Secondary Battery System (Vol.7): Evaluation of the Economics of Power Storage Systems; Efficiency, Costs and Future Challenges

Power storage systems that respond to fluctuations in output due to weather conditions are essential when adopting natural energy as a method to reduce carbon dioxide emissions. A cost model for a power storage system that utilizes batteries was developed, assuming that the batteries would be charged and discharged to their rated capacity at their rated output once a day for 330 days a year. This allowed for calculations of efficiency and cost of various battery types.

- In contrast to our former study of battery cost only, the system operator is assumed, and the calculation is performed by considering the facility cost, operating cost, and battery life (Table 1).
- The NAS battery system had the lowest cost per capacity and per cycle at 24 JPY/kWh/cycle. It is still expensive to store the surplus power from natural energy.

Table 1: Storage costs of power storage systems for various battery types [1 - 4]

			LCS assumed system	Tehachapi project	Minami-Soma secondary battery substation report	Nishi-Sendai secondary battery substation report	LCS assumed system	Buzen secondary battery substation operations report	LCS assumed System	Minami-Hayakita secondary battery substation report
	Secondary battery type		LIB (ternary system)	LIB (ternary system (LG))	LIB (SCiB)	LIB (SCiB)	NAS	NAS	Redox flow	Redox flow
	System rating	MW/MWh	10/40	8/32	40/40	20/20	10/40	50/300	10/40	15/60
Total costs (costs + conversion loss)		JPY/kWh/cycle	43	68	90 - 95	95 - 162	24 - 33	30	24 - 38	67, 89 - 106
Costs (fixed costs + variable costs)		JPY/kWh/cycle	41	65	88 - 90	92 - 151	19 - 29	25	21 - 35	61, 84 - 98
Conversion loss		JPY/kWh/cycle	2	3	2 - 6	3 - 11	5	5	3	5
	Capacity reduction rate	% per year	2.5	3.9	1.0	1.0	1.0	1.0	0.4	0.4
	Number of dischargeable cycles	Cycles	2,640	1,980	6,600	6,600	5,000 - 6,600	6,600	5,000 - 13,200	6,600 - 13,200
	Service life	Years	8	6	20	20	15 - 20	20	15 - 20	20
	System price	Million JPY	2,900	2,827	12,312	9,936	2,000 - 2,800	22,680	4,320	17,300

Proposals for Policy Development

Improvements to the efficiency of peripheral devices and battery management systems as well as the efficiency of batteries themselves are necessary for the cost reduction of the system.

1) The LIB (ternary system) needs to be improved cycle characteristics, while the LIB (SCiB) needs reductions in battery cost. It is also important to improve efficiencies of the pack/module through utilizing new electrode materials and enlarging the unit cell size.
2) It is desirable to widen the operating conditions of charging and discharging for the NAS system. A lower cost will be possible for the redox flow system by improving the charge/discharge efficiency and the circulation system. However, few researchers and companies are working in these fields. Policies such as promoting open innovations are necessary to leverage the potentials in these systems.

[1] Southern California Edison, “Tehachapi Wind Energy Storage Project: Technology Performance Report #1, #2, #3", DE-OE 0000201 (Dec. 2014, Feb. 2016, Dec. 2016).
[2] New Energy Promotion Council, FY 2016 Accomplishment Report, " Demonstration project for a large scale power storage system to improve supply and demand balance: Demonstration project for a secondary battery system to improve supply and demand balance at Minami-Soma Substation ", Tohoku Electric Power Company, Feb. 2017, and “at Buzen Secondary Battery Substation", Kyushu Electric Power Company, Feb. 2017.
[3] Ibid, FY 2017 Accomplishment Report, ”Emergent demonstration project for in a large scale power storage system: Demonstration project for a power storage system as a countermeasure for frequency fluctuations at Nishi-Sendai Substation", Tohoku Electric Power Company, Jan. 2018.
[4] Ibid, Accomplishment Report, ”Emergent demonstration project for a large scale power storage system: Demonstration project for a large scale power storage system at the Minami-Hayakita Substation", Hokkaido Electric Power Company and Sumitomo Electric Industries, Jan. 2019.