

Integrated Optimization of Charging Infrastructure, Renewable Energy and Battery Electric Bus Scheduling Subject to Power Distribution Network Constraints

In response to this environmental challenge, Battery Electric Buses (BEBs) have emerged as one of the significant contributors to this transition, offering a viable and eco-friendly alternative to traditional fossil fuel-based public transit. However, the adoption of BEBs in electric public transit systems poses challenges to the coupled electric transport and energy systems, particularly concerning the safety and efficiency of Power Distribution Networks (PDN) due to the incorporation of charging infrastructures. The most sustainable approach to mitigate the adverse impact of charging demands is to boost the PDN infrastructure by renewable energy resources. Hence, this study introduces a comprehensive BEB-PDN framework designed for the joint optimization of charging infrastructure, charging scheduling, and incorporation of the set of renewable energy sources and battery storage systems, with a particular emphasis on their impacts on PDN as shown in the following figure. To develop an integrated framework, we have coupled a BEB sub-transit system in Skövde, Sweden, with the IEEE 33-node standard test case for the PDN. The results demonstrate that without renewable energy integration, high charging demands from BEBs can lead to PDN safety violations, such as significant voltage drops at vulnerable nodes. The incorporation of renewable energy sources with battery energy storage in the BEB transit system is shown to enhance the PDN's safety while catering to the system's spatiotemporal charging demands.

