

Energy Storage Options For Central Illinois

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This paper describes an effort to “catalyze” the development of a large-scale energy storage project in central Illinois to bolster the electricity infrastructure. The methodology used should be applicable to many other sites and opportunities across the country. The results of our discussions with a major potential project participant or backer illustrate the considerable roadblocks that must be overcome to pursue large-scale storage. Emphasis is on compressed-air energy storage (CAES), a commercially ready large-scale (greater than 50 MW) option.

Our conclusion is that storage is an *asset optimization solution* and as such must gain credit for a variety of benefits if it is to be justified. These benefits cut across the divisions of the typical utility or merchant stakeholder. The emerging institutional makeup of our stakeholders (disaggregating utilities, formation of regional transmission organizations, merchant or private development of generating and transmission assets, etc) suggests that a “higher power” must enter the fray. The benefits of storage cut across the production and delivery value chain and that value chain is being broken apart.

One essential message for the EESAT audience is this. Storage suffers from two considerable roadblocks. The first is technological. Virtually all storage technologies are nascent, except pumped storage hydroelectric. Even CAES, which is offered on fully commercial terms, has only been applied in two full-scale facilities around the world. Therefore, the capital costs are high, as is the perceived “technical risk.” These problems can be solved through technological progress, improved engineering, more site-specific design and applications, better communication with investors, industry or government funded demonstrations, etc.

The other problem is institutional and public policy oriented. The institutional trends in the electricity business today are not favorable to storage. This suggests that storage advocates absolutely must work in concert to create a more favorable public policy framework and respond to these unfavorable institutional trends.

We have defined several economic “value streams” or benefits that, properly quantified, should drive storage projects: Among them:

- Enhance the value of renewable energy to the market place by converting low value unscheduled energy into dispatchable high-value electricity products
- Increasing the security and assurance of the electricity grid, much as the National Petroleum Reserve backstops oil supply and demand and natural gas storage smooths out seasonal fluctuations in supply of that energy commodity.
- Avoid or defer new transmission lines and/or overcoming existing bottlenecks.
- Arbitraging on-peak and off-peak electricity prices on a regional basis.
- Providing ancillary services to the grid operator
- Reduce the dispatch and cycling costs of coal-fired generation
- Reduce environmental impact

Given these value streams, central Illinois should be a prime candidate for large-scale energy storage.

- Illinois has deregulated its electricity market and, while it is far from a mature market, authorities have not yet “turned back the clock” on competition. In addition, there is a great disparity in electricity prices between the north (Chicago area) and southern part of the state (rural farms, mining, services). Therefore, it seems intuitively obvious that there is arbitrage value.

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- The state's generating base is diverse but regionally concentrated. Exelon/Commonwealth Edison's nuclear plants are located in the north, the large coal plants exist to the central and southern portions of the state. However, the large base of coal plants are often cycled and dispatched. Value is present if these plants can increase their capacity factor and avoid the costs of cycling.
- The political will to develop wind resources is strong in Illinois. However, through our involvement in wind energy project development, it is known that, at least in central Illinois, the daily wind resource curve runs counter to the electricity demand curve. That is, wind velocity profiles are strongest late at night, while electricity demand peaks during the day. Therefore, storage could bring under-utilized wind energy to the peak periods.
- Illinois, given current trends, will be bifurcated in terms of transmission. Ameren, a major utility serving the central and southern areas, is a member of the Midwest Independent System Operator (MISO), Exelon, serving Chicago and the northern area, is signing up with PJM. What is unclear is how ancillary services will be provided to the grid, whether on a mandated or a market basis. What is clear is that energy storage can provide ancillary services, to whoever is ultimately responsible, and thus a value can be attached for this.
- Transmission system studies by DOE and others note that significant constraints exist in moving power into Chicago. Storage in central Illinois should, depending on location and interconnection, should be able to relieve transmission constraints.
- In addition to Chicago, two other major population, and therefore load, centers in the region are St. Louis, and Indianapolis. It seems reasonable to assume that, in the case of a security (terrorism or crime) or assurance (human error, abnormal operating conditions) threat, large-scale storage in central Illinois could prevent, accelerate recovery from, or otherwise minimize the impact from, such a threat.

The other major driving force for storage in central Illinois is that the infrastructure is in place—gas pipelines, transmission lines, and most importantly, underground aquifers in which the compressed air can be stored. In fact, the Electric Power Research Institute (EPRI), along with a consortium of utilities, studied the geology near Pittsfield, IL, and deemed it suitable for CAES more than a decade ago. This isn't to discount other energy storage options, but for large scale (above 50 MW), CAES is the only option that can be considered a fully commercial proposition today, and compete with pumped storage hydroelectric.

Based on the economic analysis given here, which we stress is first-order and not rigorous, we estimate that a large-scale storage facility (300-MW CAES plant) in central Illinois could be built (all-in costs) for between \$150-200-million. The annual "value" that such a facility could provide is between \$100-\$150-million, albeit under many assumptions that are subject to challenge. The largest component of this value is in providing reliability and assurance to the electricity grid. Because of this, and the fact that the other value components are distributed among various other stakeholders (Gencos, Midwest Independent System Operator, utility transmission organization, wind energy developers, the environment, etc), two scenarios are presented to develop an actual project:

- The government, sensing a need to assure grid reliability (the largest value bucket, though the most speculative based on our analysis), could step in and subsidize that part of a storage project that is "for the public good" (environmental benefits, grid reliability), with the private sector paying the freight on the rest.
- A "merchant" or independent storage project developer would have to greatly expand the business model used to typically justify and finance a project. The business model, however, becomes more complex, involving bilateral contracts with a variety of the beneficiaries.

One of the critical next steps is to develop a second-order, more dynamic analytical model of the storage project benefits. This would involve: real-time electricity prices in the Midwest markets and future forecasts, emissions allowance prices, marginal cost calculations of storage facility output, natural gas pricing, cost estimates of T&D constraints in the region, cost-benefit comparison of solving T&D problems with traditional T&D assets or storage assets. The benefits of storage are necessarily greatest when the electricity infrastructure is most strained. Therefore, the greatest economic benefits are likely to be gained during short, but critical operating periods that could be hours in length, even minutes.

