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Secondary battery energy storage system enabling use of renewable energy to realize a zero CO_2 emission society

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Abstract
Secondary battery energy storage systems (ESSs) for unstable renewable energy sources are expected to be installed to realize a zero CO_2 emission society. ESSs are used to stabilize the power grid, mitigate a lack of electric transmission capacity, assist power control of thermal generation, stabilize load, shift and shave peak load, and provide a backup against blackouts. ESSs are particularly useful for stabilizing power grids containing photovoltaics (PVs) and wind farms (WFs). Smart grids on isolated islands and small areas cannot be operated without ESSs. In Japan, there are four large-capacity secondary battery ESSs, which contain lithium ion, vanadium redox-flow, and sodium-sulfur batteries, and have a capacity of several tens of megawatt hours for stabilizing the power grid against unstable PV and WF production. On the isolated Japanese island of Oki, PVs and WFs supply electric power along with diesel power generators. The installation of hybrid ESSs with lithium ion and sodium sulfur batteries can stabilize the power grid and decrease CO_2 emissions. Lithium ion battery ESSs have high efficiency, are compact, and operate at room temperature. However, several fires in lithium ion secondary battery ESSs have been reported that were particularly severe because the battery capacities were large, and thus large amounts of flammable electrolytes were stored in a small area. The safe production and operation of secondary batteries is crucial, so the Japan Electric Association (JEA) established Japan Electric Association Code (JEAC) 5006-2014 “Battery for Power Storage System,” which prescribes isolation distance, electrolyte amount, and the maintenance of firefighting equipment. However, these guidelines mean that lithium ion battery ESSs require a vast footprint. To date, there have been no ESS fires in Japan. The fire safety of secondary batteries should be improved to facilitate the widespread installation necessary for a zero CO_2 emission society. The development of all-solid-state batteries is desirable because they are not flammable. All-solid-state battery ESSs would have a smaller footprint and could be installed underground in urban buildings. The independence of urban power supply and demand is ideal for electric power generation by roof-top PVs, the energy output of which could be managed with all-solid-state battery ESSs located underground.