Grid Architecture Component Class Specification

Component Class Designation: Electric Grid Energy Storage

Summary Overview

Electric energy storage covers a class of components that may be attached to the electric grid at any of various levels and may provide a number of services to the grid. Grid storage falls into two major categories that distinguish their primary externally visible properties and therefore how they are applied. One category can absorb energy from the electric grid and return it directly in the same form; the other category can absorb energy from the electric grid and convert it to another use (heating, transportation) or return it to the grid indirectly.

Definitions

Ancillary services – FERC defines as "Those services necessary to support the transmission of electric power from seller to purchaser, given the obligations of control areas and transmitting utilities within those control areas, to maintain reliable operations of the interconnected transmission system. Ancillary services supplied with generation include load following, reactive power-voltage regulation, system protective services, loss compensation service, system control, load dispatch services, and energy imbalance services."

Reflexive storage – grid storage which can output electric energy to the grid in the same form as was received (example: chemical battery with a bi-directional power electronic connection to a grid)

Transitive storage – grid storage that outputs energy in some form not directly grid compatible (example: conversion of electricity into heat in thermal storage for later use in a building)

Component Class Description

Purpose and Function

The purpose of grid storage is to decouple the volatilities of electric energy sources and loads, or to provide services (such as ancillary services) to the grid. Its function is to absorb electric energy from the grid and retain it for a period of time, and then release the energy as needed. Storage may be reflexive or transitive, as shown in Figure 1 below. Reflexive storage absorbs energy form the grid and returns it to the grid. Transitive storage absorbs energy from the grid and outputs it to some other system or process, such as thermal storage used for building heat or battery storage used to run a motor to create kinetic energy in the form of transportation). Reflexive storage is further subdivided into direct reflexive (such as a chemical battery with bidirectional power electronics interface) and indirect reflexive (such as use of electricity to pump water into an elevated reservoir, thus converting to potential energy, followed by later using the water to turn a turbine and generator that puts energy back onto the grid). Storage may provide grid services on fast (milliseconds) or slow (hours) response and duration time scales.

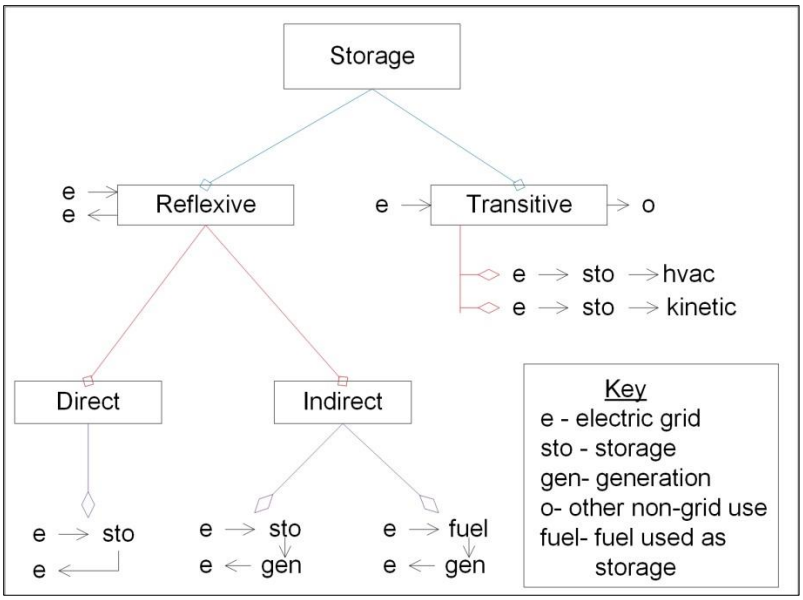

Figure 1 Storage Type Taxonomy

Key externally visible properties

Maximum energy storage capacity – largest amount of energy that the storage can contain, typically measured in MegaWatt-hours

Maximum charge ramp rate – fastest rate at which energy can flow into the storage unit from the grid, typically measured in kiloWatts or MegaWatts

Maximum discharge ramp rate – fastest rate at which energy can flow out of the storage unit

Dissipation rate – rate of loss of stored energy

Maximum number of charge/discharge cycles – upper limit on the number of charge/discharge cycles the storage unit can experience in normal service

Round trip efficiency – accounts to total losses on a complete inflow and outflow cycle

Frequency response – behavior of the storage unit under alternating input/output commands; turnaround time or speed of switching between energy input and output or alternation between charging and discharging

Model – a battery model equation set for virtual batteries is briefly described in reference document *SmartGridComm15_v4.pdf*

Interface descriptions

Energy Input interface – connection to the electric grid for energy input to the storage unit

Energy Output interface – connection for energy output from the storage unit. In direct reflexive storage, this interface may be common with of share common elements with the Energy input interface.

Control interface – interface through which external control may be exercised. This includes dispatch, ancillary services signals, and emergency condition controls.

Market interface – interface through which information is shared with markets or with aggregators that will bid the storage unit into a market or markets; this includes bi-direction flow of bid signals, as well as accounting information for settlement.

Grid State interface – interface for local grid information that may be used by controls internal to the storage unit, such as line frequency.

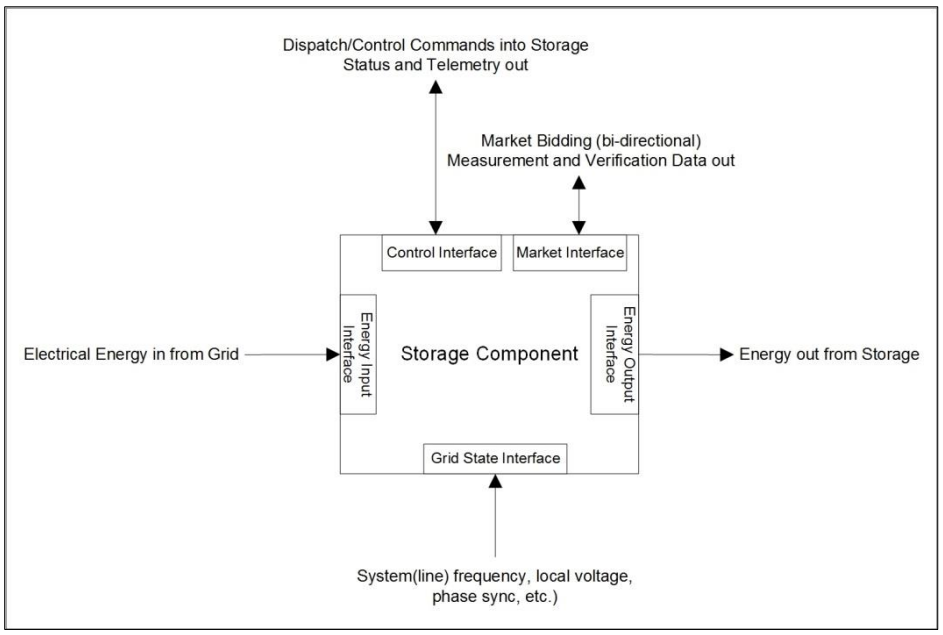

Figure 2 Storage Class Interfaces

Table of relevant standards

Standard Name	Description	Version/Date
FERC Glossary	http://www.ferc.gov/market-oversight/guide/glossary.asp	March 15, 2015
IEEE P2030.3	P2030.3 - IEEE Draft Standard for Test Procedures for Electric Energy Storage Equipment and Systems for Electric Power Systems Applications	December 2015
IEEE 1547	Standard for Interconnecting Distributed Resources with Electric Power Systems	June 2003

List of Attached Documents <list Visio drawing packages, Xcel spreadsheets, etc.; add rows as needed>

Document Name/File Name	Description	Version/Date
GMLC 1.2.1 Storage Class Diagrams v01.vsd	Visio file containing master drawings for diagrams 1 and 2	v0.1 Jun 21, 2016
SmartGridComm15_v4.pdf	Generalized Aggregation and Coordination of Residential Loads in a Smart Community	

Version History

Action	Date	Description	Author(s)
Created v0.1	21-Jun-16	Initial draft of storage component class description	JD Taft
Edited v0.2	1—Oct-16	Added round trip efficiency to properties	JD Taft