

On the Development of Microgrids for the Smart Ports

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Abstract

This paper explores microgrids' application at ports and presents a systematic framework for evaluating the benefits of microgrid integration in creating sustainable value through purposeful planning. We focus on demonstrating how a set of Smart Port Index (SPI) metrics can be incorporated into the port microgrid planning process in the proposed framework to holistically improve the smartness of the port. A two-stage stochastic mixed-integer programming model is developed to explain how the use of microgrid at a port can effectively enhance the port's performance in four key activity domains: operations, environment, energy, safety and security under operation uncertainty. The proposed model consists of an investment master problem on the first stage and a multi-objective operation planning subproblem on the second stage. Benders decomposition is implemented for solving the two-stage stochastic model, and Lexicographic Goal Programming is applied to the subproblem to deal with multiple objectives. Simulation results, compared with the minimum cost planning approach, indicate that the proposed framework is capable of guaranteeing an improvement in productivity, sustainability, and reliability of port operations