AN ECONOMICS SIMULATION ON THE SMART COMMUNITY CONNECTING THE COMMERCIAL AND RESIDENTIAL SECTORS

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Overview

Recently Japanese Government has determined the new target of GHGs reduction to achieve 26% reduction from the emission level in 2013 up to 2030. Because of the East Japan great earthquake and Fukushima nuclear accident, the discussions on the reduction target of GHGs were wandered so largely in recent 4 or 5 years and finally converged into the above-mentioned conclusion. However, in the long-run, Japan must intensify her GHGs reduction measures basically, because she already agreed 50% (or 80%) reduction of GHGs in 2050 in the past several Summits etc. In addition, the Paris agreement on post Kyoto GHGs reduction was finally approved by many countries including various developing countries in December 2015.

The GHGs emissions in Japan have increased to the large extent from the 1990 level (the base level in Kyoto Protocol), though the first commitment period of Kyoto Protocol finished in 2012. Especially, the continuous increases in GHGs emission in the commercial and residential sectors were largely influenced to the whole increases in Japan.

In recent years, the progress of information and communication technologies such as cloud computing is very remarkable. The storage system of electricity such as NAS and redox flow batteries is also being made a large progress. Therefore, in this study, we would like to analyze economics of smart community connecting the commercial and residential sectors using photovoltaic cell (PV) and electricity storage system (ESS) under various conditions including cost improvements. We also would like to discuss the future subjects of smart community.

Methods

In this study, we made economics simulations on the introduction of smart facilities such as photovoltaic cell and electricity storage system as important functions of smart community connecting the commercial and residential sectors. First of all, the average electricity demand pattern in the commercial and residential sectors was estimated by month based on the METI survey report [1], EDMC survey data [2] and Cogeneration Comprehensive Manual [3]. We also surveyed present situations on photovoltaic cell, and electricity storage system on the basis of NEDO and METI reports [4, 5]. The average daily pattern of solar power generation was estimated by month using NEDO Sunshine Database [6].

The number of house holds in the residential sector was assumed to be 1,000 and the total floor area in the commercial sector was also assumed to be 25,000 m^2. The capacity of PV for each house in the residential sector was assumed at 4 kW. In the simulation, first, we determined the starting point where purchased electricity from power company outside could be made absolutely zero (a kind of extreme case). There were two cases: one was PV maximum (PV capacity 40,000 kW and ESS capacity 20,000 kWh) and the other was ESS maximum (ESS capacity 39,000 kWh and PV capacity 5,500 kW). We made various simulations by reducing both PV and ESS capacities from these starting points.

The various differences of electricity charge between daytime and night were assumed. The economics of the introduction of smart facilities is judged from the simple payback years which is calculated by dividing the net initial cost (excluding cost covered by the subsidy) of necessary equipments by the annual profit brought by the reduction of purchased electricity.

Results

Figure 1 shows the simulation results on PV maximum case. In this case, the simple payback years is estimated 10 or lower than 10, because the sales revenue of PV electricity to power company outside by FIT system is used for the investment recovery of required ESS and PV capacities. But if the acceptance PV electricity price by FIT is lowered to 7 Yen/kWh, the economics of this case will become worse (more than 20 payback years) rapidly, as shown in Fig. 1. If the acceptance price is lowered, the cost reduction of PV and ESS sysytem will be required, also shown in Fig. 1.

Figure 2 shows the simulation results on ESS maximum case. In this case, the simple payback years is estimated about 30 years at the staring point because of large ESS capacity. If ESS capacity is lowered, the economics of this case will improve rapidly. On the contrary, if PV capacity is lowered, the economics of this case will become worse because of the sales revenue of PV electricity by FIT. If the acceptance PV electricity price by FIT is lowered to 7 Yen/kWh, the economics of this case will also become worse (more than 35 payback years) rapidly at the starting point, as shown in Fig. 2. Thus, the cost reduction of PV and ESS sysytem will be also required.

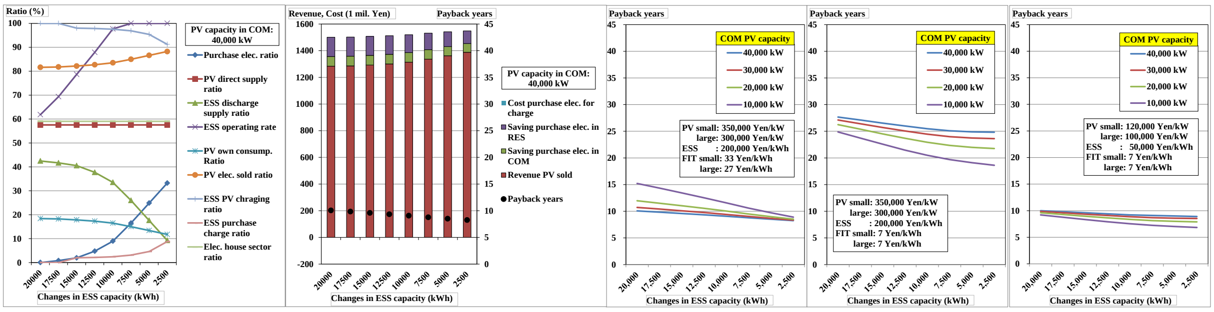

Fig. 1 Changes in electricity supply indicators and payback years in the PV maximum case

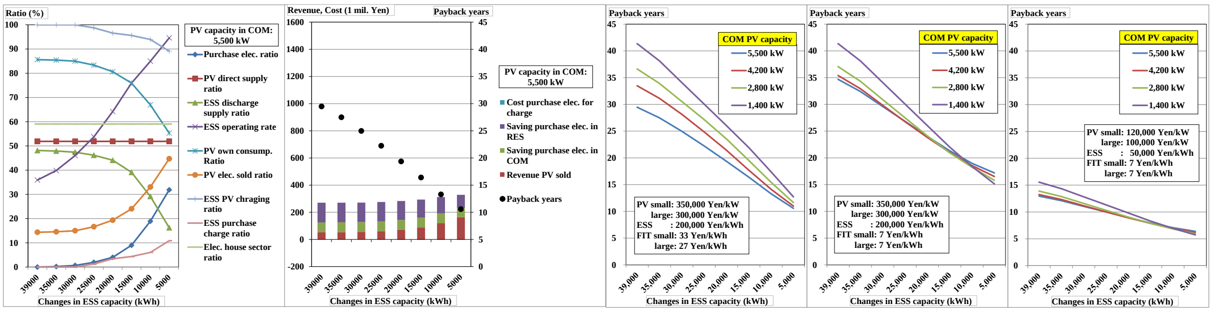

Fig. 2 Changes in electricity supply indicators and payback years in the ESS maximum case

Conclusions

The special environment brought by the preferable acceptance price of PV electricity by FIT makes large distortion to the decision making of investments to smart community. We need to reconsider desirable and sustainable FIT system more carefully.

For the expansion of smart community connecting the commercial and residential sectors, the cost reduction of smart facilities are quite important as a future subject. Of these, the cost reduction of the electricity storage system would play a essential role particularly from the viewpoint of technology innovation.

It is essential to strengthen peoples' incentives to smart community connecting the commercial and residential sectors from the viewpoints of policy. The smart community would be expected to influence to peoples' life style in the future. We need to pursue self-sufficiency of electricity supply more profoundly.

References

1. METI [2012], "Survey report on energy consumptions in the residential sector," http://www. meti.go.jp/ meti_lib/report/2012fy/E002203.pdf, (referred on April 20, 2014), March 2012.
2. EDMC [2014], "Energy Statistics 2014," Energy Conservation Center, 2014
3. ACEJ [2004], "Comprehensive manual on cogeneration system," Tsusan-shiryo-shuppannkai, 2004.
4. NEDO [2009], "Photovoltaic Cell Road Map (PV2030+)," http://www.nedo.go.jp/content/ 100116421.pdf, (referred on Jan 20, 2014), June 2009. METI [2013], "Survey report on movements of introduction of photovoltaic cells etc." http://www.meti. go.jp /meti_lib /report/2013fy/E002502.pdf, (referred on Jan 20, 2014), February 2013. JPEA [2013], "JPEA PV Outlook 2030," http://www. jpea.gr.jp/pdf/pvoutlook2013-1.pdf, (referred on Jan 20, 2014), December 2013.
5. METI [2010], "Future prospect on electricity battery industry," http://www.meti.go.jp/ report/downloadfiles/ g100519a02j.pdf, http://www.meti.go.jp/report/downloadfiles/g100519a03j. pdf, (referred on April. 20, 2014), May 2010. NEDO [2010], "Battery Road Map 2010," http://www.meti.go.jp/report/downloadfiles/g100519a05 j.pdf, (referred on April. 20, 2014), May 2010. NEDO [2013], "Battery Road Map 2013," http:// www.nedo.go.jp /content/100535728.pdf, (referred on Jan. 20, 2014), August 2013.
6. NEDO [2006], "Sunshine database," http://www.nedo.go.jp/library/nissharyou.html, (referred on Jan 20, 2014), 2006.