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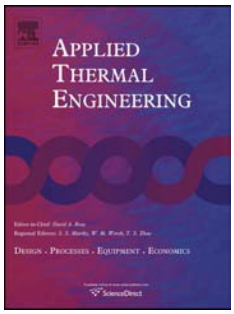

Autonomous scheduling of heat-pump water heaters for mitigating voltage rise caused by photovoltaic power generation systems

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Autonomous scheduling of heat-pump water heaters for mitigating voltage rise caused by photovoltaic power generation systems

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ABSTRACT

For mitigating negative impacts of high-penetration photovoltaic power generation system (PVS) on electric power system, sufficient capability for adjusting the apparent load fluctuation including PVS power supply as negative load is needed. The increase in the daytime electricity consumption, which follows the change in the aggregated power supply of high-penetration PVS, would be essential measure against negative impacts.

In this study, we focus on the daytime operation of a heat pump water heater (HPWH) as one of measures, and introduce a brief idea for autonomously scheduling the daytime operation of individual HPWH so that the change in the aggregated electricity consumption by a number of HPWHs follows the irradiance change in a day.

By using the electricity and hot-water consumption data for a year, we demonstrate the effect of daytime operation in terms of the voltage rise mitigation in a power distribution network caused by the reverse power flow from high-penetration PVS. The result shows that the voltage rise can be mitigated by applying the daytime operation to HPWH of a household with PVS, while the under-voltage condition due to the unnecessary daytime operation can be avoided based on the next day weather forecast.

Highlights

> Autonomous scheduling of HPWH to shape the aggregated electricity pattern is proposed.
> Aggregated electricity follows daily change in power supply of PVS.
> Decision index for daytime operation based on weather forecasting was introduced.
> Proposed method was tested by using electricity and hot-water data at 10 households.
> Proposed method was effective to mitigate voltage rise caused by reverse power of PVS.

Keywords: photovoltaic power generation system, heat-pump water heater, electric power