Providing a practical method to improve the system integration time and cost, thus creating the optimal solution for your Battery Energy Storage System (BESS) requirements.

The demand for battery systems will grow as the benefits of using them on utility grid networks is realized. Battery Energy Storage Systems (BESS) can store energy from renewable energy sources until it is actually needed, help aging power distribution systems meet growing demands or improve the power quality of the grid. Some typical uses for BESS include:

- **Load Shifting** – store energy when demand is low and deliver when demand is high
- **Peak Power Shaving** – deliver power to the grid when peak demand is high, so the distribution network does not have to deliver power
- **Power Smoothing** – “smooth” out erratic power levels from wind parks so utility receives constant power
- **Islanding** – supply network power to a section of the grid even though utility power is no longer present
- **Ancillary Services** – help to regulate grid frequency

In addition to usual battery functions, the PCS can also be used in a STATCOM mode to correct power factor, improve voltage regulation or reduce flicker at the point of connection.

In order for a battery to be useful as described above, it is first necessary to convert the DC energy in the battery into AC power and connect it to the grid. ABB provides equipment to convert DC power into AC power, that can be connected directly to the utility power grid. Simply put, the DC battery power is converted by special inverter equipment to a 3-phase AC voltage. This set of equipment is called the Power Conditioning System (PCS).

The PCS is capable of taking power from the utility grid and converting it to DC power for charging the battery as well as taking power from the battery (discharging) and sending it back to the network. Since the converter is a power electronics system, the charging and discharging can be done very quickly, if needed, such as during smoothing or frequency regulation applications.

**Power Conditioning System**

Batteries used in BESS applications can vary in power capacities from tens of kilowatts up to multi-megawatts. However, in a standard utility application, a typical size that will offer reasonable and available battery capacities is 2 x 1 MW or 2 MW total. If the application requires more battery power, it is always possible to parallel connect as many 2 MW units as needed to reach the desired system capacity.

The 2 MW rated PCS lends itself well for connecting to the network at the distribution network level typically at a medium voltage level less than 15 kV (2.4 kV, 4.16 kV, 7.2 kV, 12.47 kV, 13.8 kV, 60 Hz or 3.3 kV, 6.6 kV, 11 kV, 50 Hz for example). At this power level and voltage, the primary current is readily handled by conventional switching and protection means, which are part of the PCS total package.
The ABB Power Conditioning System is designed to be a complete package including everything between the battery and the utility bus. The main components of the PCS include:

- Incoming or primary switching and protection
- Main step-down transformer
- Auxiliary step-down transformer and power distribution
- Sine wave filter networks
- Inverters
- DC switching and protection
- Local control

The PCS enclosure houses all the main system components in one container that can be designed to cover a wide range of environmental conditions and temperatures.

In addition to initial cost and shipping advantages, the self-contained enclosure system results in:

- Reduced installation and commissioning time
- Reduced transportation cost
- Future system mobility

Referring to Figure 1, there are two completely separate inverter systems along with filter networks and DC switching to handle the equivalent of 1 MW of battery power each. Only the primary circuit protection and main transformer are shared in the PCS power circuit. The two circuit halves can be operated in tandem or independently, if desired.
Primary Switchgear
Since the PCS in most cases is connected directly to a utility line, it is necessary to have some disconnect means and overcurrent protection. The PCS can be supplied with either a fused manual disconnect switch or vacuum circuit breaker suitably rated for the incoming line voltage. Primary current and voltage transformers are provided, which are connected to a protective relay and power metering equipment.

Main Transformer
The main transformer is a dry-type unit with two equally rated secondary windings for connection to two 1 MW inverter systems. The capacity of the transformer is approximately 2200 kVA. The secondary voltages are selected to match the battery DC voltage characteristics.

Auxiliary Power
To provide control and auxiliary power to the PCS, an auxiliary power circuit is provided, which includes a MV fused disconnect switch, auxiliary power transformer, low voltage power distribution, an uninterruptible power supply (UPS) and a power source for external battery heaters, if required.

DC Switchgear
The DC section of the PCS enclosure can contain either fused DC disconnect switches or DC circuit breakers, depending upon the requirements of the battery supplier.

Inverter Modules
The heart of the power conversion unit is the inverter drive modules from ABB’s standard PCS100 low voltage drive products. The modules used in this application convert DC to three-phase AC. To achieve the total output rating required under specified conditions, twelve to sixteen identical modules are used for each 1 MW battery input. The inverter modules are specifically designed for custom applications where more system flexibility is needed.

Using the standard PCS100 inverter modules takes advantage of highly reliable, field-proven ABB technology and economies of scale from high-volume production.

The inverter drive modules are air-cooled with cooling air drawn into the front of the enclosure and forced out the back by exhaust air fans in the inverter modules. The enclosures are designed for front access and maintenance.
PCS Packaging

The enclosure for the 2 MW PCS system, shown in Figure 2, is based on a new standard 20-foot ISO sea container specially modified for the PCS. The enclosure integrator adds equipment access doors and a man door, air intake louvers or vents, exhaust fans, internal barriers, partitions and panels, lighting and power distribution, etc., so that it is the ideal enclosure for the application. Since the enclosure is considered a non-walk-in enclosure, generally there is no air conditioning included, and enough heating is provided only to avoid internal condensation. The enclosure is easily customized to meet specific customer environmental and temperature conditions if needed.

There is a man door that can be used for servicing the equipment inside. It is key interlocked with the primary disconnect switch or circuit breaker so that a service person could not enter unless the primary switchgear was open and disabled. From this entrance, the sine filter equipment and low voltage side of the transformer can be inspected and serviced if required. A typical equipment layout arrangement plan of the enclosure is shown in Figure 4.

On the end of the container is a local controls section with an HMI graphic display panel. Normally everything is controlled and monitored remotely through a customer communication network. However, the local control can be used for commissioning or maintenance checks and testing when needed.

Other PCS Options

This datasheet describes one possible packing design approach. ABB has the capability of providing custom Power Conditioning Systems for a very broad range of application and power ratings, including:

- Indoor or outdoor locations
- Low, medium or high voltage primary
- Dry-type or liquid-filled transformers
- Primary switchgear or disconnect means
- Environmental conditions including temperature, altitude, seismic, etc.
- AC and DC side protection and metering

Contact us today to learn more about your PCS options and how ABB can meet your particular needs.

Figure 5. 1 MW / 6.5 MWh Battery Energy Storage System.

Contact us

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