



Battery Energy Storage Systems, or BESS, have become a serious player within distributed Power Systems. As renewable energy grows as an alternative to traditional power generation systems and battery technology advances alongside electric vehicle production, more serious consideration is given to BESS. Many BESS applications are to provide backup power for Wind and Solar power systems. As the cost of renewable energy systems declines and we push to lower our dependence on fossil fuels for power, BESS has emerged as a solution to bridge the gap when the wind doesn't blow and the sun doesn't shine. More advanced systems for converting DC power to AC have increased the practicality of DC power being an input source to a nationwide AC distribution or utility network, in both Macro and Micro grid systems. This information sheet discusses BESS applications, the advantages and disadvantages of the technology, the growing demand for energy storage, and how BESS applications can assist traditional power generation systems.

1.0 DEFINING BATTERY ENERGY STORAGE SYSTEMS (BESS):

BESS power packages/modules are banks of rechargeable electrochemical batteries arranged to store electrical energy from primary power sources to supply various distributed energy systems, including macrogrids, microgrids, and stand-alone power applications, with electrical power as required. BESS is integrated into an application's electrical power system to ensure that electrical energy from the primary source maintains the BESS batteries at a fully charged state and ready to power the connected load when the primary source of power is unavailable, diminished, or uneconomic.

Typical BESS (Large) Self Contained System for Use with the Utility/Microgrid Network

4 CONTAINER - The container is suitable for outdoor installations, it houses a number of racks sized for the application, and all the management devices necessary for the operation of a BESS. This includes safety, security, management, and control systems.

1 CELLS - the building blocks for BESS. They convert (via a rectifier) electrical AC energy to chemical energy. DC battery energy is converted to AC utility power via inverters.

2 MODULES - are sets of cells assembled into the container. All modules are electrically connected, controlled, and managed with a monitoring system.

3 RACKS - These are sets of modules connected together.

Difference Between BESS for Domestic Use, Part of the Utility Grid System, and Within Microgrids		
BESS Application	Installation	Principal Purpose
Behind-the Meter (BTM)	Installed on the user side	Reduce energy cost, greater autonomy from grid
Front-of-the-Meter (FTM)	Installer on the grid (utility) side	Large scale systems including solar farms and power plants
Microgrid Systems	One of several power inputs	Microgrids are used by data-centers, smart grids, and other applications requiring greater reliability than the utility provides, and more renewable energy power input options

Figure -1

The installation information provided in this information sheet is informational in nature only, and should not be considered the advice of a properly licensed and qualified electrician or used in place of a detailed review of the applicable National Electric Codes and local codes. Specific questions about how this information may affect any particular situation should be addressed to a licensed and qualified electrician.



Authorized Distributor

2.0 EVOLUTION OF BESS IN ENGINE-DRIVEN GENERATOR SYSTEMS:

BESS technology has been used in standby generator systems coupled to Uninterrupted Power Systems (UPS) for many years. (See *information sheet on UPS system*). In critical applications that cannot tolerate a power interruption, even for a nanosecond, BESS ensures, through an inverter, an uninterrupted AC electrical supply to the load for the few seconds an engine-driven generator system requires to run up to speed and replace the primary power source. See **Figure 1**.

The following has driven the demand and development of BESS:

2.1 UPS SYSTEMS:

UPS systems, as detailed above, generally did not require frequent deep discharge of the batteries, and as such, traditionally incorporated lead-acid or nickel-cadmium batteries.

2.2 EVOLVING BATTERY TECHNOLOGY:

The adoption of batteries for electric vehicles required batteries that can be frequently discharged and charged as rapidly as possible without excessive heat and reduced battery life. The battery that emerged for these requirements was the lithium-ion battery. Lithium batteries, within operational recommendations, can be charged and discharged frequently for vehicle use over many years without losing capacity.

2.3 ADVANCES IN DIGITAL SWITCHING TECHNOLOGY:

Battery output as Direct Current (DC) for Utility customers has to be converted to Alternating Current (AC). DC-to-AC conversion is accomplished by inverters. Electronic switching using thyristors and transistors has improved significantly, reducing costs. Today, inverters can generate very smooth AC sine waves from DC battery power, enabling grid connection and compliance. A similar development has taken place in rectifier systems converting AC power to DC power to recharge batteries. (See *information sheet on inverters*)

2.4 RENEWABLE ENERGY:

The push to adopt more renewable power sources, driven by concerns about being too dependent on fossil fuels, created a need to store electrical energy generated by wind and solar. Storing surplus energy from renewable sources such as wind and solar is essential to ensure power is available when the sun is not shining and the wind is not blowing. Stored electrical power from wind and solar has been a primary driver of BESS technology, with the latest inverter and rectifier technology.

2.5 VARYING UTILITY GRID PEAK AND OFF-PEAK RATES:

For many years, utility companies have offered reduced rates to domestic and commercial customers. Low rates apply when grid demand is down. This frees up utility capacity during peak demand and enables customers to run certain large loads at lower rates. The development of more advanced BESS now means customers can recharge batteries with low-rate power, and power their equipment during the utility-supplied electrical output at peak, higher rates.

3.0 THE ADVANTAGES OF BESS:

In a world that is increasingly dependent on a reliable source of electrical power, having a battery storage system that stores primary AC power for use when needed brings many advantages, including:

- **Minimized Power Outages** - Increased UPS for critical applications.
- **Improved Grid Resiliency** - The utility network is under stress, and BESS can step in during brownouts and other outages.
- **Reduced Electricity Costs** - Ability to store low utility rate electricity.
- **Increased Use of Renewable Energy** - Enables renewable power systems to generate stored electricity.
- **Strengthened Local Economies** - Particularly in rural areas where the grid can be most vulnerable.

4.0 THE DISADVANTAGES OF BESS:

Despite the advantages BESS brings to power consumers in the areas of reliability, clean energy, and in some areas cost, there are still some areas of disadvantage to take into account when designing a power system, including:

- **Cost** - A battery is not always the least expensive method to store energy. A diesel fuel tank in a standby generator system can store a lot of energy in a smaller footprint.
- **Battery Lifespan** - Battery technology will continue to advance. Even the most advanced batteries are limited to a finite number of charge-and-discharge cycles before their ampere-hour capacity begins to decline.
- **Safety Concerns** - Lithium batteries can catch fire if not manufactured, installed, and/or maintained correctly. Because they burn very hot, a lithium battery fire can be difficult to extinguish.
- **Recycling and End-of-Life Management** - Batteries are made of materials that can be toxic to the environment. At the end of their life, there is a higher cost for ensuring safe disposal and recycling than for traditional power equipment.

5.0 FUTURE CONSIDERATIONS FOR THE ADOPTION OF MORE BESS:

Ongoing reliance on clean, reliable, uninterrupted power and the development of battery technology will most likely see the expansion of BESS in the following areas:

- **Large-Scale BESS** - Adoption in microgrid networks, particularly in data-center complexes.
- **Short Term Storage** - Required for an expansion of renewable power systems such as wind and solar.
- **More Advanced Battery Technology** - New batteries developed for faster charging, longer life, and safer use.
- **BESS Energy Trading** - Wholesale energy trading will continue to evolve in many ways, with more enterprises purchasing electricity at low prices and then selling it at higher prices.

To fulfill our commitment to be the leading supplier in the power generation industry, the Buckeye Power Sales team ensures they are always up-to-date with the current power industry standards as well as industry trends. As a service, our Information Sheets are circulated on a regular basis to existing and potential power customers to maintain their awareness of changes and developments in standards, codes and technology within the power industry.



CANAL WINCHESTER, OH
8155 Howe Industrial Parkway
Canal Winchester, OH 43110
(614) 751-4515
(866) 889-2628

CINCINNATI, OH
4992 Rialto Road
West Chester, OH 45069
(513) 755-2323
(800) 368-7422

CLEVELAND, OH
8465 Tower Drive
Twinsburg, OH 44087-0394
(330) 425-9165
(800) 966-2825

TOLEDO, OH
27100 Oakmead Dr.
Perrysburg, OH 43551
(855) 638-2728



CHICAGO, IL
1308 Marquette Drive
Romeoville, IL 60446
(630) 914-3000

INDIANAPOLIS, IN
1707 S. Franklin Road
Indianapolis, IN 46239
(317) 271-9661
(800) 632-0339

FORT WAYNE, IN
7525 Maplecrest Road #221
Fort Wayne, IN 46835
(855) 638-2721