Dili energy storage economics

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The economics of energy storage is reliant on the services and markets that exist on the electrical grid which energy storage can participate in. These value streams differ by region, electrical system, and grid domain (i.e. transmission, distribution, customer-sited).

The figure below provides a list of the services that energy storage can provide at the transmission or bulk energy storage level (generally 10MW or more). These include generation capacity (sometimes called resource adequacy), flexible capacity (sometimes called flexible resource adequacy), virtual transmission capacity (support transmission reliability or alleviate congestion), energy time shift, ancillary services, black start, and frequency response. This section provides more detail.

Generation capacity is the capability and availability of a resource to contribute to system load needs. Capacity resources are typically committed months to years in advance. As demand and resource mixes change, including generator retirements, new resources are needed to ensure capacity needs are met during all hours and conditions. Assuming sufficient storage duration and reliable response times, energy storage may provide reliable load peak reduction. However, energy storage is more challenging to model and assess than traditional generation, because of its limited energy capacity.

As more renewables are deployed, daily fluctuations (i.e. ramp rate requirements) in traditional energy generation are increasing. Grid planners must consider these ramp rates in long-term generation resource planning. Energy storage can alleviate ramp rate requirements by absorbing or releasing energy to effectively reduce the maximum ramp rate required by generators.

Energy time-shift recognizes an opportunity to economically move energy demand through time taking advantage of fluctuations in the marginal cost of electricity production. To do this, storage can charge when the price of electricity is low (or even negative) and discharge when prices are high. The value of energy time-shift depends heavily on market structure, load growth, and generation mix.

The figure below provides a list of the services that energy storage can provide at the distribution level (generally in the 10kW-10MW range). These include virtual distribution capacity, power quality support, resilience / backup power for microgrids, as well as the possibility to provide transmission support in certain scenarios.

The figure below provides a list of the services that energy storage can provide at the customer-sited level (generally in the 2kW-2MW range). These include customer bill savings, power quality enhancements, resilience / backup power for microgrids, as well as the possibility to provide transmission and/or distribution support in certain scenarios.

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Each grid service performed by a battery may provide some economic value, or benefit, but one service alone may not provide enough value to overcome the lifetime costs of the installation. If a specific scenario allows it, it may be possible to approach multiple grid services with one project to improve a projects economics. Keep in mind, there may be regulatory or technical complications that prevent the a project from attempting multiple stacked services.

When value stacking, energy storage service compatibility only flows from bottom up; customer storage may provide distribution and transmission-level services, but transmission storage can NOT provide distribution or customer services.

Reliability vs. Economic ServicesReliability services take priority over economic services. For example transmission / distribution deferral services are higher priority than market services.

Local vs. System LevelIn general, local objectives supersede system objectives when there is a conflict. For example, transmission / distribution deferral is a higher priority than resource adequacy, though operations should be designed such that reliability services never conflict.

An economic analysis of energy storage systems should clearly articulate what major components are included in the scope of cost. The schematic below shows the major components of an energy storage system. System components consist of batteries, power conversion system, transformer, switchgear, and monitoring and control. A proper economic analysis identifies the costs associated with each of these components.

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