

SMALL-SCALE SCALABLE COMPRESSED AIR ENERGY STORAGE SYSTEM WITH THERMAL MANAGEMENT

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Compressed air energy storage (CAES) is a promising technology for applications at sizes between utility scale and single-family home. Because of size-dependent costs and efficiencies in the expansion turbines, and in the air storage vessels, the costs do not scale with size from the utility-scale range (200 to 300 megawatts [MW]). Studies presented in this report focus on small-scale systems with thermal management. The small-scale system constructed is designed to provide 3 hours of operation at 10 kilowatts (kW) using a novel expansion turbine that is optimized to deliver high efficiency at that size. Air storage is conducted above ground in steel vessels. All components are designed to be scalable up to 10 MW.

Thermal management is practiced whereby the heat of compression from a three-stage compressor is recovered and stored, then used to heat up the compressed air before injection into the expansion turbine. This is designed to reduce consumption of natural gas in the expansion turbine. Cost analyses and optimized combinations of grid and CAES and combinations of grid, CAES, and single-axis tracking photovoltaic (PV) scenarios are presented to show the value of decreasing natural gas consumption in CAES on the economics of providing suitable energy production to meet demand on hot summer days in Tucson, Arizona.

The paper presents the following studies:

- Optimization calculations for resource mixes of grid and CAES and for grid, CAES, and single-axis tracking PV to meet demand load in summer with associated cost for producing electricity with varying avoided costs and with different natural gas consumption.
- Optimized design of a small-scale CAES system with thermal management.
- Calculated expected performance results of using the optimized design with analysis of cost.
- Measured performance of the optimized system in a grid-tied scenario and analysis of the various parts of the CAES system to determine areas of improvement.

