

# ***AN ANALYSIS OF POWER GENERATION COSTS IN JAPAN USING CORPORATE FINANCIAL STATEMENTS***

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## **Overview**

There are two generally accepted methods for estimating power generation costs: so-called “model plant” method and the method using corporate financial statements. The latter method can provide useful information for comparing thermal and nuclear power generation costs, though under some constraints. This study used the method using corporate financial statements for estimating various power generation costs in Japan, finding that the nuclear power generation cost remained stable at around 6-7 yen per kilowatt-hour(kWh) while the thermal power generation cost moved within a wide range of 9 to 12 yen/kWh in line with wild fluctuations in primary energy prices from FY2006 to FY 2010. It also shows the actual nuclear power generation unit costs in Japan are much higher than OECD’s estimate (2010), due to higher fuel and O&M costs.

## **Methods**

We followed Kunitake et al.(1999) and Matsuo et al.(2012) to calculate unit power generation costs, dividing a fiscal year’s hydro, thermal, nuclear and geothermal,etc. power generation costs by power output (kWh). Power generation costs here cover electric utility operating expenses and interest payments that appear in profit-and-loss statements. While electric utility operating expenses are broken down for hydro, thermal and nuclear power generation in profit-and-loss statements, interest payments are not. Here we estimated interest payments for each power generation method by allocating interest payments for overall electric utility operations to these power generation methods based on each method’s share of electric utility fixed assets added to construction in progress account. As the denominator we used sending-end output instead of generating-end output. Unlike Matsuo et al.(2012), we excluded the reprocessing and waste disposal expenses related with the spent fuel before FY2005, which appears in the financial statements after FY2006 because of the legislation established in 2006. We used financial statements of 12 power utilities in Japan, from FY2006 to 2011, and classified expenses into five categories: capital cost, fuel cost, backend cost, decommissioning cost and O&M (operation and maintenance) cost. All prices are adjusted to CY2010 prices using the Domestic Corporate Goods Price Index.

The method using corporate financial statements cannot estimate hydro power generation cost precisely, because hydro power generation facilities now in operation in Japan have mostly been amortized. The same problem may also affect the nuclear power generation cost to a less extent. For the nuclear cost, we simulated the depreciation of nuclear facilities of 11 utilities using an exponential function to estimate the effect of amortization on the cost calculated from the financial statements.

## **Results**

The average power generation cost for the FY2006-2010 period for the 12 utilities came to 6.5 yen/kWh for hydro, 10.1 yen/kWh for thermal, 6.7 yen/kWh for nuclear and 9.4 yen/kWh for geothermal, etc. Hydro power is the cheapest due to completed amortization. Fuel costs accounted for 7.4 yen/kWh or 74% of the thermal power generation cost. Due to the fuel price hike accompanying a crude oil price spike, the fuel cost showed wild fluctuations during the estimation period. It must also be mentioned that the fuel mix largely affects thermal generation cost, i.e. with larger share of gas-fired (smaller share of coal-fired), the unit cost gets higher.

The nuclear power generation cost of 6.7 yen/kWh includes 1.9 yen/kWh in capital cost, 0.6 yen/kWh in fuel cost, 2.7 yen/kWh in O&M cost, 1.3 yen/kWh in backend cost and 0.3 yen/kWh in reactor decommissioning cost. Nuclear power generation thus features a far cheaper fuel cost than thermal power generation. From the detailed analysis of the relationship between the average age of nuclear power facilities and the depreciation expense of 11 utilities, the “real” nuclear capital cost is estimated to be 0.4 to 0.9 yen/kWh higher. This analysis shows that the actual nuclear power generation cost is much higher than the OECD’s estimate (5.1 yen/kWh), due to higher fuel and O&M costs.

Geothermal, etc. power generation cost is lower than the thermal cost, although it must be noted that the existing geothermal power plants in Japan were constructed mainly during 1990s, and already have completed most part of amortization.

After the Fukushima Daiichi nuclear power plant accident that took place in March 2011, nuclear power plants in Japan have not been permitted to restart operation after periodic inspections. As of the end of FY2012, only two units (Ohi unit 3 and unit 4) are in operation. Nuclear share of total power output declined from 32% in FY2010 to 12% in 2011 and only 2% in 2012. Instead, thermal generation share rose to 91% in FY 2012. This caused a considerable rise in Japan's power generation costs.

The average power generating cost of 12 utilities rose from 8.4 yen/kWh in FY2010 to 11.5 yen/kWh in FY2011. A simple forecast shows that it will rise further to 12.5 yen/kWh in FY2012. Nuclear power generation unit cost rose to 15.7 yen/kWh in FY2011 due to the very low capacity factor. The total cost of power generation (total of 12 utilities) rose from 7.3 trillion yen in FY2010 to 9.3 trillion yen in FY2011. Shift from nuclear to thermal power generation resulted in the increase in fossil fuel import bill of 1.4 trillion yen in FY2011. Other factors affecting the total cost include the rise in fossil fuel prices and the change of the exchange rate. Despite the very small nuclear power output, the total cost of nuclear power has not decreased considerably.

## Conclusions

In this paper we estimated hydro, thermal, nuclear and geothermal, etc. power generation unit costs using the financial statements of 12 electric utilities in Japan. Hydro power generation is the cheapest because most of the amortization has been completed. However, in case the generation facilities are newly constructed, the cost will become much higher.

Nuclear power generation cost is estimated to be 7.1 to 7.6 yen/kWh, taking into account the effect of amortization. This is considerably higher than the OECD's estimate, but much lower than thermal power generation costs. Fuel costs account for 70 to 80% of the thermal power generation cost. Thus heavy dependence on thermal power should be regarded as highly risky because the fluctuation of fossil fuel prices can affect easily and greatly the average power generation cost.

Due to nuclear power plant shutdown after the Fukushima Daiichi nuclear power plant accident and the rise in fossil fuel prices, the average power generation cost of Japan rose from 8.4 yen/kWh in FY2010 to 11.5 yen/kWh in FY2011. It will rise further to 12.5 yen/kWh in FY2012. The increase in annual fossil fuel purchase amount caused by the shift from nuclear to thermal power was around 1.4 trillion yen in FY2011. Thus the nuclear shutdown caused a great impact to Japan's economy.

## References

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