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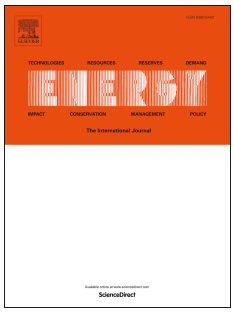

Tradeoffs between revenue and emissions in energy storage operation

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Tradeoffs between revenue and emissions in energy storage operation

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Abstract

Grid-level energy storage is an emerging technology that provides operational flexibility for managing electricity demand, integrating renewable energy, and improving system reliability. However, it has been established that revenue-maximizing grid-level energy storage tends to increase system emissions in current US electricity grids. In this work, we consider storage operational strategies that value both revenue and CO_2 emissions to understand the tradeoffs between these two criteria. We use actual electricity prices and marginal emissions factors in a linear programming model that optimizes operation between annual revenue and CO_2 emissions to find the Pareto Frontier for 22 eGRID sub-regions. We find that, in many US regions, marginal storage-induced CO_2 emissions can be decreased significantly (25-50%) with little effect on revenue (1-5%). Electricity grids with larger flexibility in daily electricity prices and in marginal emissions factors have more potential to reduce annual storage CO_2 emissions at low cost to storage operators. These results show that negative environmental effects of storage operation can be reduced or eliminated at low cost through voluntary or regulatory shifts in operational patterns.

Key words: energy storage, marginal emissions, electricity system, CO_2

Highlights:

-Existing literature agrees that revenue- or value-maximizing energy storage increases electricity system emissions

-We use a linear programming model of storage operation that values both revenue and CO_2 emissions

-Marginal storage-induced emissions can be drastically reduced (~50%) with little loss of revenue

-Increasing the round-trip efficiency of storage provides more capability to reduce storage-related emissions at low cost

Introduction:

Energy storage refers to various technologies, such as pumped hydro, compressed air energy storage (CAES), and batteries, used to store electrical energy. Grid-level energy storage can provide a variety of benefits to electricity systems, from renewable energy integration to frequency regulation, but can generally be considered a tool for increasing operational flexibility of the grid [1], [2]. While still an emerging technology, grid-level energy storage is a promising solution for modernizing the electricity grid and integrating cleaner energy sources such as wind and solar power.