ABSTRACT

Induced Carbon Emissions from Energy Storage in an ERCOT-Like Market

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Energy storage systems (ESS) have the potential to reconfigure how the electricity system is used, operated, and extended. ESS can be dispatched to enhance reliability, enable renewables, or make money. While much has been written about the first two applications, batteries are generally used for the third. Unfortunately, these economic applications are thought to *increase* grid emissions today. This needn't be so: an increase in emissions caused by a battery's inefficiency can be offset if that battery is able to displace highly-emissive generators.

In this paper, I explore different system resource mixes and ESS dispatch modes that enable carbon-neutral operation of energy storage. Specifically, I assess the induced carbon emissions that a 1MW/4MWh ESS would induce if it were dispatched for three different applications in 16 ERCOT-like markets. The analysis occurs in two parts: first, a unit-commitment model is used to generate counterfactual hourly market data, where renewables range from 17% to 81% of total energy production; second, battery dispatch algorithms are run on the simulated market data to assess emissions effects. ESS dispatch models are developed for energy arbitrage (EA), demand charge management (DCM), and carbon minimization (MinCO2).

I find that energy storage is carbon neutral in electric systems generate 17% to 40% of annual energy from renewables, depending on dispatch mode. Carbon emissions vary significantly between dispatch modes and resource scenarios. In general, (1) DCM on a time-of-use rate increases emissions; (2) EA generally reduces emissions; (3) MinCO2 and DCM on real-time pricing always reduce emissions. All economic dispatch of ESS attains only a portion of the maximum achievable environmental benefits, with MinCO2 reducing emissions by an average of 494lbs/MWh-stored than the least emissive economic dispatch mode. In addition, I find greater exposure to wholesale energy prices generally reduces induced emissions and that retail rate designs that encourage price exposure can reduce the carbon footprint of ESS without loss of economic benefit. These results indicate that the emissions induced by ESS should mitigate themselves as the regulators encourage more efficient energy consumption and as the electricity system gets greener.

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