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Operation optimization strategy of a BIPV-battery storage hybrid system

摘要

建筑光伏一体化（BIPV）系统具有环保、节约土地资源等优点，越来越受到研究者的关注，将蓄电池与 BIPV 相结合可以提高整个系统的灵活性，对于分布式可再生能源应用具有广阔前景。然而，如何根据建筑负荷最优调度光伏板、储能电池和电网的每小时能量流动至关重要，但研究较少。本文建立了一个多约束条件下的非线性优化模型，用于在晴天不同建筑负荷下 BIPV-电池储能混合系统。该优化模型通过 MATLAB 代码中的 fmincon 函数求解。在优化过程中，考虑了包括混合系统的设施成本、电价和碳价在内的总体最低日成本作为目标函数，以获得光伏、电池和电网每日电力分配的最佳运行策略，满足日常建筑需求。研究结果表明，当办公楼负荷较重时，系统对电网的高度依赖性增加；而随着电力需求减少，这种依赖性降低。在满载居民建筑场景下，当系统电池成本为 800 元/kW 时。当电压达到或超过某个水平时，光伏（PV）产生的多余绿色电力会实时售电给电网以赚取额外利润，同时绿色电力会在储能电池中累积，因为储能电池的成本正在下降。此外，采用 BIPV 电池储能混合系统的住宅建筑在白天对电网的依赖减少，可以实现自给自足。在所有情况下，高昂的储能电池成本限制了储能电池的容量。而随着 BIPV 电池储能混合系统的采用，二氧化碳排放量也得到了减少。

关键词

建筑光伏一体化储能系统；优化策略；办公楼负载；居民楼负载

Abstract

Building integrated photovoltaic (BIPV) system attracts increasing attention of researchers due to environmentally friendly and saving land resource. Combining storage battery with BIPV can improve the flexibility of the entire system, which is promising for distributed renewable energy application. However, how to optimally dispatch the hourly energy flow of PV panel, storage battery and power grid based on a building load is crucial and less investigated. In the paper, a multi-restricted condition nonlinear optimization model is established for a BIPV-battery storage hybrid system under different building loads at a clear day. The optimization model was solved by fmincon function through MATLAB code. In the optimization, overall minimum daily cost including facility cost of the hybrid system, electric price and carbon price were considered as objective function to obtain optimal operation strategy of hourly power distributions of PV, battery and grid for daily building consumption. The key finding indicates that the system has high dependence on power gird when the office building load is heavy, while reduces the depending of power grid as the electrical demand is decreased. Under full-load resident building scenario, when the system with battery cost of 800 Yuan/kW·h or higher, the redundant green power generated by photovoltaic (PV) is sold to power grid in real time to earn extra profit, while the green power is accumulated in the storage batteries as storage battery cost is declined. Moreover, the resident building with BIPV-battery storage hybrid system has less dependence on power gird during day time, realizing self-sufficiency. Under all the scenarios, high storage battery cost limits the capacity of storage battery. And the CO2 emission is reduced as the BIPV-battery storage hybrid system is adopted.

Keywords

BIPV-battery storage system; optimization strategy; office building load; resident building load

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