COMPRESSED AIR ENERGY STORAGE AND GEOGRAPHIC AGGREGATION: MUTUALLY REINFORCING STRATEGIES FOR INTEGRATING WIND POWER

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ABSTRACT

By leveraging the geographic diversity of wind energy resources, the cost and emissions of baseload wind systems can be significantly reduced as a result of reduced capital cost requirements for balancing aggregated wind resources. Specifically, re-optimizing the compressed air energy storage (CAES) configuration, including the relative capacity of the compression and turboexpander trains as well as the storage capacity of the geologic reservoir, in response to changes in wind resource characteristics yields significant capital cost reductions for the CAES system, which translates into lower levelized costs for baseload power from wind/CAES as well as reduced carbon emission intensities.

Compressed air energy storage (CAES) is a bulk storage technology well suited for wind-firming applications. Collocation and co-optimization of CAES and wind can enhance transmission line utilization, reduce the levelized cost of the combined system, and allow variable resources to serve a broader set of market functions. This analysis shows that the incorporation of geographic aggregation into the optimization framework for a hybrid wind/CAES baseload facility yields significant cost and performance benefits.

By leveraging the geographic diversity of wind energy resources, the cost and emissions of baseload wind systems can be significantly reduced as a result of reduced capital cost requirements for balancing aggregated wind resources. Specifically, re-optimizing the CAES configuration, including the relative capacity of the compression and turboexpander trains as well as the storage capacity of the geologic reservoir, in response to changes in wind resource characteristics yields significant capital cost reductions for the CAES system, which translates into lower levelized costs for baseload power from wind/CAES as well as reduced carbon emission intensities.

This approach results in significantly reduced carbon entry prices for Wind/CAES relative to alternative low carbon baseload systems and enables CAES to more cost-effectively balance wind output relative to conventional thermal generation. This suggests that resource aggregation and energy storage can be mutually reinforcing strategies for integrating wind and that their combination can reduce the cost of achieving very high wind penetrations relative to the pursuit of a single integration strategy.

BIOGRAPHICAL NOTE

Conference presenter: Samir Succar is part of the National Resources Defense Council's (NRDC's) Center for Market Innovation based in New York. Mr. Succar's work focuses on the integration of renewable energy and the role of transmission and distribution infrastructure upgrades, demand resources, energy storage, and other enabling technologies. Before joining NRDC, he was a member of the research staff of the Energy Systems Analysis group at the Princeton Environmental Institute of Princeton University, where his research focused on integration issues associated with utility-scale renewable energy and on enabling technologies for intermittent generation. A key focus of this work is the implementation of energy storage as a strategy for enhancing transmission infrastructure utilization and mitigating the intermittency of renewable energy with particular attention to compressed air energy storage and other bulk storage technologies. Previously Mr. Succar worked at the Princeton Macroelectronics Group developing fabrication methods for solution processed organic thin film transistors and at Schlumberger ATE developing charged particle optics for voltage contrast defect detection systems. He received a B.A. from Oberlin College and a Ph.D. in Electrical Engineering from Princeton University.