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Two-stage energy management framework of the cold ironing cooperative with renewable energy for ferry

Abstract

The cold ironing system is gaining interest as a promising approach to reduce emissions from ship transportation at ports, enabling further reductions with clean energy sources coordination. While cold ironing has predominantly been applied to long-staying vessels like cruise ships and containers, feasibility studies for short-berthing ships such as ferries are limited. However, the growing demand for short-distance logistics and passenger transfers highlights the need to tackle emissions issues from ferry transportation. Incorporating electrification technology together with integrated energy management systems can significantly reduce emissions from ferry operations. Accordingly, this paper proposes a cooperative cold ironing system integrated with clean energy sources for ferry terminals. A two-stage energy management strategy combining sizing and scheduling optimization is employed to reduce the port's emissions while minimizing system and operational costs. The proposed system configuration, determined through the sizing method, yields the lowest net present cost of $9.04 M. The applied energy management strategy managed to reduce operational costs by up to 63.402 %, while significantly decreasing emissions from both shipside and shoreside operations. From the shipside, emissions reductions of 38.44 % for CO_2, 97.7 % for NO_X, 96.69 % for SO_2, and 92.1 % for PM were achieved. From the shoreside, the approach led to a 28 % reduction across all emission types. Thus, implementing cold ironing powered by clean energy sources is a viable solution for reducing emissions generated by ferry operations. The proposed energy management approach enables emissions reduction and delivering cost-effectiveness at ferry terminals.

Keywords

Cold ironing; Energy management system; Ferry charger; Optimization; Ship transportation; Sizing