July 4,2011

Investigations for electricity supply outlook after the Tohoku Earthquake 1

－Effect of solar power generation system installation on electricity prices－

1. Introduction

There are many opinions on how electricity should be supplied after the Tohoku Earthquake. The composition of nuclear power generation will decrease for the time being in all scenarios. The effects of gradual installation on electricity prices and CO2 emissions were investigated here.

The number of scenarios will be increased and will be integrated into a comprehensive set of scenarios.

The cost of photovoltaic (PV) power generation is decreasing with the development of PV cell technologies and increasing market size, however, is still expensive compared to costs from existing power generation methods. Future development of technology and increase in market size will decrease the cost of PV power generation. The results of technological scenarios when current Si and CIGS (copper-indium-gallium-selenide) PV systems (Table 1) were used to calculate the effect of increasing PV system installation on electricity prices.

The calculation assumptions for the technological scenarios will be reported elsewhere.

Table 1. Cost of PV cells and cumulative installation

(yen/W)

	2011	2015	2020	2030
Factory plant size	1GW/year	1GW/year	5GW/year	5GW/year
Module	150	120	100	50
BOS	200	150	100	70
Entire system	350	270	200	120

※Output per existing plant reach 1GW/year, and there is small scale merit from increasing factory. Further cost reduction is mainly from technology breakthroughs.

※Details of each cost reduction will be analyzed further.

（Reference: Scenario of system implementation）

	2011	2015	2020	2030
Cumulative installation	4GW		38GW	80GW

(Source:LCS)

2. Scenarios with different nuclear power plant utilization

Four scenarios were considered.

・No nuclear power plants will be constructed, and the lifetime of existing nuclear power plants are set at 30 years.

・No nuclear power plants will be constructed, and the lifetime of existing nuclear power plants are set at 40 years.

・Continue using currently operate nuclear power plants that generate 17.4GW, and maintain this capacity even after the lifetime of existing plants end.

・Abandon all nuclear power plants

Fig. 1 shows the change in nuclear power plant capacity. The 40-year lifetime scenario excluded Fukishima-1 reactors 1 to 4 and Hamaoka reactors 1 and 2. The total power generation was set to 1000TWh per year in all scenarios. Hydropower generation was set to maintain the amount in 2007, and increase in PV power and decrease in nuclear power were adjusted by changes in thermal power generation where the ratio of oil, coal, and LNG fuel are set to be constant.

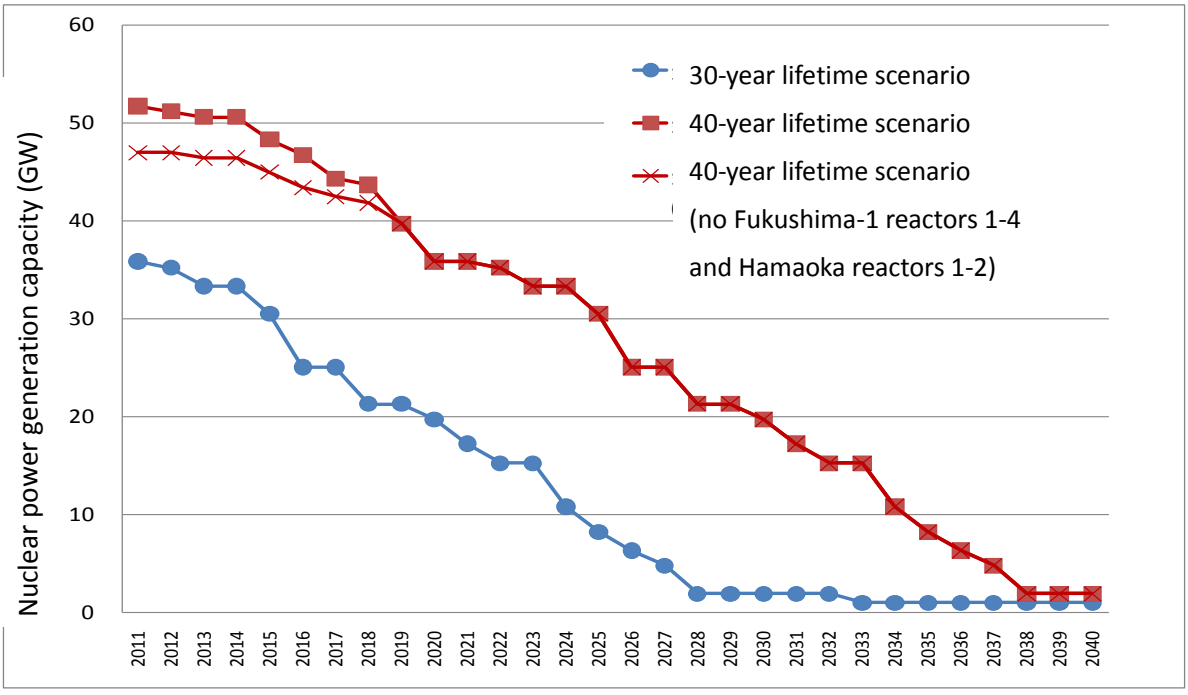

Fig. 1. Changes in nuclear power generation capacity

(Source: LCS)

3. Amount of installed PV systems and cost

The assumed amount of installed PV systems shown in Fig. 2 is based on the scenario on Table 1. The cost of PV generation systems shown in Fig. 3 was obtained using a retail price that is 1.2 times the cost of the system in Table 1, an expense ratio of 7%, and a lifetime of 20 years.

A feed-in tariff that is equal to the PV generation system cost was imposed, which was added to electricity prices from other power generation methods.

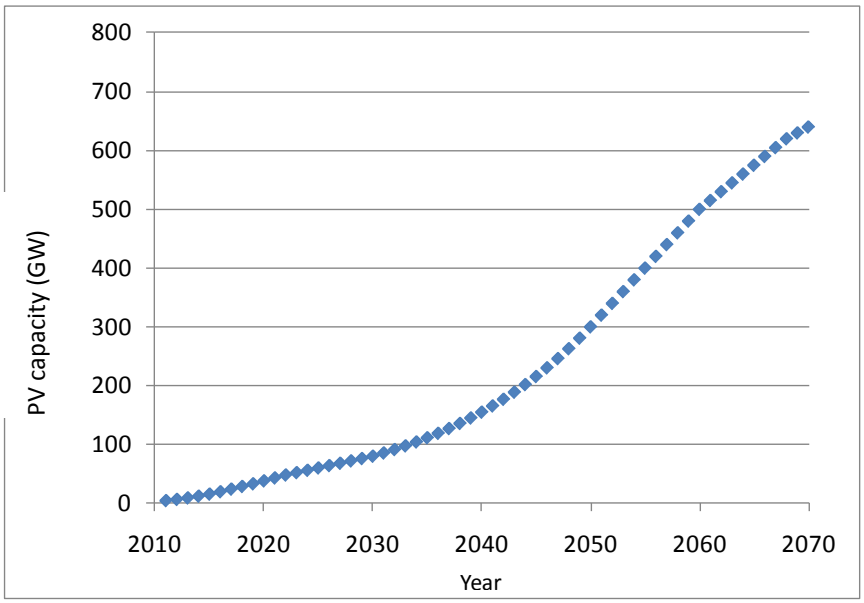

Fig. 2. PV capacity

(Source: LCS)

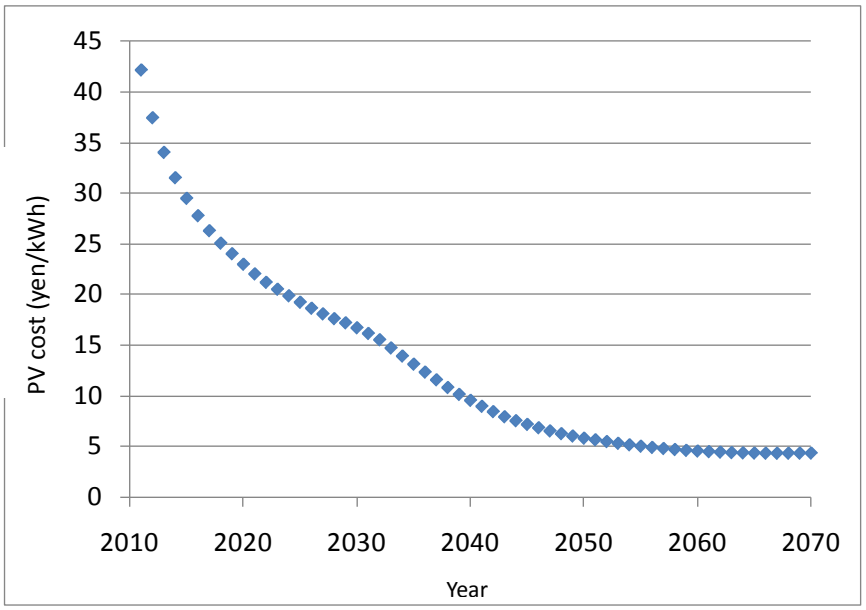

Fig. 3. PV power generation cost

(Source: LCS)

4. Power generation cost from existing generation methods

Power generation costs were broken down into costs for equipment, operation and maintenance, and fuel. The costs for equipment and operation and maintenance were based on data from the Subcommittee to Study Costs and Other Issues, Electricity Industry Committee, Advisory Committee for Natural Resources and Energy (January 16, 2004) with a 40-year statutory depreciation and a 3% discount rate. Fuel costs were calculated with power generation efficiencies and fuel prices in Tables 2 and 3.

The power generation costs used in the calculations is shown in Table 4. The power generation costs for 2007 calculated from the assumptions that were used is 10.1 yen/kWh.

Table 2. Power generation efficiencies for fuel cost calculation (sending end)

Oil	37.6%
LNG	47.4%
Coal	39.3%

Table 3. Fuel prices for fuel cost calculation

Oil	100	$/bbl
LNG	50000	yen/ton
Coal	120	$/ton

(Source: LCS)

Table 4. Power generation costs used in calculations

(yen/kWh)	Costs for equipment and operation and maintenance	Fuel cost	**Total**
Hydropower	11.9	0.0	**11.9**
Thermal-oil	11.2	12.6	**23.9**
Thermal-LNG	2.9	7.0	**9.9**
Thermal-coal	4.2	3.4	**7.6**
Nuclear	4.4	1.5	**5.9**

(Source: LCS)

5. Electricity prices in each scenario

The changes in electricity prices are shown in Fig. 4 and Table 5.

Electricity prices increases with the amount of systems installed because of the feed-in tariff for PV generation system costs. The prices increase by a maximum of 1.2 yen/kWh in the default scenario and by 1.9 yen/kWh in the scenario that abandons nuclear plants compared to

10.1 yen/kWh, the simulated price for 2007. Decrease of PV generation costs will result in the electricity prices becoming lower than when there is no PV generation by not later than 2047.

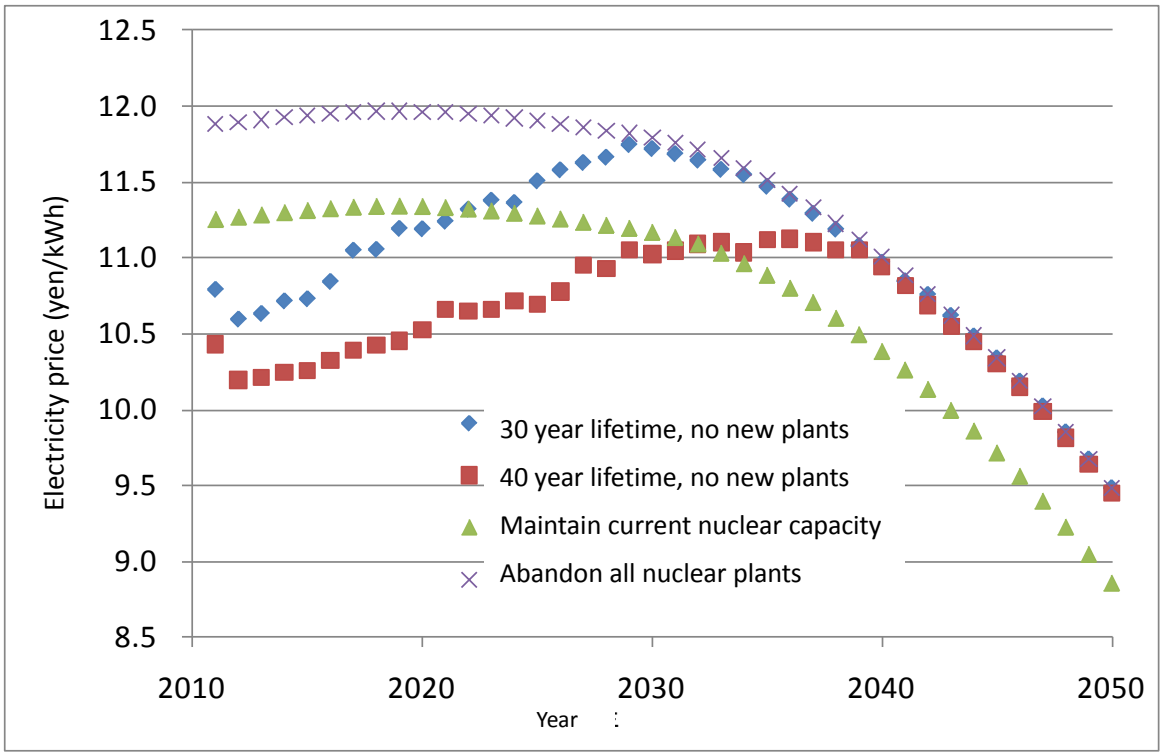

Fig. 4. Electricity prices when PV generation systems and feed-in tariff systems are installed
(Source: LCS)

Table. 5. Electricity prices when PV generation systems and feed-in tariff systems are installed (yen/kWh)

	30 year lifetime, no new plants	40 year lifetime, no new plants	Maintain current nuclear capacity	Abandon all nuclear plants	Share of PV power in total power	Increase in CO_2 emissions from power generation (abandon scenario)
	(yen/kWh)	(yen/kWh)	(yen/kWh)	(yen/kWh)	(%)	(Mt-CO_2/year)
2011	10.8	10.4	11.2	11.9	0.4	200
2015	10.7	10.3	11.3	12.0	1.6	193

2020	11.2	10.5	11.3	12.0	4	178
2030	11.7	11.0	11.2	11.8	8	151
2040	11.0	10.9	10.4	11.0	16	102
2050	9.5	9.4	8.9	9.5	30	8
2060	7.5	7.5	6.9	7.5	50	-122
2070	6.2	6.2	5.6	6.2	64	-213

(Source: LCS)

(Note) CO_2 emissions per 1kW generated was based on data from the Central Research Institute of Electric Power Industry (Evaluation of lifecycle CO_2 emissions by power source, No.468, August 2010). Specific amounts, which included indirect emissions, are hydropower—11, oil—738, coal—943, LNG (average of combined and steam)—537, nuclear—20 g-CO_2/kWh.

6. CO2 emissions

CO_2 emissions are maximized when there are no nuclear plants. Emissions increase by 200Mt-CO2 in the initial stages when not much PV systems are installed, and emissions become less than the current amount after 2050, when PV systems provide 30% of the electricity. Energy savings must be promoted in all areas, not only in thermal power generation, to reduce CO_2 emissions. Specific plans will be published later.

7. Sumamry

Increasing the share of PV power generation in total power supply from 4% to 16% from 2020 to 2040, abandoning nuclear power generation, and using thermal generation to supply the deficiency will result in an average increase in electricity by about 1.4 yen/kWh (about 1.4 trillion yen per year). However, electricity prices will become lower than the current prices after 2047.

We have provided a scenario where the installation outlook by the government was accelerated by about 1.5 times. Power supply scenarios that take into account the advances in thermal power generation (an example is fuel cell combined generation), economy, and CO_2 emissions will be considered in the future.