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Analysis of Electricity Supply and Demand through FY2012 Regarding Restart of Nuclear Power Plants

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<Problem>

Since the Great East Japan Earthquake occurred, a growing number of nuclear power plants have come to a halt. As of June 10, 35 of Japan's 54 nuclear units were out of service, leaving 19 in service. While the units in service will be halted for regular checkups, Japan's electricity supply and demand and its economy and civil life may be dramatically and widely affected depending on whether those out of service would be restarted. With this problem in mind, several scenarios on the operation and restart of nuclear power plants, electricity supply and demand for each scenario, and relevant challenges and implications, are compiled.

<Key conclusions>

<Possible nationwide electricity shortages>

- If units now out of service and those subject to future regular checkups fail to be restarted, Japan may face an extremely severe situation including electricity shortages toward FY2012.
- In the summer of FY2012, particularly, the balance of electricity supply-demand will be extremely tight. Serious nationwide electricity shortages are likely to come then. If no unit is restarted, Japan's total power generation capacity other than thermal power plants left out of service over a long time will be 7.8% less than peak electricity demand. Given that the minimum 5% reserve capacity is required for stable electricity supply, 12.4 % of the electricity consumption will have to be cut, seriously affecting industrial operations.
- If nuclear power plants now out of service and those subject to future regular checkups fail to be restarted, thermal power plants' capacity utilization rates will have to be raised to levels far higher than usual without economic activity contraction or very large-scale electricity conservation. However, this analysis indicates that oil thermal power plants may have to be operated at more than 100% of their capacity in some regions, meaning that no solution may actually exist in such case.

<Substantial growth in fossil fuel consumption and its impact>

- If nuclear power plants now out of service and those subject to future regular checkups fail to be restarted and if Japan meets the total electricity demand by raising thermal power plants' capacity utilization rates to levels that are actually difficult to achieve, its thermal fuel consumption will increase dramatically in FY2012. Coal, LNG and oil procurement costs in the year will expand by 3.5 trillion yen from FY2010. (This analysis does not take into account possible fuel price hikes under substantial demand growth or their impact.)
- If the above estimated fuel cost hike is passed on to electricity charges, there may be a cost rise of 3.7 yen per kilowatt-hour. This means that the monthly electricity bill for a normal household may increase by 1,049 yen or 18.2%. The fuel cost hike is estimated to bring about a 36% increase from 10.22 yen/kWh for the average industrial (extra high voltage)

electricity bill. Such industrial electricity charge increase is feared to affect Japan's industrial competitiveness very seriously.

- In line with the increase in consumption of thermal power generation fuels, energy-based carbon dioxide emissions will expand substantially. If nuclear power plants now out of service and those subject to future regular checkups fail to be restarted, CO_2 emissions in FY2012 may total 1.26 billion tons, up 18.7% from 1990.
- Japan is urgently required to sincerely consider restarting suspended nuclear power plants from the viewpoint of the best energy mix while the safety of the plants must be given the top priority.

<Explanation>

1. Operation of nuclear power plants in Japan

(1) As of June 10, 2011, Japan had 54 nuclear power units with a total capacity of 48.96 gigawatts. In addition to those suspended for regular checkups before the March 11 Great East Japan Earthquake, ten nuclear units came to a halt on the disaster, two units at the Hamaoka nuclear power station were suspended at the request of the government, and some others were halted for regular checkups after the disaster as earlier planned. As a result, only 19 units with a total capacity of 17.58 GW were in service as of June 10.

(2) It is difficult to expect that most of the nuclear units that came to a halt on the disaster could be restarted to provide electricity by the end of FY2012. They include four at the Fukushima Daiichi nuclear plant that the Tokyo Electric Power has decided to decommission. Similarly, it is difficult to expect that the Hamaoka nuclear plant, now subject to safety measures as requested by the government, could be restarted. Meanwhile, nuclear plants now in service will undergo regular checkups one after another under earlier plans. Therefore, electricity supply from nuclear in Japan in the immediate future (through FY2012) will depend on the restart of nuclear plants now out of service and those subject to future regular checkups, excluding those which it would be clearly difficult to restart.

2. Scenarios for restarting nuclear power plants

(1) Three scenarios

In this report, following three scenarios are created for analysis, taking into account various uncertain factors regarding the restart of suspended nuclear plants.

① Scenario for launching the restart of nuclear power plants in July 2011 (abbreviated as "July restart scenario")
   - This scenario envisages that nuclear plants now out of service will be restarted gradually toward the summer electricity demand peak in and after July 2011 as efforts to restart them make progress. The scenario has little chance to be realized and is seen as a very "optimistic scenario." Under this scenario, nuclear power plants are assumed to continue a regular cycle of operation and checkups after the restart.

② Scenario for launching the restart of nuclear plants in December 2011 (abbreviated as "December restart scenario")
   - While this scenario is based on the same basic concept as the "July restart scenario", it envisages that nuclear plants now out of service will be restarted gradually toward the winter electricity demand peak in and after December as preparations for their restart take more time.

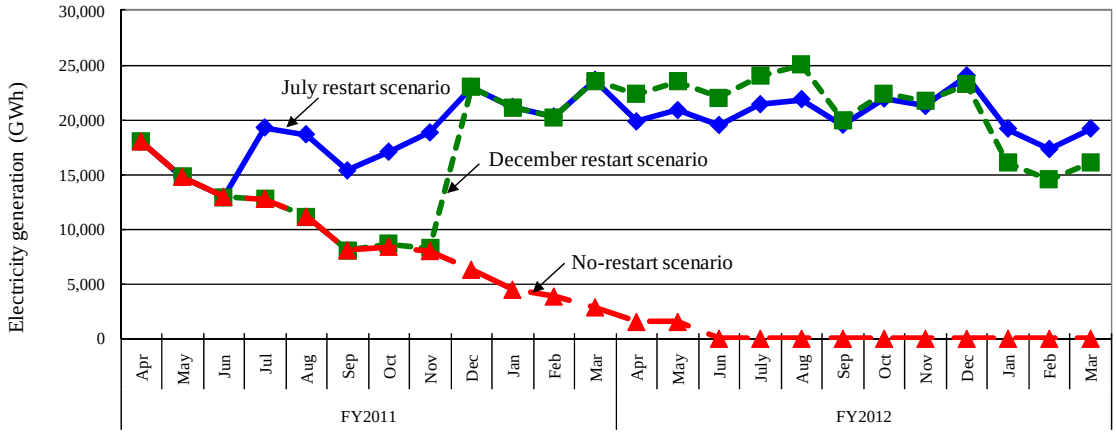
③ No-restart scenario

- This scenario envisages that nuclear plants that are now out of service or that will undergo regular checkups in the future will fail to be restarted, remaining out of service. The analysis hereinafter focuses on this scenario because of its great impact.

(2) Nuclear power generation under the three scenarios

- Figure 1 presents monthly nuclear power generation (estimates) through FY2012 under the three scenarios.
- Under the "No-restart scenario," nuclear power generation will decline as nuclear plants in service are suspended for regular checkups. In July 2012, nuclear power generation is projected to decline to zero.
- Under the "July restart scenario" and "December restart scenario," nuclear power generation will increase to some 200 GWh, close to the actual FY 2010 level, as nuclear plants now out of service are restarted gradually.

Figure 1 Envisaged nuclear power generation in FY2011-2012



3. Electricity supply and demand analysis

(1) Assumptions for electricity supply and demand analysis

Major assumptions as standards for the electricity supply and demand analysis are as follows:

Economic growth (GDP growth): 0.0% in FY2011, Up 2.6% in FY2012 (from the previous year)

Total electricity demand: Down 4.7% in FY2011, Up 2.9% in FY2012 (from the previous year)

Thermal and hydro power generation capacity: Accumulating authorized power station capacity numbers in the electricity survey statistics

Priorities in thermal power generation: Each generation company is assumed to increase power generation for each source under the priority order of coal, LNG and oil, and the trend of past results.

Capacity utilization rate: The maximum annual average capacity utilization rate is assumed at the

following levels, based on past results, fuel acceptance capacity and interviews with electricity industry players:

Coal thermal power generation: 85%
LNG thermal power generation: 70%
Oil thermal power generation: Each company is assumed to resort to oil thermal power generation if required to meet demand after using up coal and LNG thermal power generation, with no limit set on the capacity utilization rate.

(2) Electricity supply and demand analysis results (focusing on the No-restart scenario)
<Comparison of peak electricity demand[1] and generation capacity[2]>

- Under the "No-restart scenario," Japan's total electricity generation capacity will decline in line with a fall in nuclear generation capacity as time goes by.
- According to our analysis, total electricity generation capacity for all Japanese electric power companies will slip below the peak electricity demand in the summer 2012 period, when the electricity supply-demand relationship would be the tightest. The comparison of peak electricity demand and generation capacity indicates electricity shortages in the period (Figure 2).
- Under the "No-restart scenario," electric power companies' total electricity generation capacity, excluding mothballed thermal power plants, will be 7.8% less than summer peak electricity demand in 2012. Given that the minimum reserve generation capacity equivalent to some 5% of peak electricity demand is required for stable supply, 12.4 % of the electricity consumption will have to be saved, with grave impacts imposed particularly on industrial activities.
- Each electric power company's total capacity will be short of peak electricity demand in its service area in the summer of 2012. Even if electricity purchases from non-utility companies, and cooperation and electricity interchange among electric power companies are taken into account, the electricity supply-demand balance will be very tight on a nationwide basis (Figure 3).

[1] Peak electricity demand represents the highest value among monthly peaks for each electric power company between FY2005 and 2010. The national total is a simple total of peak demand values for the 10 electricity power companies. However, summer peak demand foris assumed at 60 GW (51 GW after a 15% cut) for the Tokyo Electric Power Co. and at 14.8 GW (12.58 GW after a 15% cut) for Tohoku Electric Power Co. are assumed at 60 GW and at 14.8 GW, respectively.

[2] Power generation capacity represents a three-month average, excluding the interchange among companies and including the capacity of long-idled thermal power plants. With peak monthly electricity demand taken into account, 60% of hydroelectric generation equipment capacity is counted into the capacity. Nuclear power generation capacity excludes units subject to regular checkups. Renewable energy-based power generation capacity is not taken into account except for the emergency capacity for Tokyo Electric Power Co. and Tohoku Electric Power Co. in FY2011-2012. (Renewable energy-based power generational capacity is limited to less than 0.3% of Japan's total generation capacity.) Disaster-damaged power plants are excluded from the power generation capacity. Long-idled thermal power plants include those panned for elimination. It is difficult to immediately restart them.

Figure 2-1 Japan's total power generation capacity

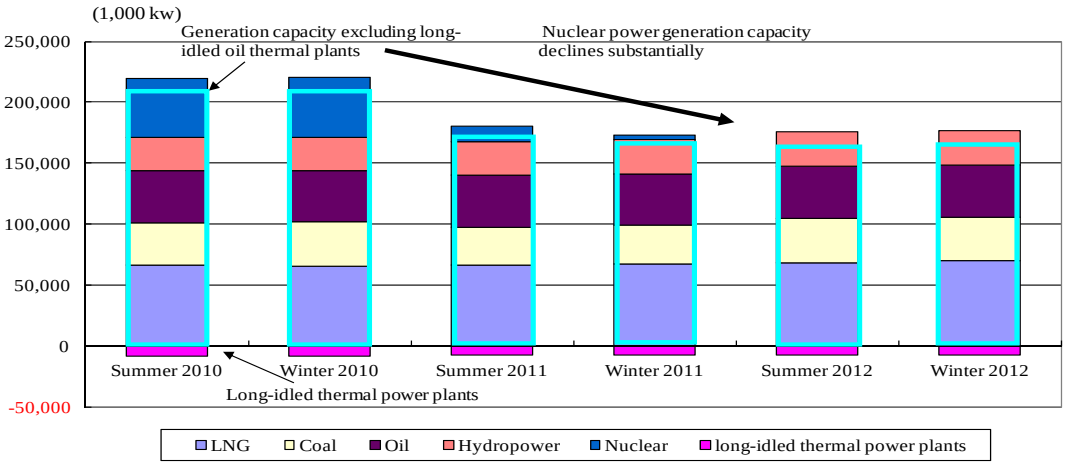


Figure 2-2 Comparison of Japan's total power generation capacity and peak demand

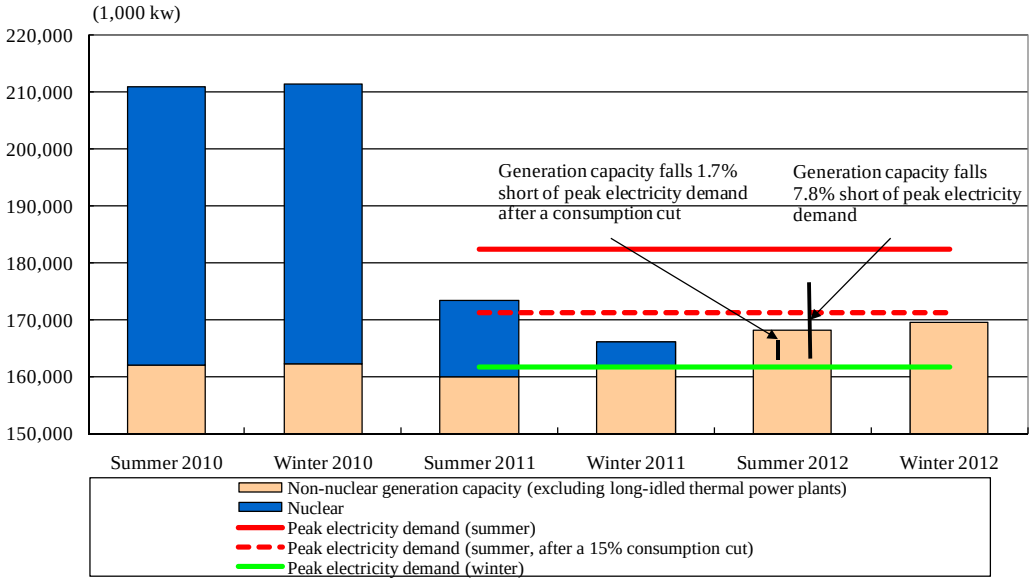
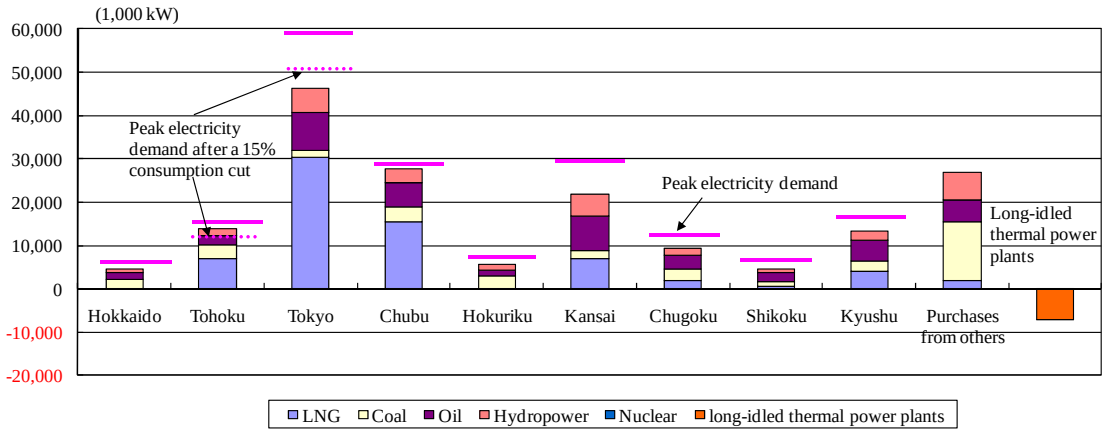


Figure 3 Each electric power company's generation capacity and local peak demand



<Electricity generation by each type of thermal power plants (No-restart scenario)>

- Under the "No-restart scenario," the annual average capacity utilization rate for coal thermal power plants of the 10 electric power companies in FY 2012 will be 85% (the assumed maximum rate).
- The annual average capacity utilization rate for LNG thermal power plants of the 10 electric power companies in FY2012 will be 68% (close to the assumed maximum rate).
- The annual average capacity utilization rate for oil thermal power plants of the 10 electric power companies in FY2012, including long-idled plants, will be 55%. Excluding long-idled plants, however, capacity utilization rates will exceed 100% for nearly half of the electric power companies, meaning that no solution may actually exist in such case.

<Thermal fuel consumption and procurement costs (No-restart scenario)>

- Fuel consumption for thermal power generation is estimated to increase as follows (Table 1):
  - Coal for power generation increases from 90.15 million tons in FY2010 to 99.23 million tons in FY2012 (up 9.08 million tons).
  - LNG for power generation increases from 44.37 million tons in FY2010 to 64.39 million tons in FY2012 (up 20.02 million tons).
  - Oil for power generation[3] increases from 13.51 million kiloliters in FY2010 to 40.96 million kl in FY2012 (up 27.45 million kl).
- Based on the above fuel consumption and CIF prices in April 2011, a thermal fuel procurement cost increase from FY2010 to 2012 is estimated at 3,473 billion yen – 19.1 billion yen for coal, 1,396 billion yen for LNG and 1,887 billion yen for oil. (Effects of the fuel cost expansion on electricity charges are explained later.)

<Thermal fuel consumption and procurement costs (comparison among scenarios)>

- A comparison of fuel consumption increases in the scenarios (Table 2) indicates that consumption increase in the "No-restart scenario" is dominantly greater for each of coal, LNG and oil.
- Based on CIF prices in April 2011, the fuel procurement cost in the "No-restart scenario" is higher than those in the "July restart scenario" and the "December restart scenario" by 2,712 and 2,756 billion yen, respectively.

[3] Fuel oil consumption includes both heavy oil and crude oil. The quantity of oil is converted to crude oil equivalent.

Table 1 Gaps between FY2010 and 2012 under No-restart scenario

	FY2010		FY2012 (no restart)		FY2012 － FY2010	
	Consumption (Respective unit)	Import value (Billion yen)	Consumption (Respective unit)	Import value (Billion yen)	Consumption (Respective unit)	Import value (Billion yen)
Fossil fuels (10＾10kcal)	125,350	3,724	182,003	7,197	56,653	3,473
Coal (1,000 tons in steaming coal)	90,148	881	99,231	1,072	9,083	191
Crude oil (1,000 kl in crude oil)	13,510	619	40,960	2,506	27,451	1,887
Natural gas (1,000 tons in LNG)	44,368	2,223	64,388	3,619	20,020	1,396

Table 2 Gaps between FY2010 and 2012 in each scenario

	July restart scenario		December restart scenario		No-restart scenario	
	Consumption (Respective unit)	Import value (Billion yen)	Consumption (Respective unit)	Import value (Billion yen)	Consumption (Respective unit)	Import value (Billion yen)
Fossil fuels (10＾10kcal)	5,980	761	4,852	717	56,653	3,473
Coal (1,000 tons in steaming coal)	57	93	△ 823	84	9,083	191
Crude oil (1,000 kl in crude oil)	△ 3,114	17	△ 3,511	△ 7	27,451	1,887
Natural gas (1,000 tons in LNG)	6,759	650	6,585	640	20,020	1,396

<CO_2 emissions (No-restart scenario)>

- Under the "No-restart scenario," energy-based CO_2 emissions will increase from 1,124 million tons in FY2010 to 1,166 million tons in FY2011 (up 10.0% from FY1990) and to 1,257 million tons in FY2012 (up 18.7% from FY1990). The five year average from the FY2008 to FY2012 can be estimated as 1,152 million tons, up 8.8% from 1,059 million tons in 1990, by using the FY2008-2009 actual results and the FY2010-2012 estimated results.

4. Challenges and implications

- As analyzed above, Japan as a whole will likely see electricity shortages particularly in the summer of 2012 if no nuclear power units are restarted.
- Even if electricity supply is secured with high capacity utilization rates achieved for thermal power plants, an increase in consumption of fuels for thermal power generation will lead to an additional fuel procurement cost of 3.5 trillion yen in FY2012.
- If the additional fuel procurement cost is simply passed on to an electricity charge, the cost may rise by 3.7 yen per kilowatt-hour. As a result, the monthly electricity bill for a standard family may rise by 1,048 yen or 18.2%. The fuel cost hike of 3.7 yen represents a 36% increase from 10.22 yen/kWh for the average industrial (extra high voltage) electricity bill. Such industrial electricity charge increase is feared to seriously affect the competitiveness of Japanese industries, especially that of the manufacturing industries.
- The procurement prices of fuels could be higher than the level assumed for this analysis if massive additional fuel procurement by Japan affects the supply-demand relationship for international markets. In such case, there could be a larger procurement cost increase and electricity charge hike.
- The sharp increase in fuel procurement cost (i.e., overseas transfer of income) could negatively

affect to lower Japan's economic growth[4]. In addition, the sharpe rise in the electricity charge can negatively affect the international competitiveness of Japanese industries and the entire economy. Further, electricity conservation and shortages could exert adverse impacts on economic growth.

- Based on the above challenges, Japan is urgently required to sincerely consider restarting suspended nuclear power plants while giving top priority to their safety from the viewpoint of the best energy mix.

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[4] In this analysis based on the additional fuel procurement costs under the "No-restart scenario," the real GDP growth rate is estimated to be lowered by 0.1 percentage point.