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In the transition to a decarbonized electric power system, variable renewable energy (VRE) resources such as wind and solar photovoltaics play a vital role due to their availability, scalability, and affordability. However, the degree to which VRE resources can be successfully deployed to decarbonize the electric power system hinges on the future availability and cost of energy storage technologies.

In apaperrecently published inApplied Energy, researchers from MIT and Princeton University examine battery storage to determine the key drivers that impact its economic value, how that value might change with increasing deployment over time, and the implications for the long-term cost-effectiveness of storage.

"Battery storage helps make better use of electricity system assets, including wind and solar farms, natural gas power plants, and transmission lines, and that can defer or eliminate unnecessary investment in these capital-intensive assets," saysDharik Mallapragada, the paper"s lead author. "Our paper demonstrates that this "capacity deferral," or substitution of batteries for generation or transmission capacity, is the primary source of storage value."

Other sources of storage value include providing operating reserves to electricity system operators, avoiding fuel cost and wear and tear incurred by cycling on and off gas-fired power plants, and shifting energy from low price periods to high value periods -- but the paper showed that these sources are secondary in importance to value from avoiding capacity investments.

"As more and more storage is deployed, the value of additional storage steadily falls," explains Jenkins. "That creates a race between the declining cost of batteries and their declining value, and our paper demonstrates that the cost of batteries must continue to fall if storage is to play a major role in electricity systems."

The results of the study highlight the importance of reforming electricity market structures or contracting practices to enable storage developers to monetize the value from substituting generation and transmission capacity -- a central component of their economic viability.

"In practice, there are few direct markets to monetize the capacity substitution value that is provided by storage," says Mallapragada. "Depending on their administrative design and market rules, capacity markets may or may not adequately compensate storage for providing energy during peak load periods."

In addition, Mallapragada notes that developers and integrated utilities in regulated markets can implicitly

capture capacity substitution value through integrated development of wind, solar, and energy storage projects. Recentprojectannouncementssupport the observation that this may be a preferred method for capturing storage value.

The economic value of energy storage is closely tied to other major trends impacting today"s power system, most notably the increasing penetration of wind and solar generation. However, in some cases, the continued decline of wind and solar costs could negatively impact storage value, which could create pressure to reduce storage costs in order to remain cost-effective.

"It is a common perception that battery storage and wind and solar power are complementary," says Sepulveda. "Our results show that is true, and that all else equal, more solar and wind means greater storage value. That said, as wind and solar get cheaper over time, that can reduce the value storage derives from lowering renewable energy curtailment and avoiding wind and solar capacity investments. Given the long-term cost declines projected for wind and solar, I think this is an important consideration for storage technology developers."

"Since storage derives much of its value from capacity deferral, going into this research, my expectation was that the cheaper wind and solar gets, the lower the value of energy storage will become, but our paper shows that is not always the case," explains Mallapragada. "There are some scenarios where other factors that contribute to storage value, such as increases in transmission capacity deferral, outweigh the reduction in wind and solar deferral value, resulting in higher overall storage value."