Storage

Electric storage can be classified as one of three types, depending on the needs of the system where the storage is built. This white paper will use the terms *short-duration, daily-cycle,* and *long-duration* to describe the different types of electric storage and considerations for each. Each region may have a specific need (or set of needs) for storage, and quite possibly multiple types simultaneously. All known storage resources should be included in energy reliability assessments, as either supply resources when they are discharging or as demand when they are charging. Sub-hourly cycling storage resources would be a challenge to model on an hourly granularity, however all known storage resources should be included in energy reliability assessments as both supply (discharging) and demand (charging), depending on the state of charge.

Short-duration storage can be used for frequency regulation. These resources include smaller batteries, less than 2 hours of storage, and flywheels on the lower end of the spectrum for energy capacity and power capability. These storage types can cycle quickly and often in response to signals defined to maintain a balanced Area Control Error (ACE)[1].

Daily-cycle storage currently includes four- to eight-hour duration batteries and pumped hydro storage stations. These resources charge the battery or fill the upper pondage when net demand is low and discharge or generate power when demand is high. The charging cycle can happen multiple times a day, depending on the flexibility of the storage resources. The operation of daily-cycle storage can be modeled as a fixed charge/pump load at normally lower demand periods and as a fixed discharge/generating resource at normally higher demand periods. Another option for modeling daily-cycle storage is to include the specific capabilities as part of the energy balance from hour to hour. This effectively tells the analyst when to charge/pump and discharge/generate, based on the resource's state of charge, or other specific system conditions.

Long-duration storage can be chemical storage, such as a battery or power-to-gas-to-power conversion where excess electric energy is used to create hydrogen which can be stored and used later as needed. However, currently in some regions Long-duration storage will more likely be traditional energy or fuel storage (e.g., liquified natural gas or oil). Long-duration storage can be called upon when renewable resources (solar and wind) are not able to produce power for several hours. For example, solar generation in the evening after the sun sets, or for days due to weather systems that reduce wind movement or solar radiance, coupled with high demand conditions.

Specific storage data is needed to perform an Energy Reliability Assessment (ERA). The following table lists several data elements, and potential sources for that data, that should be included in an ERA.

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[1] ACE is defined by NERC in BAL-001-1 (https://www.nerc.com/pa/Stand/Reliability%20Standards/BAL-001-1.pdf)

Data	Potential Sources	Notes/Additional Considerations
Limitations on Cycling	Primary: Registration data	
Transitions time between charge and discharge		
Cycling efficiency		
Co-located/Hybrid or stand-alone storage		
State of Charge		
Location		
No-load losses		

All electric storage requires energy be stored before it can be withdrawn. An Energy Reliability Assessment can be used to show when energy storage needs to be charged, and when it should be discharged. It may also indicate when there may not be enough energy stored to keep the system balanced with variable supply or volatile demand.

Co-located storage resources can further complicate modeling. Solar or wind generators with storage devices at the same location as the generation allow the production of electricity to exceed interconnection limitations. The excess energy is then stored at the associated storage device and withdrawn from the storage device when VER production drops off. The additional complication comes from visibility but allows the use of the same transmission assets with no need to expand the transmission system. Metering at the output of a co-located storage facility adds a layer of obfuscation between the weather conditions and the production of the renewable resource. Metering the individual components can remove that obfuscation but may be costly to add to a project or to retrofit. Modeling these resources in Energy Reliability Assessments as individual components may give the analyst more flexibility with modeling tools and a better understanding of the production from the facility.

Electric storage is a net energy demand where for every MWh removed from energy storage, more than one MWh must be supplied. This “round trip efficiency of storage” is an important consideration for performing an Energy Reliability Assessment, primarily for accuracy, but also for deciding on action plans when energy supplies are inadequate. Based on the results of an Energy Reliability Assessment, system operators may elect to not use stored energy to maximize the efficiency of fuels. Maximizing storage resources is a complicated process and both supply and demand implications of storage resources should be considered when formulating action plans in the face of an energy deficiency.