Abstract

The transition to a low-carbon electricity system is likely to require grid-scale energy storage to smooth the variability and intermittency of renewable energy. I investigate whether private incentives for operating and investing in grid-scale energy storage are optimal, and the need for policies that complement investments in renewables with encouraging energy storage. In a wholesale electricity market, energy storage systems generate profit by arbitraging inter-temporal electricity price differences. In addition, storage induces non-pecuniary externalities due to production efficiency and carbon emissions. I build a new dynamic equilibrium framework to quantify these effects of grid-scale energy storage and apply it to study the South Australian Electricity Market. This equilibrium framework computes a supply function equilibrium using estimated best responses from conventional sources to observed variation in the residual demand volatility. The first set of results shows that although entering the electricity market is not profitable for privately operated storage, such entry would increase consumer surplus, total welfare and reduce emission. A storage operator that minimizes the cost of acquiring electricity could further improve consumer surplus by twice as much. Importantly, a competitive storage market could not achieve this outcome because other power plants distort prices. These results argue for a capacity market to compensate for a private firm for investing in storage. The second set of results shows that at moderate levels of renewable power introducing grid-scale storage to the system reduces renewable generators' revenue by decreasing average prices. For high levels of renewable generation capacity, storage increases the return to renewable production and decreases CO2 emissions by preventing curtailment during low demand periods.