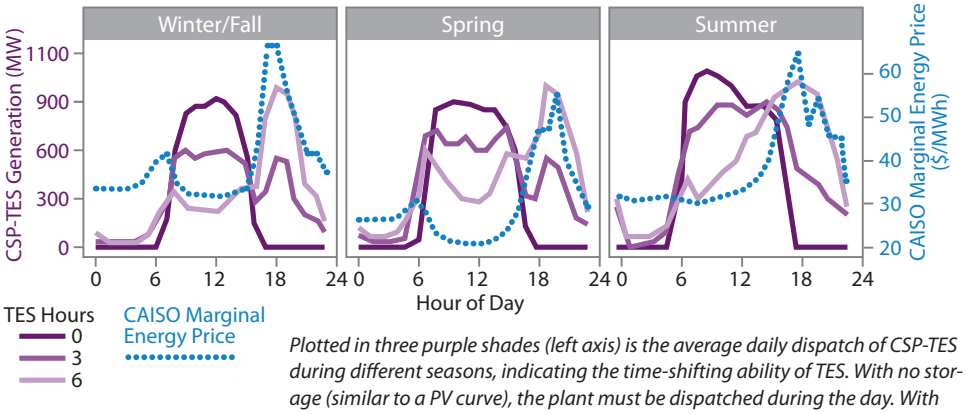
NREL
NATIONAL RENEWABLE ENERGY LABORATORY

NREL Quantifies Value of CSP to the Grid

Highlights in Research & Development

In California study, greater penetration of renewable energy means greater value of CSP with thermal energy storage.

The penetration of variable-generation renewable energy sources is growing in the state of California. To help utility planners understand the potential impact of this situation, researchers at the National Renewable Energy Laboratory (NREL) analyzed concentrating solar power (CSP) with thermal energy storage (TES), looking at the value of both CSP-TES and utility-scale photovoltaics (PV).



Plotted in three purple shades (left axis) is the average daily dispatch of CSP-TES during different seasons, indicating the time-shifting ability of TES. With no storage (similar to a PV curve), the plant must be dispatched during the day. With increasing energy storage, the plant dispatch follows the marginal energy price of the California Independent System Operator (dotted blue curve, right axis).

Two values were of special interest. First was the "operational value," which represents the avoided costs of conventional generation and includes fuel costs, start-up costs, variable operation and maintenance costs, and emission costs. The second was the "capacity value," which reflects the ability of PV or CSP-TES to avoid the cost of building new conventional thermal generators in systems that need capacity in response to growing energy demand or plant retirements.

NREL compared the total operating costs of a system with and without an incremental amount of CSP-TES or solar PV, and also analyzed capacity value. In the NREL analysis, CSP—with its ability to store and dispatch energy for several hours or more—helps maintain firm capacity in the hours when the sun is not available. Compared to non-dispatchable PV, the combined operational and capacity value translates to an increase in value of 5 cents per kilowatt-hour to utility-scale solar energy in California under the 2020-mandated 33% renewable portfolio standard (RPS), or 6 cents per kilowatt-hour under a 40% RPS.

By providing renewable electricity into the evening hours, CSP-TES allows greater PV and wind penetration by reducing the need to curtail generation by these technologies.

More robust estimates of the impact of increased penetration of PV on capacity value are needed. Furthermore, the analysis of capacity value shows an interaction between the capacity value of PV and CSP that warrants additional analysis.

Technical Contact: Mark Mehos, *mark.mehos@nrel.gov*

Reference: Jorgenson, J.; Denholm, P.; Mehos, M. (2014). *Estimating the Value of Utility-Scale Solar Technologies in California under a 40% Renewable Portfolio Standard*. NREL/TP-6A20-61685. *www.nrel.gov/docs/fy14osti/61685.pdf.*

Key Research Results

Achievement

In a study for California, NREL compared total operating costs of a system with and without an incremental amount of CSP-TES or solar PV; NREL also analyzed capacity value.

Key Result

When compared to variable-generation PV, CSP-TES is estimated to provide an additional value of 5 cents per kilowatt-hour to utility-scale solar energy in California under the 2020-mandated 33% RPS, or 6 cents per kilowatt-hour under a 40% RPS.

Potential Impact

As the penetration of renewables rises, so does the relative value of CSP due to its continued ability to generate during periods of peak demand. This capability means that CSP-TES can reliably serve California's desire for clean energy, while minimizing the impact on its regional grid.

NREL is a national laboratory of the U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, operated by the Alliance for Sustainable Energy, LLC.

15013 Denver West Parkway
Golden, CO 80401
303-275-3000 | www.nrel.gov

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