Energy Storage
Benefits Existing Power Generation Facilities

Market Status

The US wholesale power market has a number of immense challenges before it; efficiency, reliability, and security of the electric power industry are areas of particular concern. The choice now is to either increase regulatory oversight or expand the flexibility and capability of existing assets—both generation and transmission. A renewed emphasis on energy storage technologies stands as a solution to this later choice. In essence, energy storage technologies can act as the "shock absorber" for the Grid.

The current electric power system is built around a central tenant; electricity must be produced when it is needed and used once it is produced. Energy storage technologies break this linkage by allowing for operators to produce and store electricity for later use—as one would in other commodity markets. Although this has obvious benefit to the consumer of energy as a means to enable a risk-management strategy, storage also promises to provide assistance to power generators as well—by allowing them to operate in a more cost-effective manner. This strategy has already been proven to be successful in the natural gas industry. By optimizing the existing generation assets, less capital is needed to provide a higher level of service.

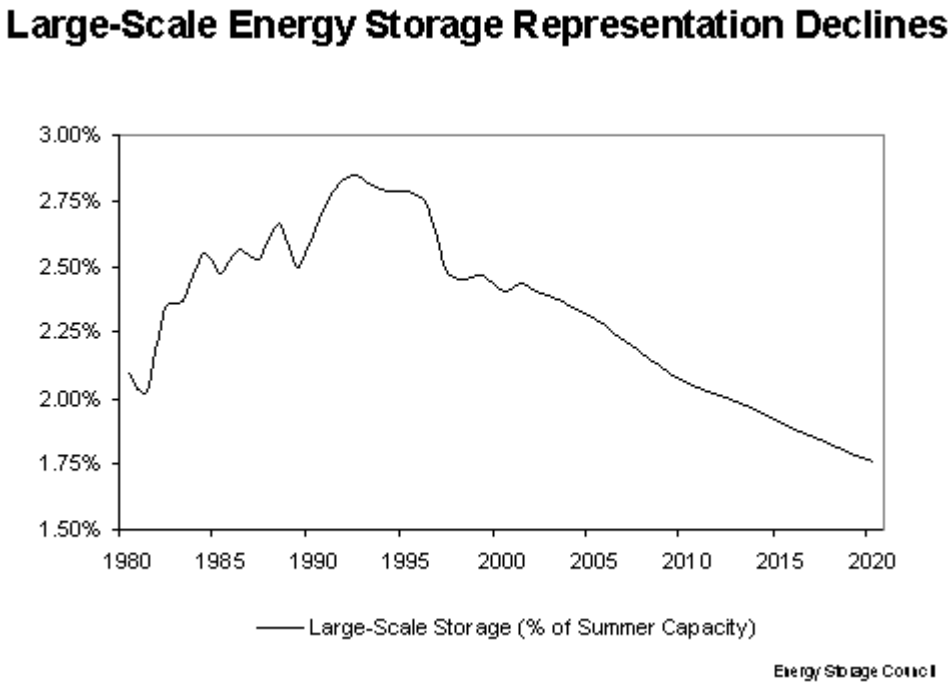
Energy Storage Rebirth

Energy Storage is not a new concept. At both the wholesale and retail level, firms have recognized the importance of its flexibility and have invested significant amounts of capital in these technologies.

In the wholesale market, Utilities had built a number of pumped-hydro facilities in the 1970's and 1980's, resulting in a storage component of nearly 3% of all US summer capability by the early 1990's. As a comparison, European countries hold roughly 5% of their capacity in large-scale storage capacity, while Japan holds roughly 10%. Expectations are for these international capabilities to be maintained or expanded. However, fallout from deregulation in the US has caused the investment in large-scale energy storage in this country to fall off, promising to lower large-scale storage's representation in the market for the foreseeable future unless additional large-scale storage facilities are built.

Reversing this worrisome trend could be an important component of improving the country's level of reliability and security in the coming years. As the economy rebounds over the next few years, demand will surge, requiring the

existing generation assets to improve their performance. To increase their operating performance to provide increased reliability and security for the electric power industry, energy storage assets can be coupled with baseload coal facilities.



Energy Storage's Impact on Power Generators

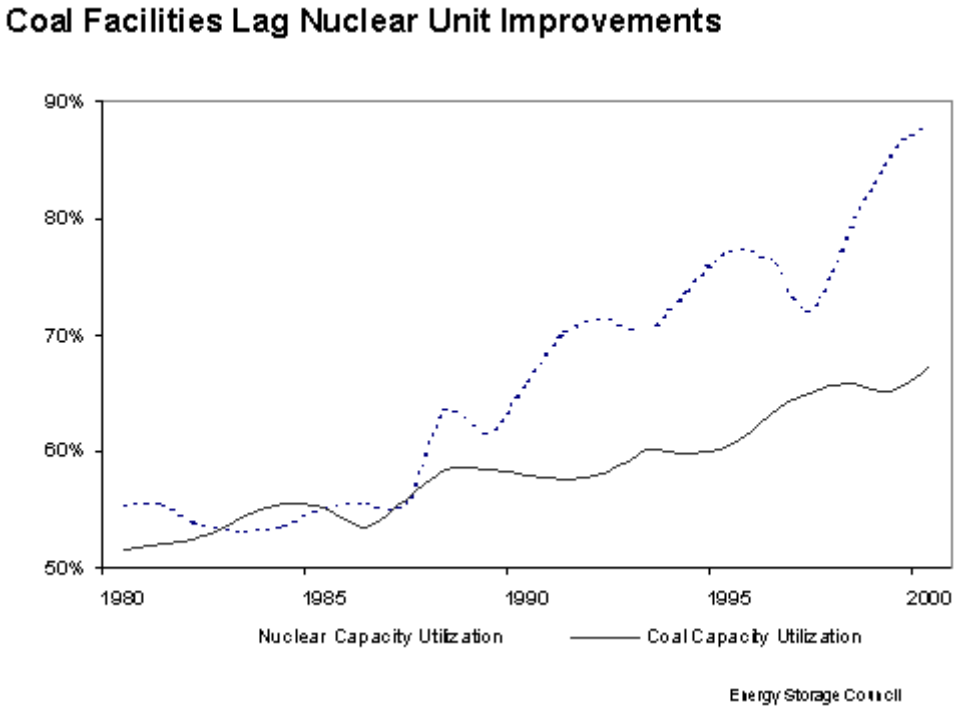
Large-scale storage facilities can arbitrage baseload generation for commodity sales by providing power in long-duration discharges and provide low-cost ancillary services such as load following and spinning reserves. Because of their size, they are able to have an impact across a wide area. This helps on both the supply and demand side of the wholesale generation market. Although they do help offset the need for some additional peaking capacity, large-scale storage facilities are focused more as system optimizers rather than generation replacement.

By adding large-scale energy storage systems, generation firms can leverage their existing assets for additional revenue and, through higher utilization, greater efficiency of the facility. Coupled with a storage facility, a generation facility can gain some much-needed flexibility during the critical scheduled "outage" seasons of the spring and fall to prevent spot make-up purchases. Besides time of use, other optimizing roles for storage include improving the economic and environmental profiles of fossil and nuclear assets by reducing dispatch and

cycling costs and providing flexible products to sell in the wholesale market. All of these changes will allow the facility to produce more power, lowering the fixed cost per unit output and improving the competitiveness of these capital-intensive facilities.

Coal-Fired Facilities

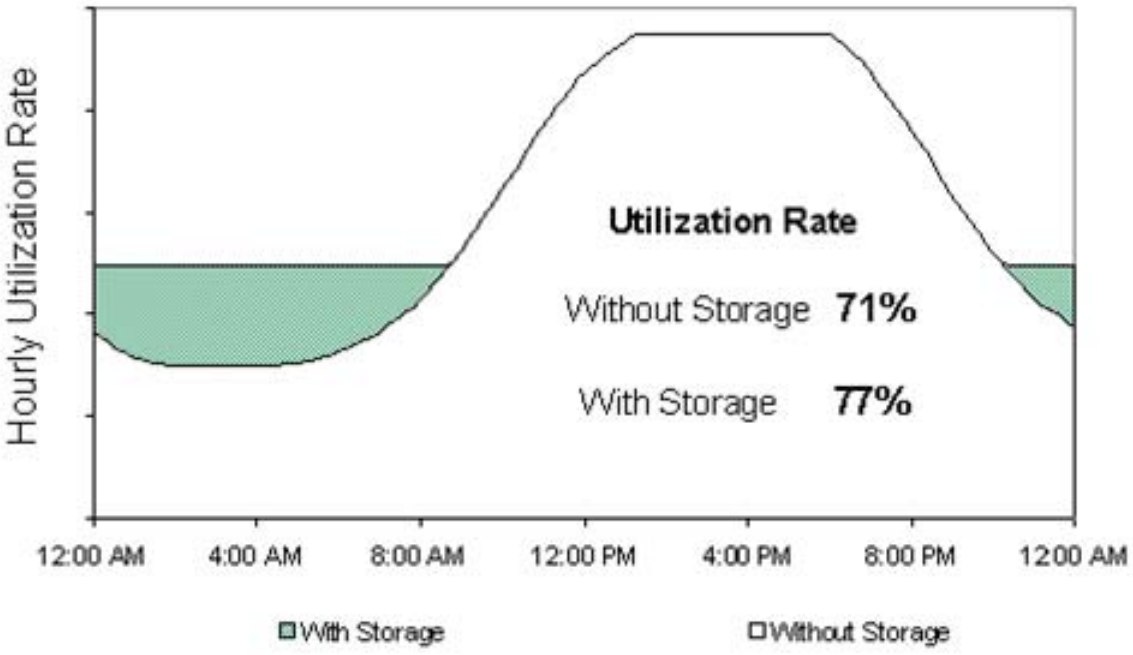
Coal-fired generation facilities represent the largest fleet of power facilities (by capacity) and, not surprisingly, stand to gain the most from a close working relationship with large-scale storage facilities. Besides providing for additional power sales, using storage for daily arbitrage activity will actually solve a number of operational issues for these plants and cause them to run in a more



economical and operationally efficient manner that will lower their overall per-unit production cost.

During off-peak hours, coal facilities ramp down their utilization rate. By generating more power at night for release during the day, these facilities will not be required to perform as much of the load following role as they currently do. In large part due to this variable resources market role, coal facilities in 2000 had an average utilization rate of 71%, compared to nuclear facilities that maintained a rate of 88%. Adjusting the output of the facility lowers the efficiency of the facility, placing additional stress on the plant's systems, increasing O&M budgets with additional maintenance, and resulting in shorter life spans of critical equipment.

Another issue to owners is the tightening environmental restrictions on coal facilities. Beyond adding required emission control technologies (that adds a few mills to the operating cost on an annualized basis), emission limits (NOx restrictions, etc) can constrain the power facility from operating in the most profitable mode during peak times such as summer. Since the environmental characteristics actually decline at partial power, storage could help these facilities reduce their total emission per unit of output by shifting some



production to the evening when the facility could run at its rated- instead of partial-generating capacity. This would have yet another benefit: by producing more power at night, air quality near the coal facility is reduced since ozone-induced haze (a by-product of NOx, O_2, and sunlight) is less likely to develop without the addition of sunlight.

Example

One way to see the benefits of a installing a new large-scale energy storage facility is to show the impact on a typical coal facility. This example will only deal with annual average costs to show in broad-stroke how large-scale energy storage can assist baseload facilities. However, as one of the most important impacts a storage facility is to allow coal units to operate in a more efficient fashion on a marginal basis, the real impacts would be even more effective.

In this example, we will look into coupling a 1000 MW coal facility operating at a 71% utilization-rate with a 405MW CAES facility (80% round-trip system efficiency utilizing a 300 MW compression motor). Operating the compressor for 8 hours each night, five nights per week, results in over 568,000 additional MWh of demand from the coal unit during off-peak periods. This could increase the coal facility's utilization by over of 6% (to 77%), lowering it's production cost by roughly 1.4 $/MWh (based on $25/MWh). Therefore, besides the additional $6.7 million of additional power sales the coal unit could capture during off-peak periods, the facility could receive an additional $8.5 million from its current power sales with the new, lower production costs.