is a viable business option worth the investment and new construction for the relevant businesses which are actually involved in power plant construction and operation.

The generation power of 17.75 GW from the new plans consists of 15 GW from high-efficiency coal-fired power (Ultra Super Critical: USC), and 1.25 GW from advanced high-efficiency coal-fired power (Integrated coal Gasification Combined Cycle: IGCC). They are promoted in line with the "higher-efficiency, lower environmental impact" target as described in the "Long-term Energy Supply and Demand Outlook" mentioned earlier.

Figure 8: New construction and expansion of thermal power plants

○ As many LNG-fired plants are also included in the new thermal plant construction, they do not show over-independence on coal-fired power.

<Reference: New thermal plant construction after FY2013 (including plans)>

High-efficiency coal fired (USC) : 15 GW
Advanced high-efficiency thermal (IGCC) : 1.25 GW
1.5 GW when assuming 15 small-scale coal-fired plants
} Coal 17.75 GW

High-efficiency LNG fired (GTCC) : 29 GW
} LNG 29 GW

[FY2014 thermal power facility capacity by fuel]
Coal fired: 41 GW, LNG fired: 69 GW, Fossil oils: 46 GW

Coal fired

Technology	Facility capacity	Full-scale implementation
Sub Critical (Sub-C)	9 GW	From 1960s
Super Critical (SC)	17 GW	From 1980s
Ultra Super Critical (USC)	16 GW	From around 1995

LNG-fired power

Technology	Facility capacity	Full-scale implementation
Conventional	25 GW	From 1970s
Combined cycle (GTCC)	45 GW	From 1980s

Note: General and Wholesale Electricity Utilities, and Wholesale Electricity Utilities Supply total. Facility capacity as of March 2015.
Source: Compiled based on an overview of power source development, etc.

Source: Advisory Committee for Natural Resources and Energy, Committee on Energy Efficiency and Renewable Energy, Energy Efficiency and Conservation Subcommittee, WG on Tendering Systems of Thermal Power Supply (third meeting) - distributed material (Regarding power generation efficiency standards for higher-efficiency thermal power generation)

Figure 9 was presented at a meeting of "WG on Tendering Systems of Thermal Power Supply" under the Advisory Committee for Natural Resources and Energy, in July 2015 (first meeting).

This chart indicates coal-fired power plants producing 47 GW will be required to achieve the best mix of power sources identified by the Advisory Committee for Natural Resources and Energy. Considering that facilities with about 40 GW capacity are already in operation, and new construction plans for 17.75 GW as mentioned above have been confirmed, it should be possible to adequately secure the capacity required to attain the best mix in 2030, even if some facilities retire due to aging or low-efficiency.

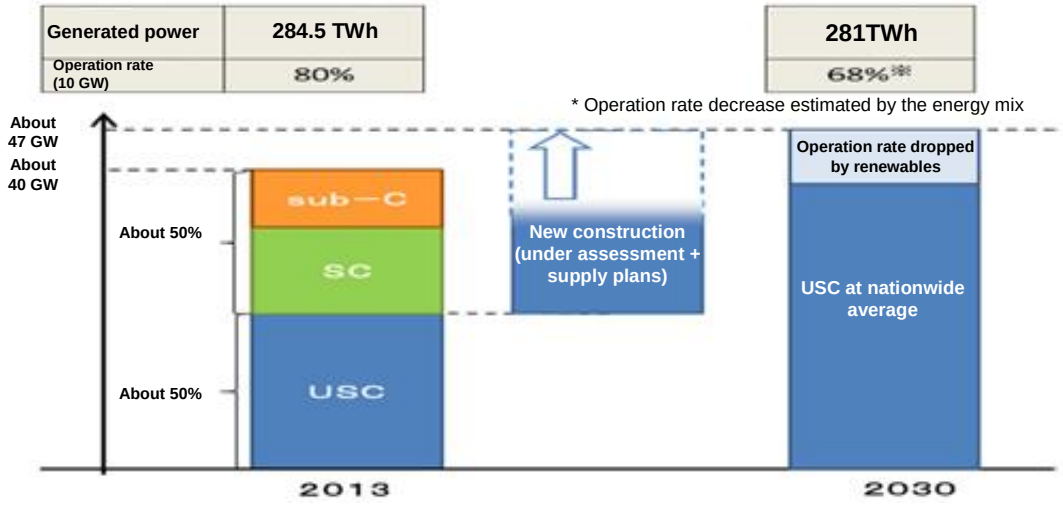
This means that the anticipated policy target of "277 TWh, which is 26% of the total generated power of 1,065 TWh in 2030" has already been sufficiently ensured by highly motivated operators' investment and construction plans as of now.

Nevertheless, it is also important to note that policy makers have pointed out the potential need for appropriate regulations on less-efficient, small-scale coal-fired plants in the future.

Figure 9: Future of thermal power generation to achieve long-term energy supply and demand outlook targets

- Thermal power generation's efficiency differs by facility scale and applied technology.
- To reach the goals set in the Long-term Energy Supply and Demand Outlook, LNG-fired power must attain an overall efficiency equivalent to that of combined cycle (GTCC). And coal-fired power must maximize the latest thermal technologies such as IGCC and IGFC, replace non-efficient power plants, and reach an efficiency equivalent to that of USC (Ultra Super Critical) as equipment overall.
- From these perspectives, should appropriate regulations be put in place to govern new construction of non-efficient small-scale coal-fired power plants?

Coal-fired power generation capacity required for energy mix targets



Source: WG on Tendering Systems of Thermal Power Supply (first meeting) - distributed material (Response to power business under the Energy Conservation Law)

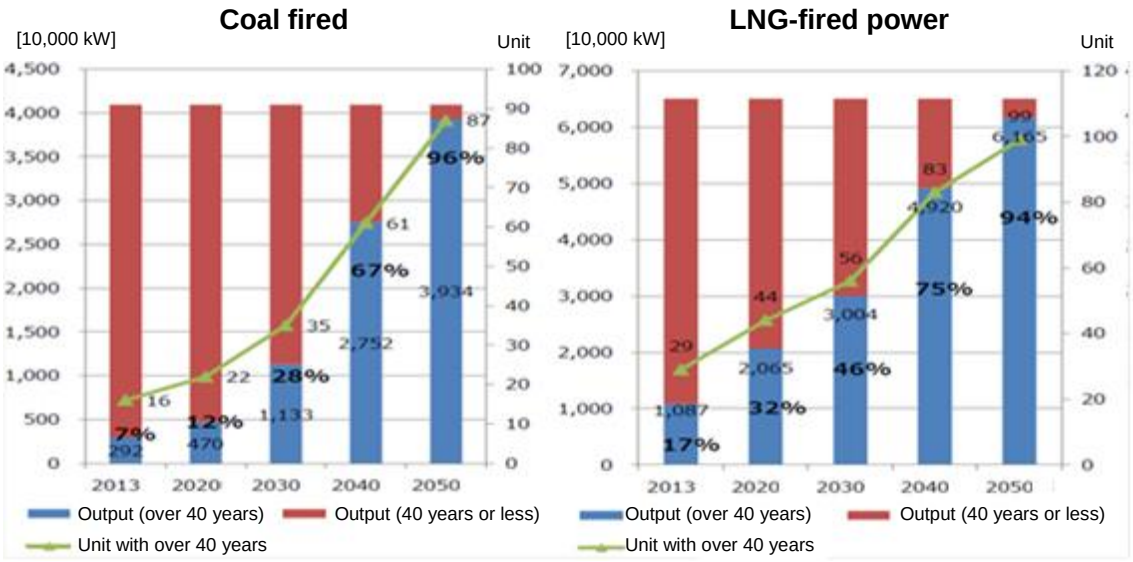
(3) Situations surrounding aging thermal power generation

It appears that the thermal power plants retired in 2015 in the United States were older or smaller than the plants that continue to operate.

Most coal-fired power facilities retired in 2015 in the U.S. began operation between 1950 and 1970, with the average number of operation years being 54. The facilities which will continue their operation are relatively new, and have been operating for an average of 38.

When we compare this with the situations surrounding aging coal-fired power plants in Japan based on the material distributed at the third meeting of WG on Tendering Systems of Thermal Power Supply (Figure 10), only 7% of coal-fired power plant capacity exceeded the 40-year mark during FY2013, and the number will remain below 30% (28%) even in 2030. This means, even assuming plant retirement after 40 years, that the required capacity for the best mix at 47 GW level in 2030 will be covered nearly entirely with the planned 17.74 GW new construction in the future.

Figure 10: Situations by year (or changes by aging) of coal- and LNG-fired power plants with over 40 years of operation



Source: Advisory Committee for Natural Resources and Energy, Committee on Energy Efficiency and Renewable Energy, Energy Efficiency and Conservation Subcommittee, WG on Tendering Systems of Thermal Power Supply (third meeting) - distributed material

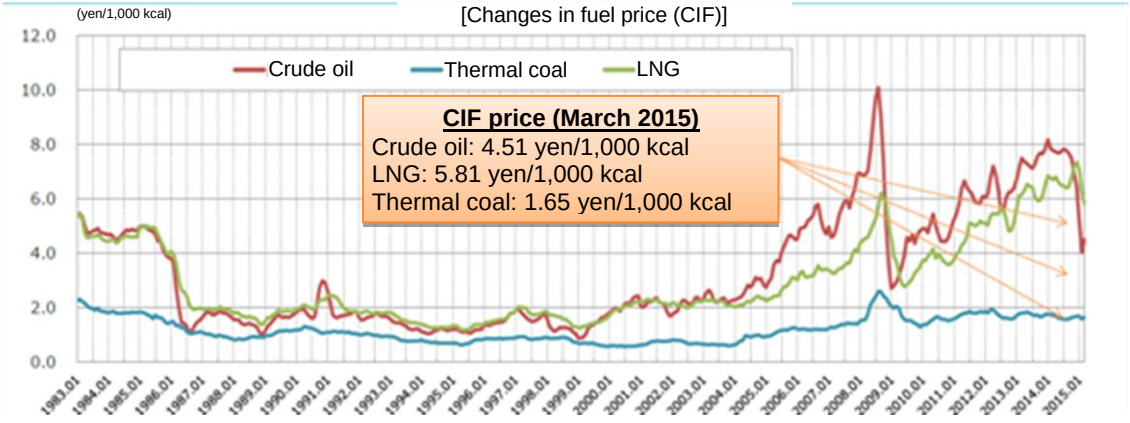
With regard to the issue of capacity size, either large or small, small-scale power plants (100 MW class) will account only for a total of 1.5 GW out of 17.75 GW over all the new plant construction planned for coal-fired power facilities. There are no grounds for concern that early facility retirement due to the small size will lead to an insufficient power capacity.

(4) Competition with natural gas

In the case of the United States, as the relative fuel cost ratio per power generation (natural gas price/coal price) before reaching a power plant approaches a two-fold mark, operation at coal-fired power plants starts to slow down. Once the relative ratio dips below the two-fold value, it swiftly shifts to natural gas use.

The figure below (Figure 11) compares import prices of coal, LNG, and crude oil in Japan since 1983.

Figure 11: Changes in fuel price and future projection



Source: Advisory Committee for Natural Resources and Energy, Committee on Energy Efficiency and Renewable Energy, Energy Efficiency and Conservation Subcommittee, WG on Tendering Systems of Thermal Power Supply (third meeting) - distributed material

The most current data in the figure, recorded as of March 2015, shows a sharp drop in crude oil price, with the LNG price just beginning to follow the trend.

Commentary to Figure 11 explains that in 2015,

i. Price of coal remained stable at low levels compared with crude oil and LNG. (Crude oil: 4.4 times higher, LNG 3.9 times higher)

ii. Generation cost of coal-fired power provided advantage in fuel cost over LNG.

However, an additional price drop in crude oil caused the LNG price, which generally moves with crude oil price, also to decline sharply.

LNG import price dipped to 3.67 yen/1,000 kcal in January 2016, from 5.81 yen on average in March 2015. During the same period, the thermal coal import price showed a decline to 1.37 yen from 1.65 yen, with a decrease in relative LNG/coal price ratio from 3.52 times to 2.68 times.

We can understand that the U.S. is approaching the cut-off level where a shift from coal to natural gas begins.

3. Japan-U.S. comparison, etc., in conclusion.

The current situation in the United States as described in 1 can be summarized as:

- Sharp drop in domestic coal production.
- The main cause is lower demand for coal for power generation.
- The first influencing factor in the lower demand for coal for power generation is tighter environmental regulations. The enforcement of "Mercury and Air Toxic Standards (MATS)" by the DOE in April 2015 led to the retirement of 18 GW power plants. 80% of the capacity,

almost 14 GW, was from coal-fired power plants. On the contrary, retired competing natural gas fired plants remained just below 2.5 GW.

- Coal-fired power plants suspended or retired during 2015 had aging facilities with an average operation time of 54 years. Continuing facilities had an average age of 38 years, newer in comparison.
- The average capacity of retired coal-fired power units in 2015 was 133 MW, smaller than the continuing plants' average capacity of 278 MW.
- The second influencing factor of the lower demand for coal for power generation was a sharp drop in the natural gas price which pushed a shift from coal-fired power to natural gas.
- As a result, coal shared the position of largest power source with natural gas during 2015 (equivalent shares), and is expected to be surpassed and replaced by natural gas in 2016.
- Stockpiles of coal are rapidly expanding, forcing shippers to withhold shipments.

When we focus on issues seen in the United States only, it appears that we have no choice but to conclude that "there is no tomorrow for the coal industry."

In comparison, the situations in Japan as addressed in 2 were:

- Coal demand for power generation steadily increased since 1990, and became a significant player to form the best mix, along with nuclear and natural gas sources before the Great East Japan Earthquake.
- Future prospects for coal-fired power from the standpoint of policy goals remain bright, with the anticipated power generation for FY2030 being at the same level as 2014 when it made up for 31% of the total generated power. ("Long-term Energy Supply and Demand Outlook" by Advisory Committee for Natural Resources and Energy, July 2015)
- However, the required target of further "progress in efficiency improvement and reduction in environmental impact" needs to be met.
- The Ministry of the Environment (MOE) shifted its position and approved coal-fired power generation under the conditions of tighter CO_2 emission control in 2016.
- Commercially, new construction plans for 17.75 GW of power capacity have also been confirmed. Approximately 15 GW will be produced by USC, and 1.25 GW by advanced high-efficiency thermal power (IGCC), which will satisfy the requirement of "high-efficiency, low-environmental impact." New regulations will be considered for small-scale power plants at 1.5 GW level.

This situation reminded me of a youth in Japan after the Meiji Restoration, walking up a hill to see "the clouds over the hill (what bright future may there be)" in the novel "Clouds Over the Hill" by Ryotaro Shiba.

What factors and causes made such drastic differences in the climate for coal between Japan and the United States?

One answer you can find in this article is the incredible progress shale gas has made in the United States, accompanied by a sharp drop in the price of natural gas.

The shale gas revolution delivered a blow to its rival, coal. The blow has proved quite damaging. It appears that we will only have to wait and see if or when the gas price starts to climb before we can dream about “coal’s future.”

In 2017, we expect the shale gas revolution will arrive in Japan. Before the next two to three years pass, shale LNG in an amount of over 20 million tons will surge over Asia. How much will the revolution lower the relative price ratio between natural gas and coal? Will it be strong enough to blow away the “clouds over the hill”?

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