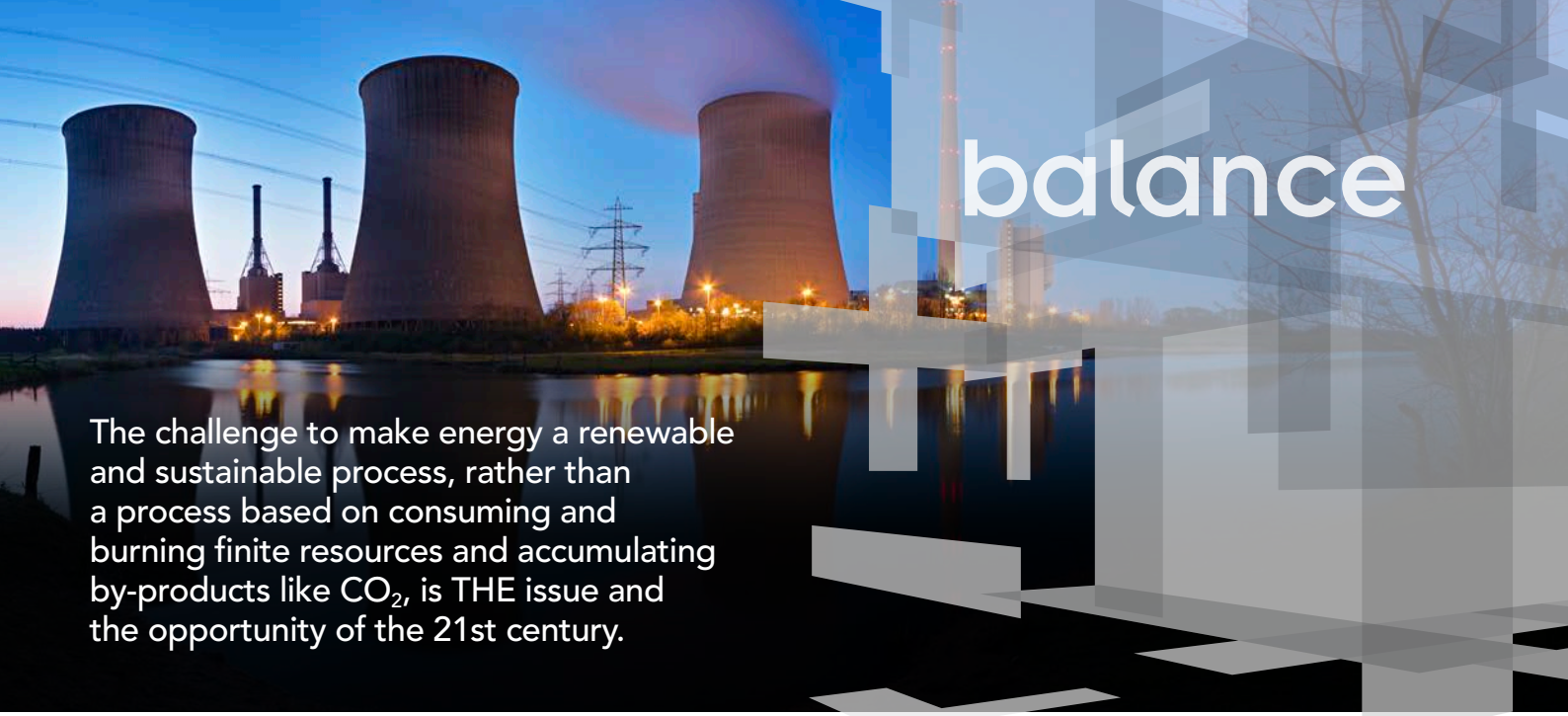
Ecoult Megawatt Scale Energy Storage

Beka unigy UltraBattery®

Powered by UltraBattery® technology

ecoult
energy storage solutions

Contents



balance

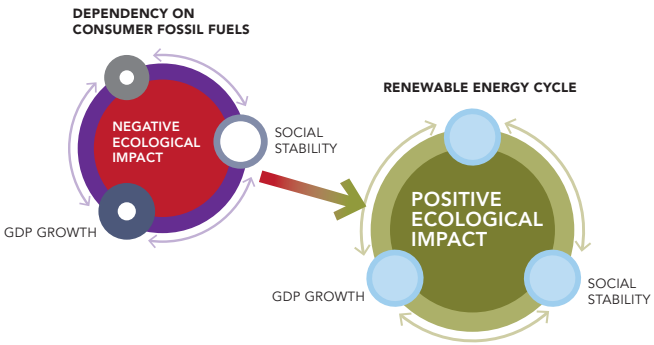
The challenge to make energy a renewable and sustainable process, rather than a process based on consuming and burning finite resources and accumulating by-products like CO_2, is THE issue and the opportunity of the 21st century.

Balancing the Renewable Energy Cycle

Our society is consuming coal and other fossil fuels, accumulated and stored over hundreds of millions of years, at an extremely fast rate. GDP growth in the last century has been a direct function of the amount of fossil fuels burnt. Whether we like it or not, social stability and contentment today depends on continued GDP growth, and one key driver of GDP growth is use of energy. Fossil fuel, within the world of energy, is particularly attractive because it allows the transformation of its high energy content at low prices, for release WHEN we want to use it, via transmission systems which get the energy to WHERE we want to use it.

But what about the ecological impact on our living planet, and our home, and the legitimate concerns of nations dependent on future and continued access to fuel supplies?

Renewable energy generation starts to disconnect the dependence of GDP growth from fossil fuel dependence and consumption. The challenge to make energy a renewable and sustainable process, rather than a process based on consuming and burning finite resources and accumulating by-products like CO_2, is THE issue and the opportunity of the 21st century. Unrestrained fossil fuel use is not sustainable. But it will take time to transition. It is likely that fossil fuels and renewables will have to live together side by side for a long time. The transition to a reliable and cost-effective renewables-based economy is inevitable, and to achieve that without huge social dislocation or material adverse environmental impact we must act quickly and effectively.



A key challenge to how quickly renewable energy can be adopted is the management of WHEN. Unlike fossil fuels, renewable energy generation is restricted by WHEN: it suffers from intermittency and reliability issues, i.e. the wind doesn't always blow and the sun doesn't always shine, WHEN you need it.

Energy storage is the missing piece of the puzzle in the renewable energy cycle. Energy storage can provide the answer to making renewable energy dispatchable, i.e. making it available whenever it is needed.

Ecoult believes that energy storage is now a prime determinant of how quickly society can effectively shift from dependency on fossil fuel consumption to one that is more renewables based. The need and potential for broad adoption of energy storage is very clear but today energy storage is still too expensive for much of that potential to be realised. The cost of storage needs to be lower on a per kW and per kWh basis.

Ecoult intends to make a real difference in the transition to renewables-based consumption with economical, safe, and environmentally sound energy storage solutions. In this endeavor we are backed by our parent, East Penn Manufacturing Company Inc., which manufactures our

breakthrough UltraBattery® in their state-of-the-art battery manufacturing facility at Lyon Station, Pennsylvania, with utmost commitment to quality, safety, and recyclability.

At Ecoult we are aiming to build a strong energy storage business that will be globally trusted and supported. We are focused on disciplined delivery to meet our clients' storage requirements and expectations. We are applying our resources in a pragmatic manner aimed at both delivering impact and economic reward for our stakeholders – our clients; our parent, East Penn Manufacturing; our employees; our government sponsors; and our suppliers.

Ecoult is therefore targeting applications where a relatively small amount of storage has a big impact, such as controlling seconds to minutes of short-term power variability, where we can utilize the breakthrough capabilities of our UltraBattery® storage to deliver solutions today that make both immediate economic sense and impact. One example is displacing peaking gas turbines that are being used to try to correct the continuously varying last percent or two of the mismatch between supply and demand in real time on the grid, called regulation services. Energy storage is not only more accurate and faster at providing this service, it is cheaper and cleaner. It is one example of how storage can effectively displace and replace the inefficient use of fossil fuels. Another example is controlling the ramp rate of wind and solar farms (or at nodes) before the output gets to the grid, so that more renewables can be accommodated on a congested grid, with less renewable output curtailment.

Our aim is to make application of UltraBattery® energy storage to control variability so simple and straightforward that it becomes just one more tool in a utility network architect's and engineer's kit.

Ecoult already has a proven track record of successfully implementing and deploying the UltraBattery® technology in several large megawatt scale complete energy storage solutions for solar and wind smoothing, energy shifting and frequency regulation services. These solutions use a modularized framework we call UBer™ (UltraBattery® Energy Resource). Ecoult can integrate full turnkey solutions using UBer™ or provide UBer™ as a solution platform with the associated storage modules for integration by customers or their integrators.

Our immediate mission is pragmatic. But our passion for energy storage is deep. For energy storage to become an ordinary part of grid design, storage needs to extend beyond variability management and deliver on its full potential toward complementing renewable energy generation and making energy use a fully renewable cycle. To achieve this, fundamental breakthroughs will need to be achieved. Ecoult and the great team and partners we have assembled together aim to do our bit to be significant contributors to the innovation and transformation process that will make energy storage ordinary, and the renewable energy cycle a natural process.

Thank you for your interest in Ecoult and our offerings. We hope the following material will be helpful to you.

John Wood, CEO Ecoult

fast

Ecoult Megawatt Scale Energy Storage Applications

Grid Ancillary Services: Fast-Ramping, Continuous Power Support for Reliable and Efficient Power Grids

Ecoult energy storage technologies can provide a technically and economically superior alternative and complement to traditional generation assets in the supply of grid ancillary services – services that address the mismatch in timing between production and demand and mitigate intermittency produced by generation or carried on transmission assets.

The fast-responding storage technologies have several advantages over fossil fuel generation assets such as gas turbines or coal generation plants, which are unable to efficiently or effectively meet the rapid and sudden frequency regulation and ramp rate control requirements of the modern grid.

Fossil fuel generation assets with ramp response times of up to 5 to 10 minutes are commonly used today to attempt to address variability that can move from a need for extra power to power dumping in seconds. The contribution of these assets is approximate at best, with only a fraction of the activity being converted to correction of the variability being addressed, and can on occasion actually be counterproductive. Using fossil fuel generation assets to provide ancillary services in this manner puts additional stress on the equipment, leading to an increase in maintenance costs and a potential reduction in productive life. The combination of reduced efficiency, higher operating costs, and increased CO_2 emissions leads to an overall uneconomic, inefficient energy management practice when utilizing conventional generation assets.

The business case for deploying fast-ramping, smart-grid energy storage resources on the other hand is compelling. Ecoult's UBer™ (UltraBattery® Energy Resource) transforms the way ancillary services are delivered: Responding to active signals, the continuously fast-ramping UltraBattery® technology is able to release or absorb power within seconds with highest accuracy of performance – and no CO_2 emissions. The flexible scalable energy storage solution allows existing fossil fuel generation assets to be more productively assigned to ordinary energy generation.

Ecoult solutions for ancillary services support utilities, Independent System Operators (ISOs), Regional Transmission Organizations (RTOs), and energy services companies in building and maintaining reliable, efficient, and environmentally sound grids while at the same time reducing dependencies on conventional generation assets, decreasing carbon emissions, extracting maximum efficiency from existing infrastructure, and minimizing costs in new investments. This ultimately enables an economic and environmentally sound energy management practice.

Ecoult's continuous 3MW frequency regulation service capability bidding into the open PJM market (PA, US) is one example of highly efficient ancillary services delivered by energy storage.

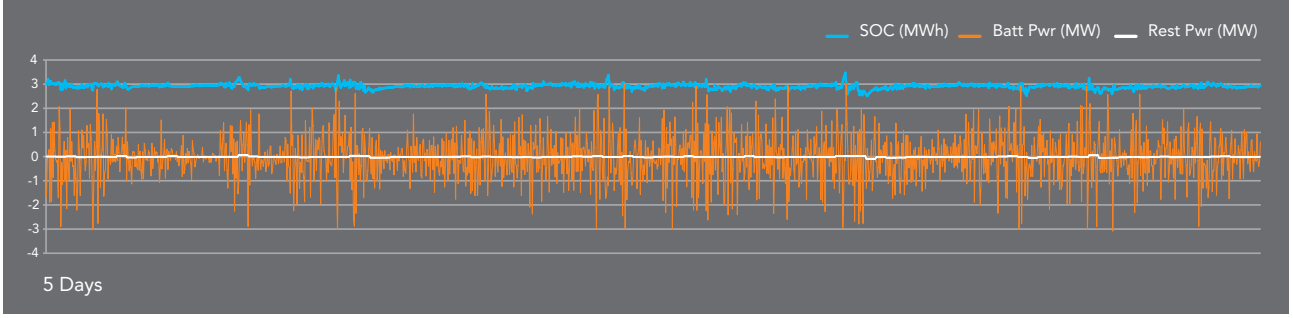
Ecoult Grid Ancillary Service Solutions

- **Frequency Regulation Services:** In response to a system operator's control signal the UBer™ injects or withdraws power within seconds with highest accuracy of performance into the grid, correcting fluctuations in grid frequency.
- **Spinning Reserve:** Ecoult's UBer™ is flexibly scalable with the ability to provide immediate power output for periods of 1 to 2 hours in response to a major generator or transmission outage.
- **Flexible Ramping:** ISOs have identified a need to have storage resources available – on call – to respond to quick ramping needs. The Ecoult UBer™ can provide such responses very effectively and can be configured to provide support for flexible ramping alongside additional ancillary services.
- **Power Quality/UPS/Back-up:** The UBer™ can be configured to provide emergency back-up power during grid blackouts, ensuring mission-critical equipment and processes are uninterrupted by power outages even while also participating in the provision of ancillary services to the grid. In case of a wide-area outage, Ecoult's UBer™ can also provide black start capability, reenergizing a system from total or partial failure without support from the grid.

Key Features and Benefits

+ Effective frequency regulation – 3 to 4 times more effective than conventional gas peaker plants at frequency response
+ Contributes to reliable, efficient, and environmentally sound grids
+ Supports reallocation of fossil-fuel-based generation resources away from variability management to activities where they are more efficient
+ High-quality power within seconds
+ Flexible and scalable to multiple MW
+ Quick deployment of energy storage systems compared to fossil-fuel-based regulating generators
+ Virtually zero CO_2 emissions
+ Recyclable technology

PJM Regulation (5 Days) – Fast-Response Signal with UltraBattery®



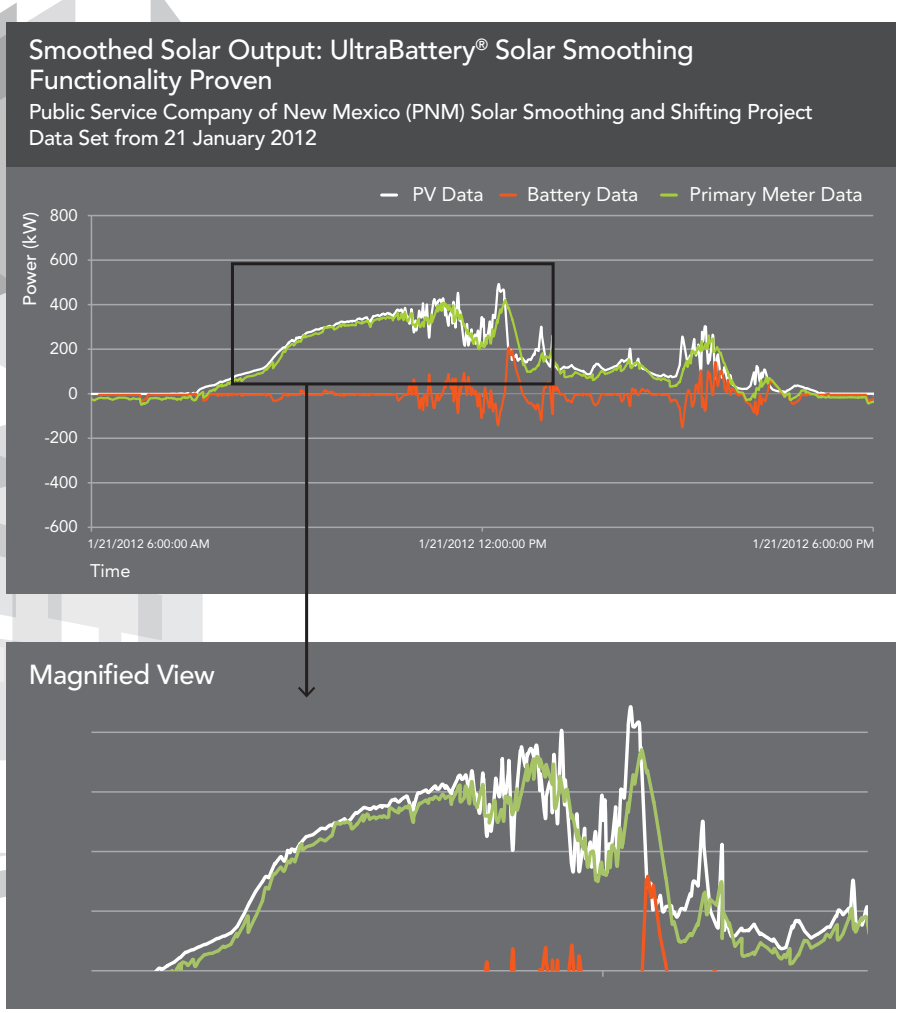
clean

Ecoult Megawatt Scale Energy Storage Applications

Renewables Integration: Bringing Smoothed Wind and Solar Power to the Grid

The numerous benefits of renewable energy sources are well known: not just are they free of CO_2 emissions and have the potential to supply many times the total current global energy production, renewables also help reduce the dependence on energy imports. They are suitable for integration both on-grid and off-grid, supporting the development of remote environments around the world without the need to build or extend cost-intensive grid infrastructure.

The rapid growth of renewable energy and its large-scale integration – fostered by renewable portfolio standards coming into effect – are accompanied by opportunities and challenges alike. Electricity providers are increasingly faced with the challenge to integrate variable renewable generation with the existing generation portfolio and the electricity grid. In order to operate reliably, grids need to continuously balance energy supply and demand – a task complicated by the intermittency of renewable energy such as solar and wind. Sudden fluctuations in renewable output can cause grid instabilities which in turn can present hurdles to the rising penetration and integration of renewables.



Cost-effective, practical, safe, and environmentally sound solutions help to smooth out the variability of renewables and store excess energy for times of unfavorable weather conditions. This puts energy storage solutions on the agenda.

Ecoult's UBer™ (UltraBattery® Energy Resource) has the ability to control ramp rates of solar and wind generation, reducing volatility, and increasing reliability of renewable energy. UBer™ makes wind and solar farm output more grid-friendly, which allows the energy network to carry more renewable energy. Deploying UBer™ helps toward matching energy supply and demand while at the same time reducing dependencies on conventional, unsustainable fossil fuel generation. It allows existing infrastructure and capacity to be used more efficiently, and the cost of generating power in peak periods as well as carbon emissions to be decreased. UBer™ can help meet connection compliance requirements for variability management, such as site approval, and can help avoid curtailments.

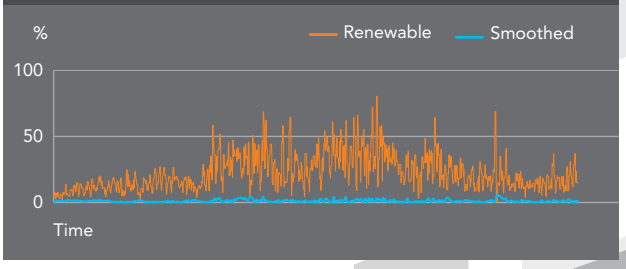
Ecoult's energy storage solutions for renewables integration ultimately support renewable energy developers, utilities, Independent System Operators (ISOs), Regional Transmission Organizations (RTOs), and energy services companies in creating and maintaining stable, clean power grids, and an economic and environmentally sound energy management practice.

The outperformance of the solar and wind smoothing and shifting capability of the UBer™ has already been proven in large-scale demonstration projects in Australia and the US.

Ecoult Renewables Integration Solutions

- **Power Smoothing:** Ecoult's UBer™ allows the integration of intermittent renewable energy sources by ensuring ramp rates are kept within the limits that can be managed by the grid and intermittencies generated from variations in wind speed or sun are reduced. The UBer™ monitors the intermittent renewable output and responds to variations by either absorbing or releasing power within seconds to smooth the ramp rate of output before presenting it to the grid. This management of second-to-second variations in system generation, load and frequency reduces volatility and increases reliability of renewable energy.
- **Renewable Energy Time-Shift:** Renewable energy resources often generate a significant amount of energy at night or off-peak times when the need and value of energy is low. Ecoult's UBer™ stores energy at these times and discharges it when energy demand and thus the value of energy are high. UBer™ is able to store and discharge energy as required, allowing utilities to improve overall system performance at peak times.
- **Back-up for Renewable Generation Defecit:** The UBer™ can provide emergency back-up power in case renewable energy sources are not able to produce sufficient output, for example under unfavorable weather conditions. This ensures the grid can operate reliably and mission-critical equipment is uninterrupted.

5-Minute Power Variability Reduction with UltraBattery®



Key Features and Benefits

+ Enables reliable, efficient, and environmentally sound electricity grids
+ Supports the continued penetration of wind and solar energy in grid systems
+ Virtually zero CO_2 emissions
+ Fast-responding energy storage
+ Reduces dependency on conventional generation
+ Maximizes capacity and infrastructure utilization
+ Flexible and scalable from kW to multiple MW
+ Recyclable technology

remote

Ecoult Megawatt Scale Energy Storage Applications

Microgrids: Electrifying On-Grid and Remote Microgrids with Reliable and Clean Power

Microgrids will play a pivotal role in solving the energy challenges of the future: they have the power to efficiently and flexibly meet the growing energy demand of communities, whether they are grid-connected or not.

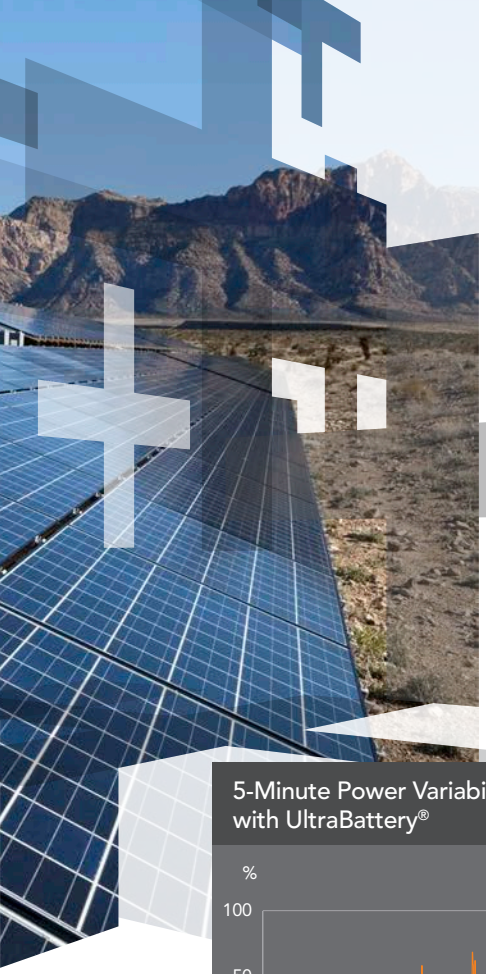
Small-scale versions of the centralized electricity system, microgrids, are designed to generate, distribute, and regulate power for small communities by integrating local, renewable power generating sources such as wind, solar, and hydro power as well as diesel generators. The proximity of power generation to loads results in a reduction in transmission losses while at the same time emission free, reliable energy is supplied. Microgrids allow for the installation of electricity supply quickly without the need for expensive transmission infrastructure investments and the lengthy development approval and construction process. This will especially empower remote, non-grid-connected communities around the world.

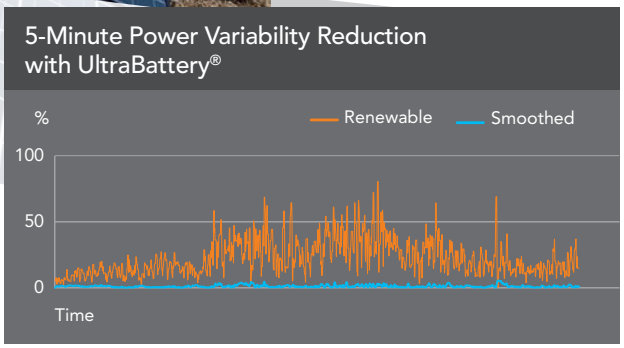
The opportunities associated with microgrids are however accompanied by challenges concerning voltage, frequency, and power quality as well as power supply during unfavorable weather conditions. Ecoult's UBer™ (UltraBattery® Energy Resource) can help provide the answer to these challenges by offering a reliable, safe, and environmentally sound way for on-grid and remote microgrids to smooth volatile renewable power output and to cover periods of loss of solar or wind energy. Similarly, UBer™ can improve the efficiency of diesel generators by absorbing sudden changes in loads so that the diesel generators can work at a steady and optimal band.

UBer™ can provide frequency stability and respond to demand peaks while at the same time deferring transmission and infrastructure investments. The UBer™ for on-grid and off-grid microgrids ultimately enables an economic, efficient, and environmentally sound energy management practice benefiting communities in urban or remote environments, energy services companies and utilities.

Ecoult Microgrid Solutions

- **Power Smoothing:** Ecoult's UBer™ allows the integration of intermittent renewable energy sources by ensuring ramp rates are kept within the limits that can be managed by the microgrid and intermittencies generated from variations in wind speed or sun are reduced. The UBer™ monitors the intermittent renewable output and responds to variations by either absorbing or releasing power within seconds to smooth the ramp rate of output before presenting it to the grid. This management of second-to-second variations in system generation, load, and frequency increases the reliability and economics of renewable energy.





- **Renewable Energy Time-Shift:** Renewable energy resources generate a significant amount of energy at night or off-peak times. Ecoult's UBer™ charges energy at these times and discharges it when supply is scarce and energy demand is high. UBer™ is able to store and discharge energy for minutes or hours, allowing microgrids to improve overall system performance at peak times as well as to cover for periods of loss of solar or wind power.
- **Back-up for Renewable Generation Deficits:** The UBer™ can provide emergency back-up power in case renewable energy sources are not able to produce sufficient output, for example under unfavorable weather conditions. This ensures the microgrid can operate reliably and mission-critical equipment is uninterrupted. Systems can be designed with battery and renewable generation alone or also incorporate back-up diesel generation.
- **Efficiencies from Diesel Generation:** When applied to systems with both renewable and diesel generation sources the UBer™ can be utilized to minimize the use of diesel by compensating for sudden changes in loads.
- **Frequency Response:** The UBer™ is able to actively correct frequency deviations within seconds through the automatic, autonomous, and rapid release or absorbance of power in response to changes in frequency.
- **Voltage Support Service:** Ecoult's UBer™ supports reliable and efficient microgrids through the delivery of voltage control and reactive power support services, crucial for providing sufficient reserve margins and dynamic response capabilities. The UBer™ manages reactive power on an alternating-current (AC) power system by releasing or absorbing reactive power (VARs) while at the same time releasing or absorbing real power. This enables the smooth operation of customer and power-system equipment, the maximization of the amount of real power that can be transferred across a congested transmission interface as well as improved efficiency of transmission.

Key Features and Benefits

+ Enables reliable, efficient, and environmentally sound microgrids
+ Supports increasing power demand in urban and remote areas
+ Transmission and distribution investment deferral on utility side
+ Continuous power and improved power quality
+ Energy-efficient diesel generation
+ Virtually zero CO_2 emissions
+ Quick deployment of energy storage systems compared to lengthy approval and construction processes required for transmission and distribution networks
+ Flexible and scalable from kW to multiple MW
+ Recyclable technology

UltraBattery® Technology: The New Dimension in Lead Acid

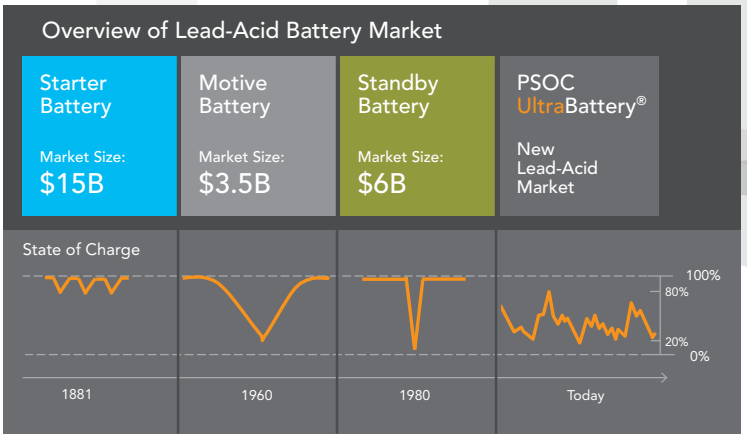
UltraBattery® is a completely new class of lead-acid technology: a hybrid, long-life lead-acid battery that – unlike starter, motive, and standby lead-acid batteries – operates very efficiently in continuous Partial State of Charge (PSoC) use without frequent overcharge maintenance cycles.

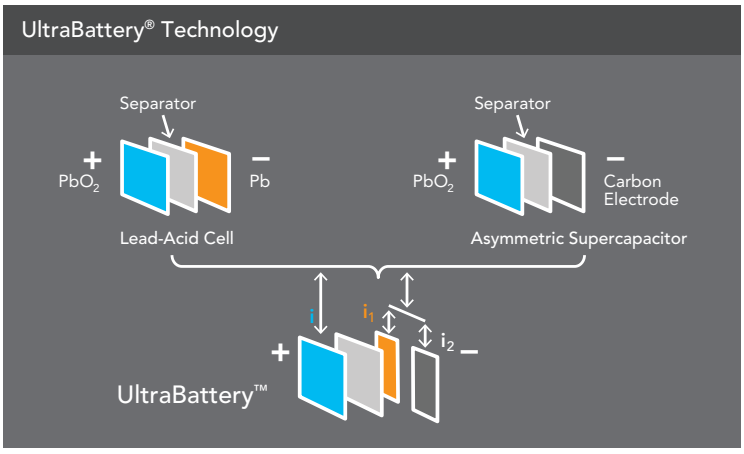
It can be utilized to continually manage energy intermittencies, smooth power, and shift energy, using a band of charge that is neither totally full nor totally empty.

The UltraBattery® combines the advantages of the most tried and tested advanced lead-acid battery technology with the advantages of an asymmetric capacitor – enabling an optimal balance of an energy-storing lead-acid battery with the quick charge acceptance, power discharge, and longevity of a capacitor.

Standard valve-regulated lead-acid (VRLA) batteries form 'hard' lead sulfate deposits inside the negative plate when operated continuously in a Partial State of Charge (PSoC) regime, unless given frequent refresh overcharge cycles. To address the needs of power applications, Australia's Commonwealth Scientific and Industrial Research Organisation (CSIRO) invented the breakthrough advanced VRLA UltraBattery®. The capacitor integrated in the UltraBattery® chemistry modifies the process associated with the formation and dissolving of sulfate crystals in the negative plate when charging and discharging. This enables the UltraBattery® to operate with high efficiency in Partial State of Charge use, and combined with the cycling endurance of the technology, results in an ability to process a much greater amount of energy in the device's usable lifetime – a significant multiple over standard lead-acid technology. This capability is fundamental to the typical grid and renewables requirements for smoothing the variability and shifting of energy.

With its high cycling life, high conversion efficiency and low operating costs, UltraBattery® offers an economical $/kWh solution for whole of life for continuous regulation services and intermittency control. It is safe, recyclable and with virtually zero emissions the economic and environmentally sound alternative to conventional generation assets. The outperformance of UltraBattery® across a range of key performance parameters has been proven in multiple tests by Sandia National Laboratory, the Advanced Lead Acid Battery Consortium (ALABC), CSIRO, Furukawa Battery, East Penn Manufacturing and Ecoult.

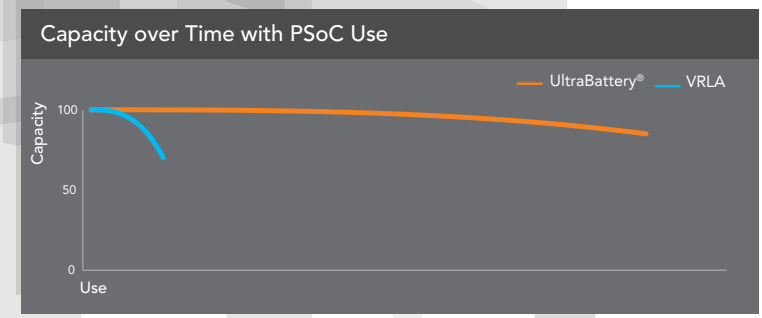




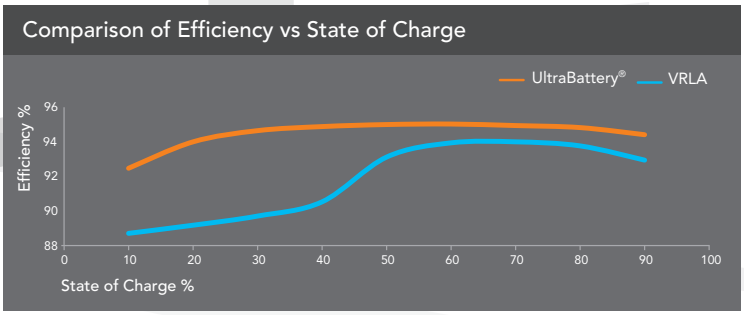
UltraBattery® – Simple, Safe, and Environmentally Sound Energy Storage

+ Economical $/kWh for whole of life

UltraBattery® offers the most advantageous combination of high cycling life and high conversion efficiency, making it a very cost-competitive energy storage solution. UltraBattery® provides the lowest $/kWh for whole of life for continuous regulation services and intermittency control, as acknowledged in the EPRI report *Electricity Energy Storage Technology Options* (December 2010).



The UltraBattery® can turn over much more energy during its life than a standard VRLA



UltraBattery® is more efficient than a standard VRLA across a wide range of SoC

+ High cycling life
Multiple tests by Sandia, CSIRO, East Penn Manufacturing, and Furukawa Batteries show the high cycle life of the UltraBattery® technology. Independent testing of UltraBattery® against an electric utility/ discharge High Rate Partial State of Charge (HRPSoC) profile performed by Sandia National Laboratories showed that the UltraBattery® cycle performance was about 13x greater (>15,000 cycles) than a comparable AGM VRLA battery (1,100 cycles) (*UltraBattery® Test Results for Utility Cycling Applications*, December 2008). Ecoult has conducted and is continuing to conduct exclusive performance characterization of the UltraBattery® against relevant use profiles. This testing directly links the high cycling life of the UltraBattery® technology to real world applications.

+ Safe and Robust
The UltraBattery® has the abuse tolerance, versatility, and track record of dependability critical for a large amount of battery power in one location. It is manufactured by East Penn Manufacturing whose quality and environmental management systems are certified to ISO 9001:2008, ISO/TS 16949:2009, and ISO 14001:2004. The UltraBattery® is also certified as non-hazardous for transportation by the IATA and DOT.

+ Available
Ecoult has the ability to deliver volume production of UltraBattery® modules manufactured by East Penn Manufacturing.

+ Environmentally sound and recyclable
The UltraBattery® technology not only allows the efficient integration of renewable energy sources, making it a major driver in decreasing CO_2 emissions, it is also recyclable. At the end of a project, we can pick up the batteries from site, replace and recycle them for our customers.

+ High efficiency in Partial State of Charge use
UltraBattery® displays 93%+ DC to DC efficiency in Partial State of Charge (PSoC) use between 30% and 70% State of Charge (SoC).

+ Flexible charge/discharge power output
UltraBattery's® enhanced performance is exhibited over a wide State of Charge (SoC) range.

+ Excellent string behavior
The individual cells of UltraBattery® strings stay closer in unison than standard cell technology.

+ Scalable
Ecoult provides scalable battery configurations for applications ranging from kW to multiple MW with power and energy being separately scalable.

+ Reliable
The UltraBattery®, complemented by the UBer™ (UltraBattery® Energy Resource) platform, is continuously monitored by an integrated battery management and monitoring system, ensuring maximum longevity and performance of the UltraBattery® cells.

For applications requiring large energy loads to be shifted at low rates of discharge over a duration greater than one hour, the UltraBattery® can be complemented by the Deka Synergy® Battery, an advanced lead carbon technology developed and produced by East Penn Manufacturing. The Deka Synergy® Battery has exhibited the ability to cycle longer than traditional VRLA batteries while maintaining its capacity, when used in low-rate Partial State of Charge (PSoC) applications.

Deka unigy
UltraBattery®

safe

The UBer™ Platform – Ecoult's UltraBattery® Energy Resource

The UltraBattery® technology is available as the UltraBattery® Energy Resource (UBer™), a complete energy storage solution engineered to provide a robust, safe, and flexible scalable platform for energy storage systems.

The UBer™ supports the management of short- to medium-term intermittencies and shifting of energy. The UBer™ is cost-effective, safe, reliable, and simple to deploy, maintain, and recycle, making it a low risk path for grid-scale energy storage applications.

Ecoult's UBer™ product modules comprise:

- UBer™ Storage Blocks:
  - UltraBattery® Storage Blocks
  - Deka Synergy® Storage Blocks
- UBer™ Power Conversion Blocks (optional)
- UBer™ Master and Subsystem Controllers
- UBer™ Secure Communications Framework
- UBer™ Battery Management and Monitoring System

Service modules can be provided by Ecoult or UBer™ service partners, or Ecoult can support customers and their preferred integrator.

Ecoult's service modules comprise:

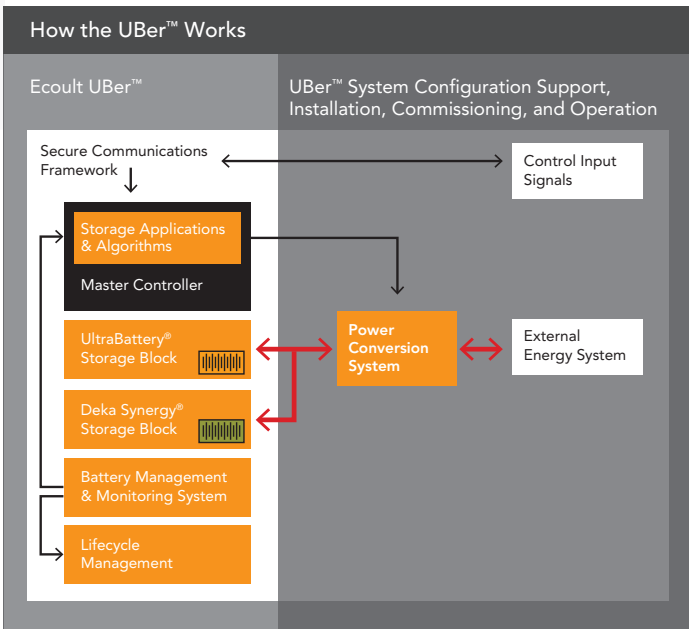
- Storage Applications and Algorithms Development
- UBer™ System Configuration, Installation, Commissioning and Operation
- UBer™ Lifecycle Management – Monitoring and Alerts
- UBer™ Lifecycle Management – Maintenance and Recycling Services

How the UBer™ works

UBer™ is a platform tool to make the process of applying a storage solution to deliver on a business need easy and straightforward. UBer™ has been designed to provide the requisite support, controls, and safeguards, wrapped around the physical energy storage, to ensure that the application can be implemented flexibly, securely, and in a manner that makes best use of the storage asset.

The Secure Communications Framework in the UBer™ receives external control input signals (from renewable sources, grid or diesel generators) and reviews and forwards the signals to the Storage Applications and Algorithms module. At the same time, the Storage Applications and Algorithms module also receives input from the Battery Monitoring and Management System, which monitors and flags security sensors indicating the State of Charge (SoC) and the State of Health (SoH) of the battery cells. The external control signals and the inputs from the Battery Monitoring and Management system are used by the Storage Applications and Algorithms module to determine response actions. Via the Secure Communications Framework, the Storage Applications and Algorithms module then sends commands to control the Power Conversion System (PCS) to deliver the target objectives.

The role of the PCS in an UBer™ solution is to control bi-directional flow of power from DC to AC and AC to DC and to provide grid integration. It is controlled by the commands generated by the Storage Applications and Algorithms module.



UBer™ Storage Blocks

Ecoult's UBer™ is modular and can be configured flexibly to implement a wide range of power and energy options by combining an appropriate selection of UltraBattery® Storage Blocks and Deka Synergy® Storage Blocks.

For more information please refer to the *UBer™ Megawatt Scale System Configuration* brochure.

UBer™ Power Conversion Blocks (optional)

Each UBer™ Power Conversion Block is a complete power solution ready for use including independent connection to a medium-voltage class collector feeder. The power from this feeder is then transformed to the grid voltage at a centralized substation.

Ecoult can provide and integrate the Power Conversion System or can support customers and their preferred PCS supplier in integrating the PCS.

UBer™ Master and Subsystem Controllers

The UBer™ Master Controller provides the execution environment for the Storage Applications and Algorithms module. The Master and Subsystem Controllers together are responsible for operation of the entire storage system including ensuring it operates inside the intended State of Charge (SoC) boundaries. UBer™ will suspend operation of the store if the application tries to operate outside the defined boundaries of the system or safety is compromised.

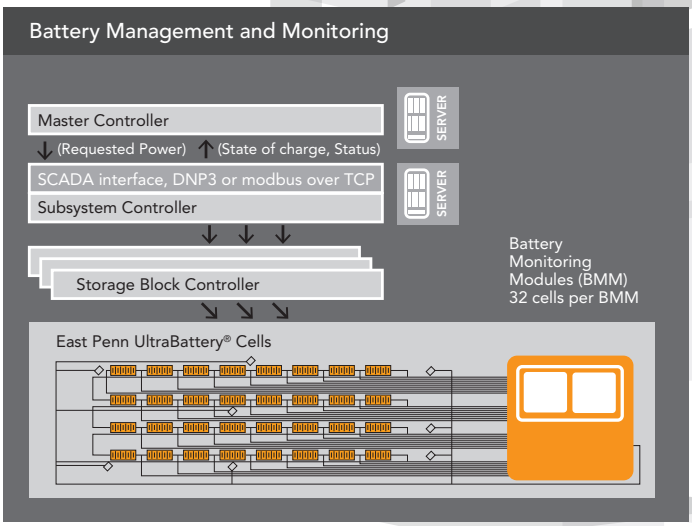
UBer™ Secure Communications Framework

Ecoult provides standard DNP3 and modbus control interfaces over TCP/IP and can add protocol converters to implement customer-specific communications or customer-secure communications protocols.

Ecoult's monitoring and control interfaces are protected by SSL mechanisms as recommended by NIST (National Institute of Standards and Technology).

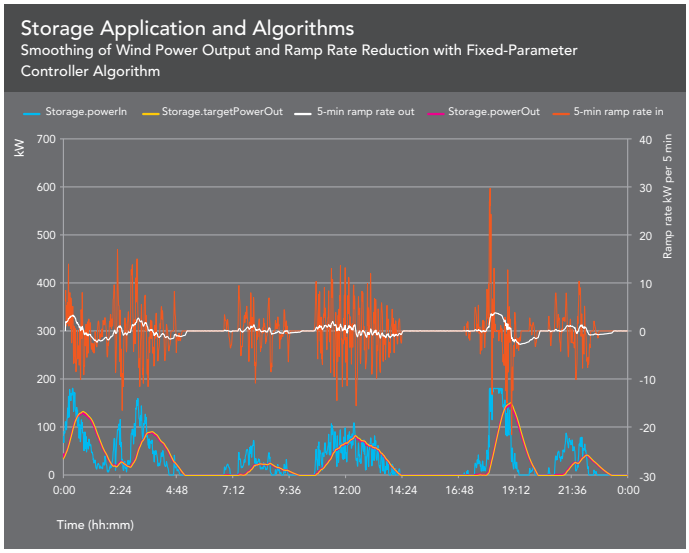
UBer™ Battery Management and Monitoring System

Ecoult's UBer™ Battery Management and Monitoring System is composed of several controllers coordinated to command, protect, and monitor the storage system, ensuring maximum longevity and performance of the battery cells. The controllers are built into every UBer™ Storage Block.



Storage Applications and Algorithms Development (optional)

The storage application layer including any storage algorithms can be developed by the customer, by third parties, or by Ecoult in collaboration with the Commonwealth Scientific and Industrial Research Organisation (CSIRO). Ecoult's advanced application algorithms allow the delivery of highly effective outputs against the target impact objectives while utilizing the storage asset more effectively, thus maximizing economic returns from the use of storage.



UBer™ System Configuration Support, Installation, Commissioning, and Operation (optional)

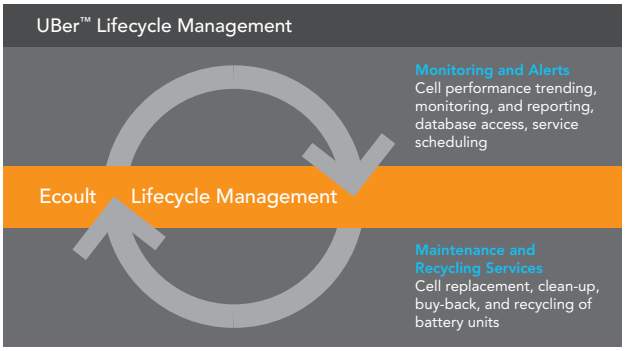
Ecoult will work with each customer or the overall project integrator to ensure the UBer™ storage system is sized and configured correctly to deliver the intended outcome.

Installation, commissioning, and operation of the UBer™ System can also be provided by Ecoult or UBer™ service partners or the customer's preferred system integrators.

For more information please refer to the *UBer™ Megawatt Scale System Configuration* brochure.

Lifecycle Management – Monitoring and Alerts (optional)

Ecoult can accompany customers through the entire lifecycle of the storage solution. Our lifecycle management tools and services are able to constantly monitor the performance and State of Health (SoH) of the battery cells and provide customers with daily reports. Remote monitoring of the UBer™ is via SCADA (supervisory control and data acquisition) and alerts are generated if the system performance is outside previously set specifications.



Different data are sampled at 30-second intervals, analysed, and stored in 24-hour data reports for customers to download, identifying system component trends including cell State of Health (SoH). Specifically, the data tracked by Ecoult Lifecycle Management includes:

- Time/date
- Control signal
- Response signal
- State of Charge (SoC) of UBer™ Storage Block
- System status.

Certain events such as changes in operational mode, changes in the authorizing party, or state changes of access control switches, hydrogen sensors, and smoke sensors are relevant to the security and safety of the systems. Logged by the UBer™ Lifecycle Management tools, this information is forwarded as email alerts to customers. Summary alerts are sent to nominated phone numbers as voice messages or as SMS text messages and include time, date, and nature of the event.

Internal system variables of the power converter and battery storage are monitored by the UBer™ Lifecycle Management tools and alerts are provided to customers if critical values fall outside specifications or if trends in data are outside set specifications.

Lifecycle Management – Maintenance and Recycling Services Module (optional)

Ecoult can offer comprehensive battery maintenance or replacement services and at the end of a project Ecoult can offer a final clean-up as well as a buy-back and recycling of the battery units for customers.

Ecoult UBer™ – Safe, Complete, and Flexible Scalable Energy Storage Platform

+ Simple to deploy, maintain, and recycle
+ Safe and reliable
+ Around-the-clock protection and monitoring of energy cells
+ System operating safeguards
+ Standardized, complete platform
+ Modular, flexible, and scalable
+ Low-risk energy storage
+ Field proven

Eka unigy UltraBattery®

flexible

UBer™ Megawatt Scale System Configuration

Ecoult will work with each customer or the overall project integrator to ensure the UBer™ storage system is sized and configured correctly to deliver the intended outcome.

Ecoult's UBer™ is implemented by creating applications that run on an UBer™ Energy Storage System. The UBer™ System is modular and can be configured flexibly to implement a wide range of power capability and energy capacity options.

Configuring a Megawatt Scale UBer™ System

An UBer™ System comprises one or more UBer™ Subsystems which are connected to the same AC bus.

Each UBer™ Subsystem comprises an UBer™ Power Conversion Block with a specific maximum power rating which is interfaced with one or more UBer™ Storage Blocks selected to provide the required energy capability.

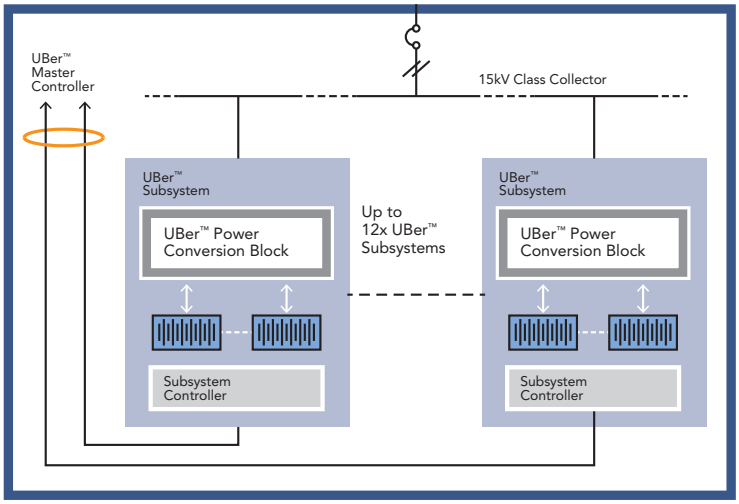
Each UBer™ Subsystem has an UBer™ Subsystem Controller which is responsible for the subsystem's operation.

The UBer™ Master Controller communicates commands to subsystems via the Subsystem Controllers. The Subsystem Controllers in turn feed back voltage, current, power, and status, including fault status.

UBer™ Master Controller

Operation of the overall UBer™ System is maintained by the UBer™ Master Controller, which interfaces across all subsystems connected in an UBer™ System. The capabilities of the overall UBer™ System are a function of the subsystems. The subsystems are electrically independent from each other beyond connection to the transmission system, but are logically synchronized in operation by the Master Controller. Where an UBer™ System uses multiple subsystems, the subsystems can be controlled fully and independently, providing, for example, for continuous system operation during maintenance of a subsystem.

1 to 18 MW UBer™ Energy Storage System
Configured with 1 to 12 UBer™ 1 or 1.5 MW Subsystems



The UBer™ Master Controller provides the following macro functions:

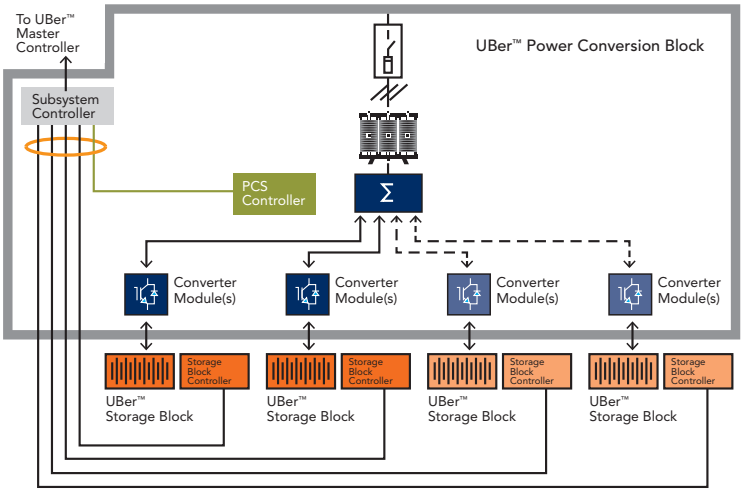
- Coordination of operating modes (grid-connect or off-grid)
- Power Conversion System (PCS) control, including the supply of active power (P) commands and reactive power (Q) in grid-connect mode
- Acquisition and feedback of measurement and system status
- Monitoring and management of the batteries including State of Charge (SoC) Limits and State of Health (SoH)
- Control of the human–machine interface (HMI) terminal. Local control and display of system status is through an HMI terminal mounted central to the installation
- If applicable, interfacing to the utility either via SCADA or customer via internet or other digital communication means
- Remote monitoring of the UBer™ System by Ecoult via internet. The Master Controller logs battery cell status, PCS status, and other system data hourly to a remote Ecoult database where the data is analyzed by Ecoult to monitor system reliability and provide reports to customers
- Email alerts for selected system events.

The UBer™ Master Controller can manage up to 12 UBer™ Subsystem Controllers, which allows for systems of up to 18MW to be configured using a single Master Controller. Larger systems can be created as multiples of the UBer™ MC-MW-12 solutions. Customization of the UBer™ Master Controller is also possible.

UBer™ Subsystem Controller

The UBer™ Subsystem Controller provides control and monitoring of the entire subsystem including the PCS, transformer and main AC breaker. The Master Controller communicates commands to the UBer™ Subsystem Controllers, while the Subsystem Controllers feed back voltage, current, power, and status, including fault status. Actual PCS faults are displayed on a human–machine interface (HMI) within the PCS.

1.0 or 1.5 MW UBer™ Subsystem



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UBer™ Power Conversion Blocks

Each UBer™ Power Conversion Block is a complete power solution ready for use within an UBer™ System, including independent connection to a medium-voltage class collector feeder. The power from this feeder is then transformed to the grid voltage at a centralized substation. More than one 18MW UBer™ System may feed the substation.

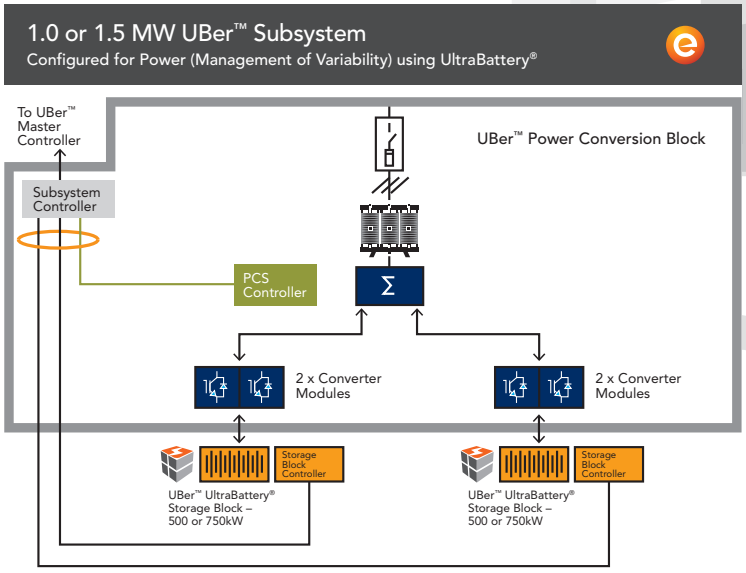
Each UBer™ Power Conversion Block comprises:

- Multiple bi-directional converter modules with the capability to parallel pairs of converters or access each independently (for example, a 1000kW UBer™ Power Conversion Block contains 4 x 250KW converter modules and a 1500kW UBer™ Power Conversion Block contains 4 x 375KW converter modules)
- A main DC contactor for each converter module
- A DC capacitor pre-charge circuit (charged from battery side)
- An AC filter for the PCS output compliant with IEEE1547 with an option for AC EMI filters
- 1 x PCS controller
- 1 x PCS transformer rated for use in variability management duty
- 1 x fused isolation switch connected to the primary of the PCS transformer for protection and maintenance.

Two standard UBer™ Power Conversion Blocks are available today for configuring MW scale UBer™ Subsystems:

- UBer™ PCB-320/1000KW-TS is a 1 MW capable Power Conversion Block based around storage with nominal 640 (+/- 320) VDC potential (320 x 2V cells)
- UBer™ PCB-480/1500KW-SS is a 1.5MW capable Power Conversion Block based around storage with nominal 960 (+/- 480) VDC potential (480 x 2V cells).

Custom UBer™ Power Conversion Block configurations can also be provided.



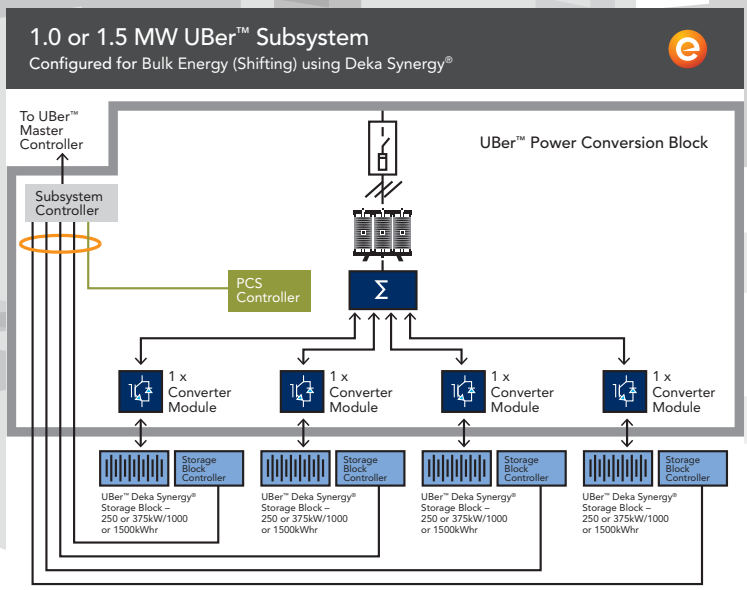
UBer™ Storage Blocks

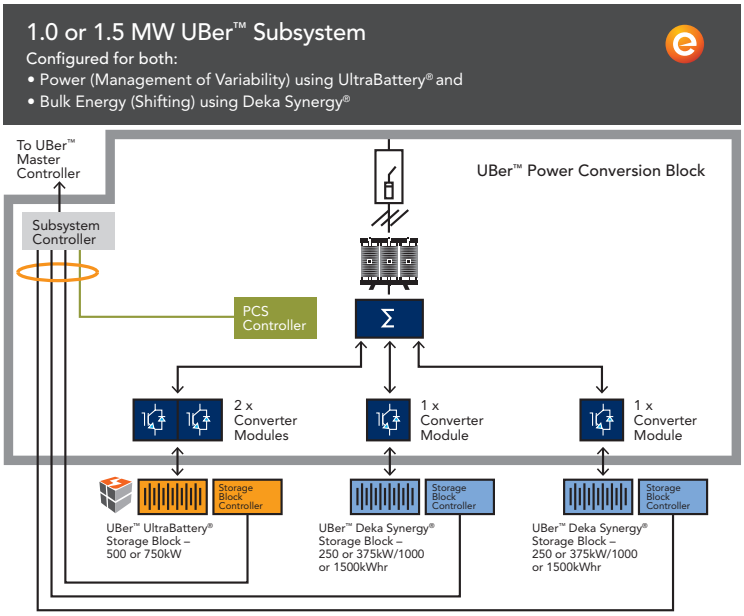
The energy storage for use with each UBer™ Power Conversion Block to create the UBer™ Subsystem is made up of UBer™ Storage Blocks. These are strings of batteries incorporating the UBer™ Battery Management and Monitoring modules, a UBer™ Storage Block Controller, and a fused isolation switch. The Storage Block can be provided either containerized or ready for installation in a building. There are two types of UBer™ Storage Blocks:

- UBer™ UltraBattery® Storage Blocks are intended for both power applications (variability management) and energy applications (energy shifting)
- UBer™ Deka Synergy® Storage Blocks are intended for energy applications (energy shifting).

Each Ecoult Storage Block of battery cells includes distributed processors and a Storage Block Controller (SBC) that monitors the string current, voltages of all cells, and temperatures of sample cells within the block. The Storage Block Controller calculates State of Charge (SoC) for the string and individual cells and can apply slight loads to individual cells to match cell SoCs. The Storage Block Controller can periodically apply a test load to the string and measure responses of cells to determine the cell State of Health (SoH).

The four converter modules within the Power Conversion Block can be used independently or paralleled to match the power rating of Storage Blocks. This flexibility allows for a single UBer™ Power Conversion Block to be optimized for variability management (power), or for energy shifting (energy) or, optionally, for 50% of its capability to be used for power and 50% for energy applications.





Two standard UltraBattery® Storage Blocks and two standard Deka Synergy® Storage Blocks are available for use with UBer™ Power Conversion Blocks. Custom UltraBattery® Storage Blocks and Deka Synergy® Storage Blocks configurations can also be provided.

Standard UBer™ UltraBattery® Storage Blocks

- UBer™ USB-320/500KW – UltraBattery® Storage Blocks for use with UBer™ Subsystems with nominal +/- 320V DC potential (320 x 2V cells)
- UBer™ USB-480/750KW – UltraBattery® Storage Blocks for use with UBer™ Subsystems with nominal +/- 480V DC potential (480 x 2V cells)

Note: Standard UltraBattery® Storage Blocks are not designed to be connected in parallel to increase energy capability. Custom configurations may be made available through consultation with Ecoult.

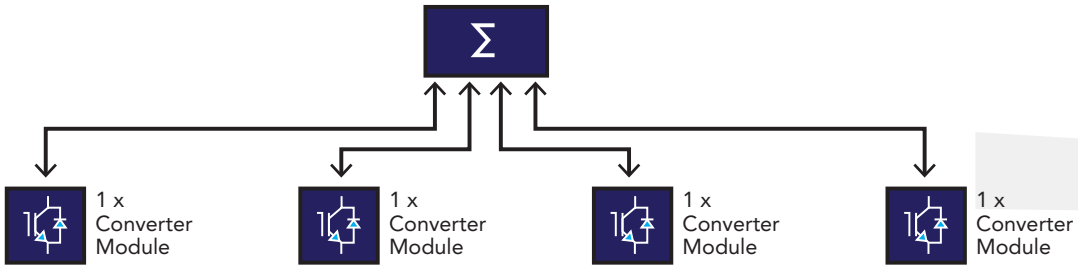
Standard UBer™ Deka Synergy® Storage Blocks

- UBer™ SSB-320/250KW – UBer™ Deka Synergy® Storage Blocks for use with UBer™ Subsystems with nominal +/- 320V DC potential (640 VDC terminal to terminal)
- UBer™ SSB-480/375KW – UBer™ Deka Synergy® Storage Blocks for use with UBer™ Subsystems with nominal +/- 480V DC potential (960VDC terminal to terminal)

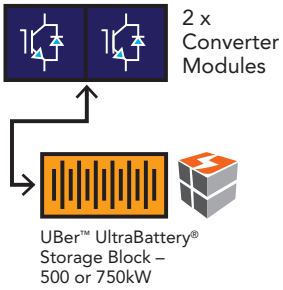
Note: Up to 3 standard UBer™ Deka Synergy® Storage Blocks can be paralleled and connected to a single converter module to increase energy capability. When parallel configurations are used, the design of overall system cabling must be considered to equalize impedances between blocks. Consultation with Ecoult is recommended when using parallel strings. In cases where multiple blocks are paralleled, the UBer™ Subsystem Controller has logic to equalize block State of Charges (SoCs) prior to operating block contactors to minimize inrush currents between blocks.

Summary of Configuration Options for UBer™ Storage Blocks and UBer™ Power Conversion Blocks

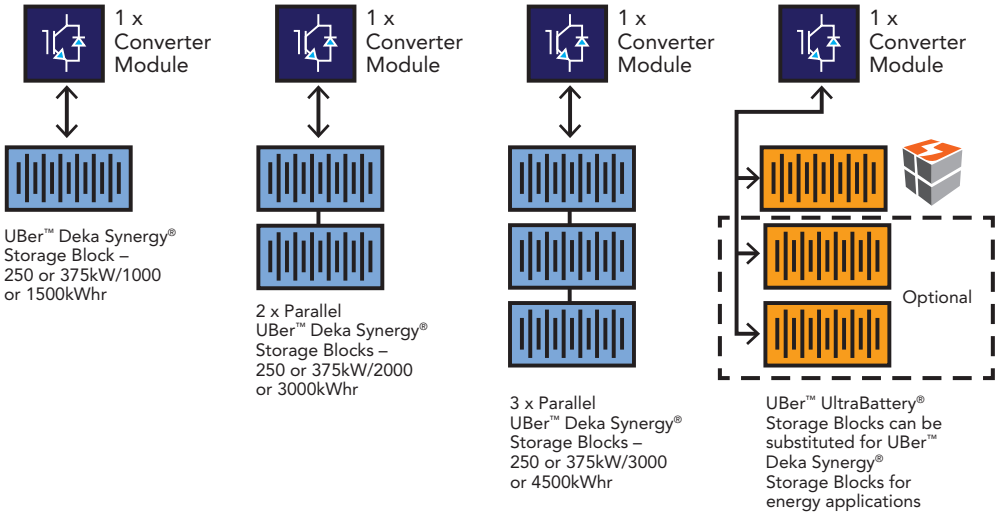
UBer™ Power Conversion Blocks have four independently controlled converter modules.



When used for applications which address variability management, such as regulation services or renewable ramp rate management, Ecoult recommends use of UBer™ UltraBattery® Storage Blocks and two converter modules dedicated to each UltraBattery® Storage Block.



When used for applications which address bulk energy shifting, such as peak demand management or the modification of the profile of generation, Ecoult recommends use of UBer™ Deka Synergy® Storage Blocks. When used in energy mode, each converter module is used independently, connected to up to three paralleled Deka Synergy® Storage Blocks. Using the Deka Synergy® Storage Blocks in parallel multiples the available application energy for each UltraBattery® Storage Block deployed. UltraBattery® Storage Blocks can be used for bulk energy shifting and exhibit extended longevity wherever the proportion of energy shifted each day is high.



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Important Configuration Notes

- The DC ratings for UBer™ Power Conversion Blocks and UBer™ Storage Blocks must always be matched (e.g. UBer™ PCB-320/1000-TS Power Conversion Blocks use UBer™ USB-320/500KW UltraBattery® Storage Blocks or UBer™ SSB-320/250KW Deka Synergy® Storage Blocks).
- The total power rating for UBer™ Power Conversion Blocks should not exceed the total power rating of any associated UBer™ Storage Blocks.

UBer™ System – Modes of Operation

The UBer™ System has two operating modes: grid-connect mode, and off-grid mode.

In grid-connect mode, the UBer™ System either charges or discharges active power (P) to the grid in response to a command, and likewise either generates leading or lagging reactive power (Q) in response to a command. An active power (P) command can be received for individual converter modules, which enables one or more converter modules to respond to a smoothing algorithm while the remaining converters modules respond to a shifting algorithm. A single reactive power (Q) command can be received from either a VAR regulator or an automatic voltage regulator (AVR). In grid-connect mode, the startup sequence is first to energize the PCS transformer using battery power, and then to synchronize the UBer™ to the grid prior to closing the main AC breaker. This prevents PCS transformer inrush and provides for a bumpless connection to the grid.

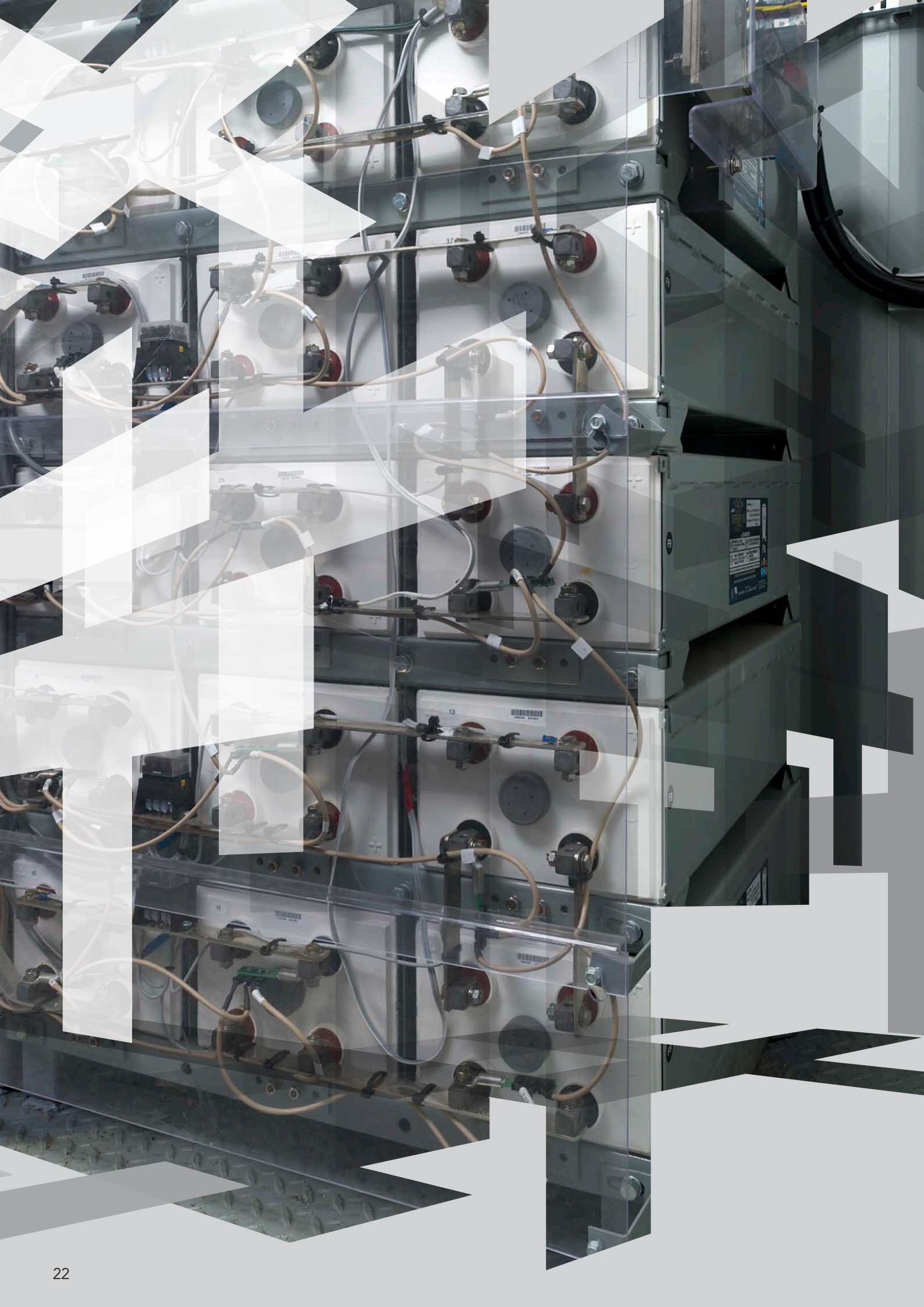
In off-grid mode, the UBer™ System can regulate frequency and voltage and become the master on the 'microgrid' for which all other generators follow. This is accomplished by a set of microgrid algorithms based on droop control.

The amount of active power is limited by the maximum power rating of the power converter modules and the State of Charge (SoC) limits for the batteries, which will curtail power once the limits are reached. In the case of reactive power, the sum of the active and reactive components is limited to the MVA rating of the PCS.

Codes and Standards

The Ecoult UBer™ is designed, manufactured and tested in conformance with the applicable requirements of the latest editions, revisions, and addenda of the codes and standards published by the following authorities:

- ANSI (American National Standards Institute)
- IEEE (Institute of Electrical and Electronics Engineers)
- NEC (National Electrical Code)
- NEMA (National Electrical Manufacturers Association)
- NFPA (National Fire Protection Association)
- UL1741 (designed and constructed to Underwriters Laboratories standard 1741, including by reference IEEE1547 interconnections standards. The system does not have a UL1741 certification nameplate. Witnessing of IEEE1547 interconnection tests is an option).



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UBer® Storage Blocks and Complementing Power Conversion Blocks

UBer™ Storage Blocks and Complementing Power Conversion Block +/-320VDC

UBer™ Storage Block	Nominal String Voltage	Power Rating	Recommended Use	100% Capacity at 24 Hours Rate
UBer™ USB-320/500KW UltraBattery® Storage Block	+/-320 VDC	+/-500kW	Intermittency Management or Energy Shifting	1 MWh*
UBer™ SSB-320/250kW Deka Synergy® Storage Block	+/-320 VDC	+/-250kW	Energy Shifting	1 MWh*
UBer™ Power Conversion Block	**Nominal DC Voltage**	**AC Power Rating**	**DC Power Rating**	**AC Connection**
UBer™ PCB-320-1000KW-TS	+/-320V	1000kW continuous	Configurable for: 2 x 500kW 1 x 500kW and 1 x 250kW or 2 x 250kW	11kV/13.2kV/13.8kV (others on request)

UBer™ Storage Blocks and Complementing Power Conversion Block +/-480VDC

UBer™ Storage Block	Nominal String Voltage	Power Rating	Recommended Use	100% Capacity at 24 Hours Rate
UBer™ USB-480/750KW UltraBattery® Storage Block	+/-480 VDC	+/-750kW	Intermittency Management or Energy Shifting	1.5 MWh*
UBer™ SSB-480/375kW Deka Synergy® Storage Block	+/-480 VDC	+/-375kW	Energy Shifting	1.5 MWh*
UBer™ Power Conversion Block	**Nominal DC Voltage**	**AC Power Rating**	**DC Power Rating**	**AC Connection**
UBer™ PCB-480-1500KW-SS	+/-480V	1500kW	Configurable for: 2 x 750kW or 1 x 750kW and 2 x 375kW	11kV/13.2kV/13.8kV (others on request)

* Please refer to recommended usable energy ratings for energy shifting and intermittency management in the UBer™ Storage Block data sheets.

UltraBattery® Storage Block

UBer™ USB-320/500KW

Ecoult UBer™ UltraBattery® Storage Blocks can be supplied in a modular containerized solution or ready for installation in the battery room of a building.

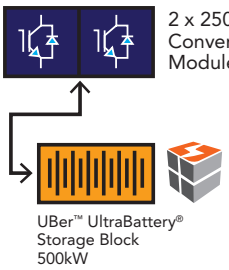
Each UBer™ UltraBattery® Storage Block is a complete platform including:

- UltraBattery® cells
- UBer™ Battery Management and Monitoring Solution
- UBer™ Storage Block Controller
- Integrated heating/cooling/ventilation
- Battery room ancillaries
- Isolation fuse switch.

Technical Specifications of UBer™ USB-320/500KW UltraBattery® Storage Block

Cell Technology	East Penn UltraBattery® AVR-95-33
Number of Cells	320
String Voltage – Nominal	+/- 320 VDC
– Maximum	+/- 400 VDC
– Minimum	+/-270 VDC
Power Rating	+/-500kW
100% Capacity at 24 Hours Rate	1 MWh

Intermittency Management



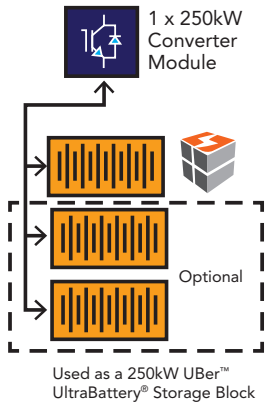
Recommended for applications requiring stabilization of intermittent renewable energy or other energy sources or loads at power levels of less than 500kW.

- Energy band available for application use 350 kWh*
- Total energy available before battery replacement 2GWh**

* Maximum energy band is only achieved at average power levels lower than the peak power rating. Contact Ecoult for details.

** Expected performance under recommended operating conditions. For typical smoothing role with peak power of +/-500kW, 85% of duty at less than +/-250kW and 50% of duty at less than +/-100kW.

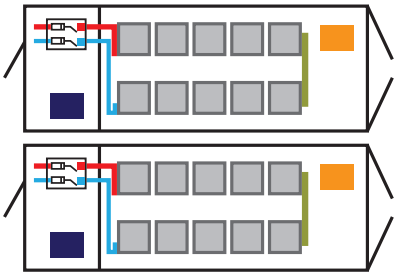
Energy-Shifting Applications



Suitable for energy-shifting applications at Partial State of Charge (PSoC) and power levels of less than 250kW. Can be used as a single Storage Block or in a parallel configuration comprising up to a maximum of three Storage Blocks.

		Recommended Shifting Ratings (PSoC)	
Blocks in Parallel	**Power**	**(Hours)**	**(kWhrs)**
1	100kW	3.5	350
	250kW	1.0	250
2	100kW	7.8	780
	250kW	2.6	650
3	100kW	12.5	1250
	250kW	4.3	1075

UBer™ USB-320/500KW Containerized UltraBattery® Storage Block



The UBer™ USB-320/500KW Containerized UltraBattery® Storage Block is supplied in 2 x 20' ISO shipping containers.

- Dimensions: 2 x 19'10.5" L x 8' W x 8'6" H [6.06m L x 2.44m W x 2.59m H]
- Shipping weight: 2 x 50,000lb [2 x 22,680 kg]
- Operating ambient conditions: Outdoor with an ambient temperature ranging from -25°C to +45°C [-13°F to + 113°F]
- Relative humidity: 0% to 100% relative humidity condensing
- Storage temperature: -18°C to +32°C [0°F to +89°F] without aux power; -40°C to +60°C [-40°F to +140°F] with aux power

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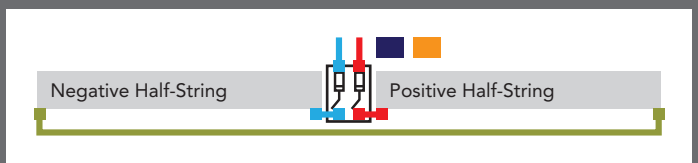
UBer™ USB-320/500KW UltraBattery® Storage Block for Building Installation

The UBer™ USB-320/500KW UltraBattery® Storage Block for building installation is supplied as 2 x 160-cell units with stacks 10-high.

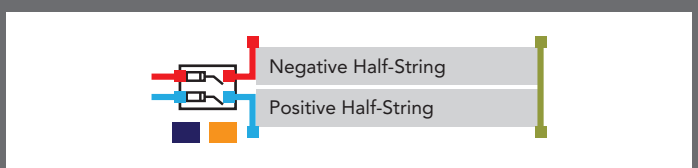
- Dimensions: 2 x 20' L x 10' W x 9' H [6.10m L x 3.05m W x 2.74m H]
- Shipping weight: 43 pallets x 2,200lb [43 x 1,000kg]
- Storage temperature: -18°C to +32°C [0°F to +89°F]

Example Building Configurations

Inline Storage Block



Wrapped Storage Block



UltraBattery® Storage Block

UBer™ USB-480/750KW

Ecoult UBer™ UltraBattery® Storage Blocks can be supplied in a modular containerized solution or ready for installation in the battery room of a building.

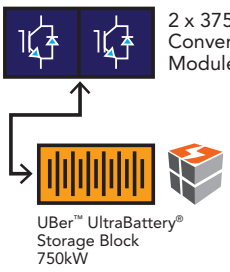
Each UBer™ UltraBattery® Storage Block is a complete platform including:

- UltraBattery® cells
- UBer™ Battery Management and Monitoring Solution
- UBer™ Storage Block Controller
- Integrated heating/cooling/ventilation
- Battery room ancillaries
- Isolation fuse switch.

Technical Specifications of UBer™ USB-480/750KW UltraBattery® Storage Block

Cell Technology	East Penn UltraBattery® AVR-95-33
Number of Cells	480
String Voltage – Nominal	+/- 480 VDC
– Maximum	+/- 600 VDC
– Minimum	+/-400 VDC
Power Rating	+/-750kW
100% Capacity at 24 Hours Rate	1.5 MWh

Intermittency Management



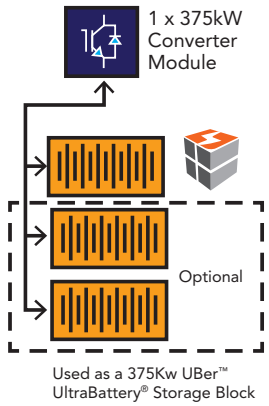
Recommended for applications requiring stabilization of intermittent renewable energy or other energy sources or loads at power levels of less than 750kW.

- Energy band available for application use 530 kWh*
- Total energy available before battery replacement 3GWh**

* Maximum energy band is only achieved at average power levels lower than the peak power rating. Contact Ecoult for details.

** Expected performance under recommended operating conditions. For typical smoothing role with peak power of +/-750kW, 85% of duty at less than +/-375kW and 50% of duty at less than +/-150kW.

Energy-Shifting Applications

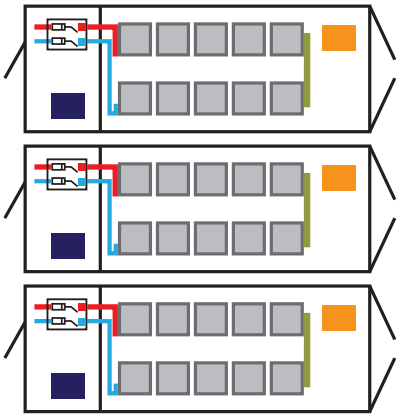


Suitable for energy-shifting applications at Partial State of Charge (PSoC) and power levels of less than 375kW. Can be used as a single Storage Block or in a parallel configuration comprising up to a maximum of three Storage Blocks.

		Recommended Shifting Ratings (PSoC)	
Blocks in Parallel	**Power**	**(Hours)**	**(kWhrs)**
1	100kW	5.6	560
	250kW	1.8	450
	375kW	1.0	375
2	100kW	12.5	1250
	250kW	4.3	1075
	375kW	2.6	975
3	100kW	19.9	1990
	250kW	6.9	1725
	375kW	4.3	1613

UBer™ USB-480/750KW Containerized UltraBattery® Storage Block

The UBer™ USB-480/750KW Containerized UltraBattery® Storage Block is supplied in 3 x 20' ISO shipping containers.

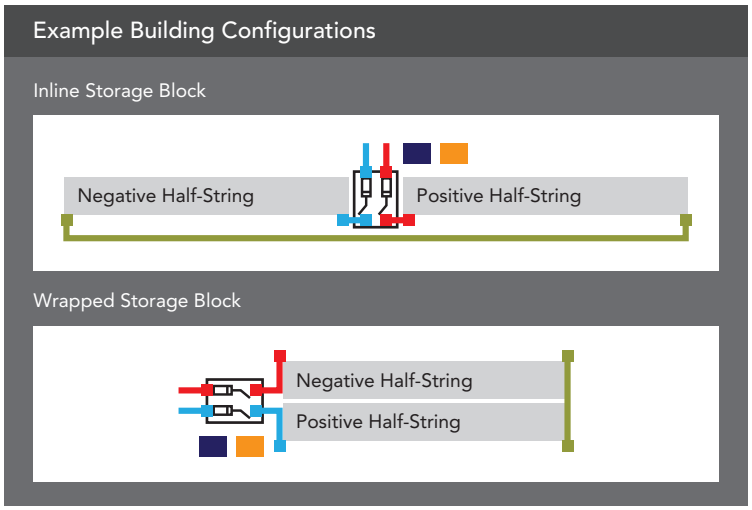


- Dimensions: 3 x 19'10.5" L x 8' W x 8'6" H [6.06m L x 2.44m W x 2.59m H]
- Shipping weight: 3 x 50,000lb [3 x 22,680 kg]
- Operating ambient conditions: Outdoor with an ambient temperature ranging from -25°C to +45°C [-13°F to + 113°F]
- Relative humidity: 0% to 100% relative humidity condensing
- Storage temperature: -18°C to +32°C [0°F to +89°F] without aux power; -40°C to +60°C [-40°F to +140°F] with aux power

UBer™ USB-480/750KW UltraBattery® Storage Block for Building Installation

The UBer™ USB-480/750KW UltraBattery® Storage Block for building installation is supplied as 3 x 160-cell units with stacks 10-high.

- Dimensions: 3 x 20' L x 10' W x 9' H [6.10m L x 3.05m W x 2.74m H]
- Shipping weight: 63 pallets x 2,200lb [63 x 1,000kg]
- Storage temperature: -18°C to +32°C [0°F to +89°F]



Deka Synergy® Storage Block
UBer™ SSB-320/250KW

Ecoult UBer™ Deka Synergy® Storage Blocks can be supplied in a modular containerized solution or ready for installation in the battery room of a building.

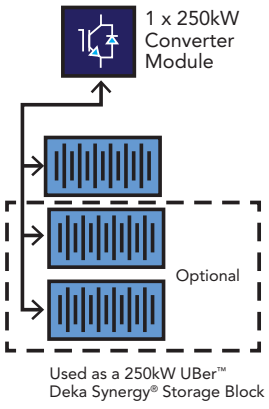
Each UBer™ Deka Synergy® Storage Block is a complete platform including:

- Deka Synergy® cells
- UBer™ Battery Management and Monitoring Solution
- UBer™ Storage Block Controller
- Integrated heating/cooling/ventilation
- Battery room ancillaries
- Isolation fuse switch.

Technical Specifications of UBer™ SSB-320/250KW Deka Synergy® Storage Block

Cell Technology	East Penn Deka Synergy® AVR-95-33
Number of Cells	320
String Voltage – Nominal	+/- 320 VDC
– Maximum	+/- 400 VDC
– Minimum	+/-270 VDC
Power Rating	+/-250kW
100% Capacity at 24 Hours Rate	1 MWh

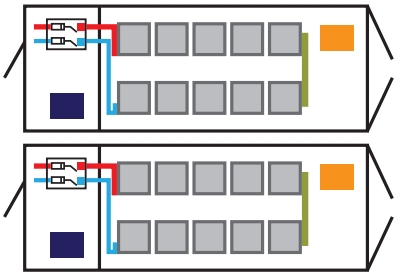
Energy-Shifting Applications



Suitable for energy-shifting applications at Partial State of Charge (PSoC) and power levels of less than 250kW. Can be used as a single Storage Block or in a parallel configuration comprising up to a maximum of three Storage Blocks.

		Recommended Shifting Ratings (PSoC)	
Blocks in Parallel	**Power**	**(Hours)**	**(kWhrs)**
1	100kW	3.5	350
	250kW	1.0	250
2	100kW	7.8	780
	250kW	2.6	650
3	100kW	12.5	1250
	250kW	4.3	1075

UBer™ SSB-320/250KW Containerized Deka Synergy® Storage Block



The UBer™ SSB-320/250KW Containerized Deka Synergy® Storage Block is supplied in 2 x 20' ISO shipping containers.

- Dimensions: 2 x 19'10.5" L x 8' W x 8'6" H [6.06m L x 2.44m W x 2.59m H]
- Shipping weight: 2 x 50,000lb [2 x 22,680 kg]
- Operating ambient conditions: Outdoor with an ambient temperature ranging from -25°C to +45°C [-13°F to + 113°F]
- Relative humidity: 0% to 100% relative humidity condensing
- Storage temperature: -18°C to +32°C [0°F to +89°F] without aux power; -40°C to +60°C [-40°F to +140°F] with aux power

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UBer™ SSB-320/250KW Deka Synergy® Storage Block for Building Installation

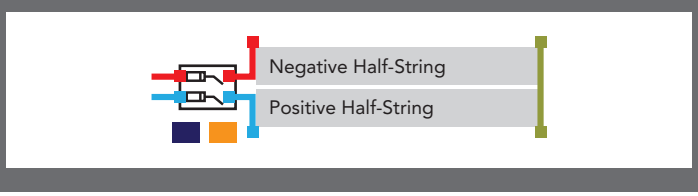
The UBer™ SSB-320/250KW Deka Synergy® Storage Block for building installation is supplied as 2 x 160-cell units with stacks 10-high.

- Dimensions: 2 x 20' L x 10' W x 9' H [6.10m L x 3.05m W x 2.74m H]
- Shipping weight: 43 pallets x 2,200lb [43 x 1,000kg]
- Storage temperature: -18°C to +32°C [0°F to +89°F]

Example Building Configurations

Inline Storage Block

Wrapped Storage Block



Deka Synergy® Storage Block
UBer™ SSB-480/375KW

Ecoult UBer™ Deka Synergy® Storage Blocks can be supplied in a modular containerized solution or ready for installation in the battery room of a building.

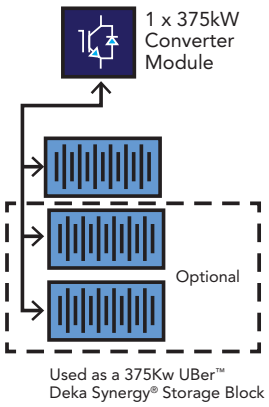
Each UBer™ Deka Synergy® Storage Block is a complete platform including:

- Deka Synergy® cells
- UBer™ Battery Management and Monitoring Solution
- UBer™ Storage Block Controller
- Integrated heating/cooling/ventilation
- Battery room ancillaries
- Isolation fuse switch.

Technical Specifications of UBer™ SSB-480/375KW Deka Synergy® Storage Block

Cell Technology	East Penn Deka Synergy® AVR-95-33
Number of Cells	480
String Voltage – Nominal	+/- 480 VDC
– Maximum	+/- 600 VDC
– Minimum	+/-400 VDC
Power Rating	+/-375kW
100% Capacity at 24 Hours Rate	1.5 MWh

Energy-Shifting Applications

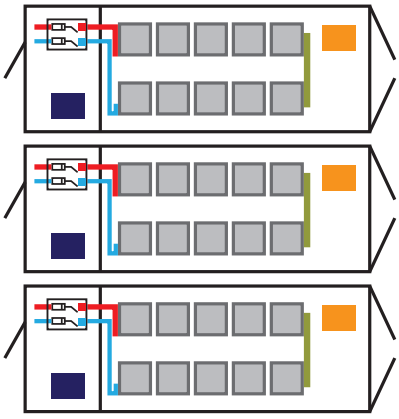


Suitable for energy-shifting applications at Partial State of Charge (PSoC) and power levels of less than 375kW. Can be used as a single Storage Block or in a parallel configuration comprising up to a maximum of three Storage Blocks.

		Recommended Shifting Ratings (PSoC)	
Blocks in Parallel	**Power**	**(Hours)**	**(kWhrs)**
1	100kW	5.6	560
	250kW	1.8	450
	375kW	1.0	375
2	100kW	12.5	1250
	250kW	4.3	1075
	375kW	2.6	975
3	100kW	19.9	1990
	250kW	6.9	1725
	375kW	4.3	1613

UBer™ SSB-480/375KW Containerized Deka Synergy® Storage Block

The UBer™ SSB-480/375KW Containerized Deka Synergy® Storage Block is supplied in 3 x 20' ISO shipping containers.

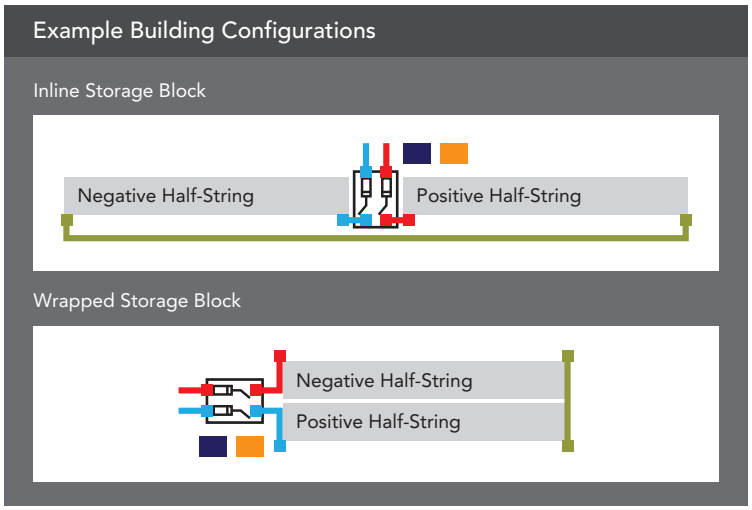


- Dimensions: 3 x 19'10.5" L x 8' W x 8'6" H [6.06m L x 2.44m W x 2.59m H]
- Shipping weight: 3 x 50,000lb [3 x 22,680 kg]
- Operating ambient conditions: Outdoor with an ambient temperature ranging from -25°C to +45°C [-13°F to + 113°F]
- Relative humidity: 0% to 100% relative humidity condensing
- Storage temperature: -18°C to +32°C [0°F to +89°F] without aux power; -40°C to +60°C [-40°F to +140°F] with aux power

UBer™ SSB-480/375KW Deka Synergy® Storage Block for Building Installation

The UBer™ SSB-480/375KW Deka Synergy® Storage Block for building installation is supplied as 3 x 160-cell units with stacks 10-high.

- Dimensions: 3 x 20' L x 10' W x 9' H [6.10m L x 3.05m W x 2.74m H]
- Shipping weight: 63 pallets x 2,200lb [63 x 1,000kg]
- Storage temperature: -18°C to +32°C [0°F to +89°F]



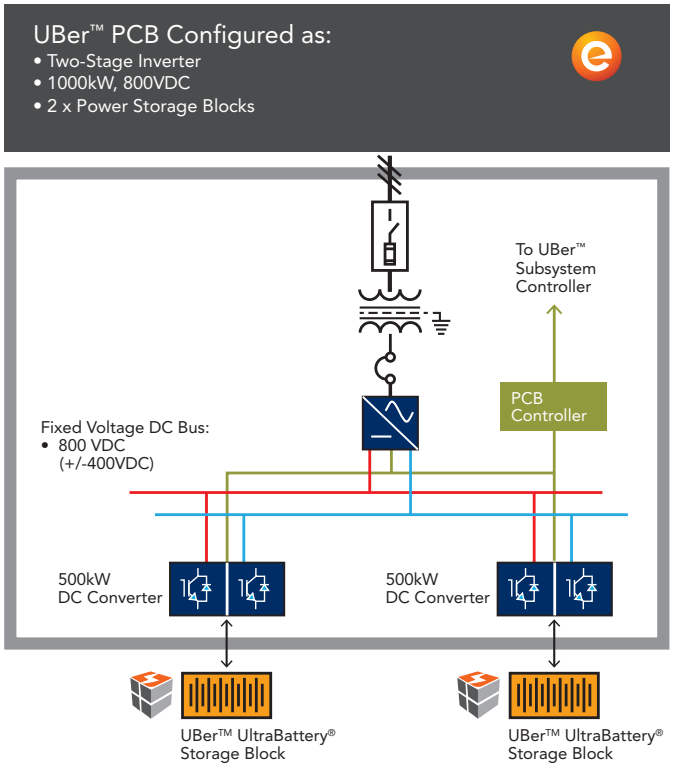
Power Conversion Block

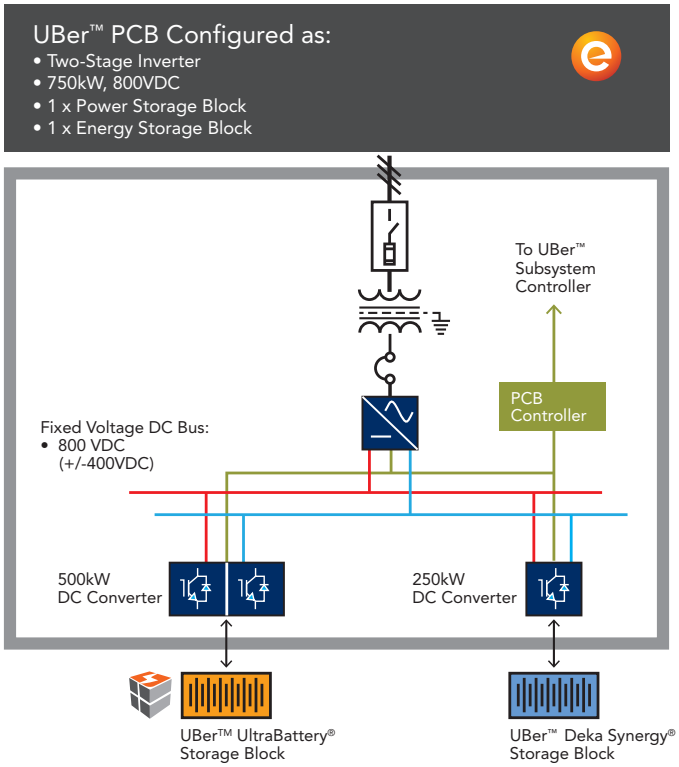
UBer™ PCB-320-1000kW-TS

The UBer™ PCB-320-1000kW-TS Power Conversion Block (PCB) is a two-stage inverter for use with a single winding transformer. The output of the PCB is designed for 15kV class AC power systems, and can be wound for 11kV to 13.8kV voltages. It is composed of:

- A single winding transformer with a 15kV class primary and a 480VAC secondary, complete with a fused load-break isolation switch, and surge protection
- A single (common) DC to AC inverter complete with 480VAC breaker for grid-side protections including anti-islanding (if required)
- Two independently controlled bi-directional DC to DC converters, each equipped complete with a DC contactor and protections
- A PCB Controller for power (P) regulation of each DC converter, reactive power (Q) regulation of the common inverter, and supervisory control and protection
- A human–machine interface (HMI).

The PCB is designed such that different energy storage blocks may be controlled by the individual DC converters. In addition, a PCB may be interconnected with up to 11 other PCBs (a total of 12 PCBs) on a single 15kV class feeder to a centralized substation for interconnection to the main grid.





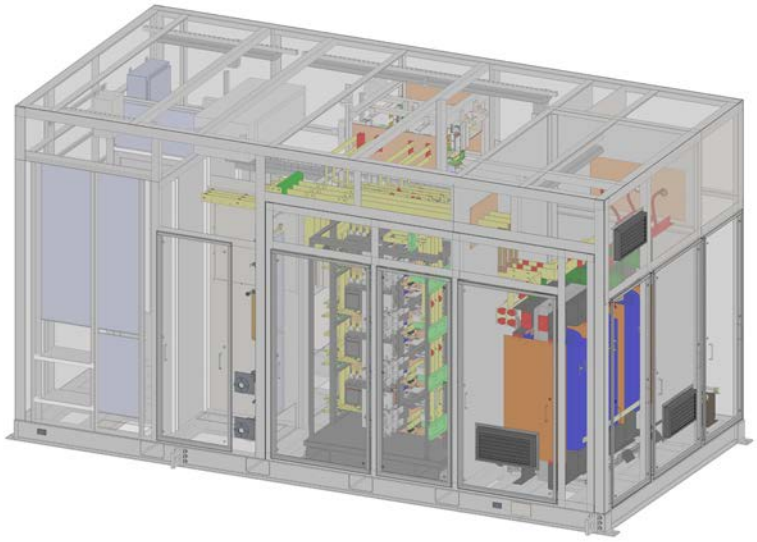
Manufactured by S&C Electric Co for Ecoult

Two-Stage Design – 800VDC, 1000kW

AC RATING	
Nominal AC Voltage	15kV class (34kV class on request)
Termination	Wye with neutral brought out
Frequency	50/60 Hz
Volt-Amps	1000 kVA continuous
Power	1000 kW continuous
Short-Term Rating	115% for 10 seconds repeated every 60 seconds
Voltage Variation	+/- 5% with +/- 10% transients
Voltage Unbalance	+/- 2%
Interconnection Protections	Compliant with IEEE1547
DC RATING OF EACH INVERTER (4 IN TOTAL)	
Maximum DC Voltage	800VDC
Power	Configurable for 2 x 500kW; 1 x 500kW and 1 x 250kW; or 2 x 250kW, over operating voltage range
Grounding Configuration	High resistance, midpoint grounded on DC output of inverter
OPERATING CONDITIONS	
Installation	Outdoor and indoor designs
Altitude	1000 meters
Ambient Air	-25˚C to +45˚C (-13˚F to +113˚F), 0% to 100% relative humidity, condensing
GENERAL FEATURES	
Cooling Means	Inverter and DC converters: forced air cooling with air inlets and outlets screened and filtered to prevent the ingress of sand and insects. Control section: air conditioned
Efficiency	94% at full load
Protections	AC under/over-voltage, AC under/over-frequency, over-current limit and trip, transformer over-temperature, transformer primary fusing, high-speed inverter fusing, inverter/converter over-temperature, DC ground fault
Construction	Constructed and tested to UL1741
Auxiliary Power	120 VAC UPS for control power
Options	Revenue grade meter, indoor and outdoor designs, de-rating for higher altitudes and temperatures
Storage Conditions	-40˚C to +60˚C (-40˚F to +140˚F), 15% to 85% relative humidity, non-condensing

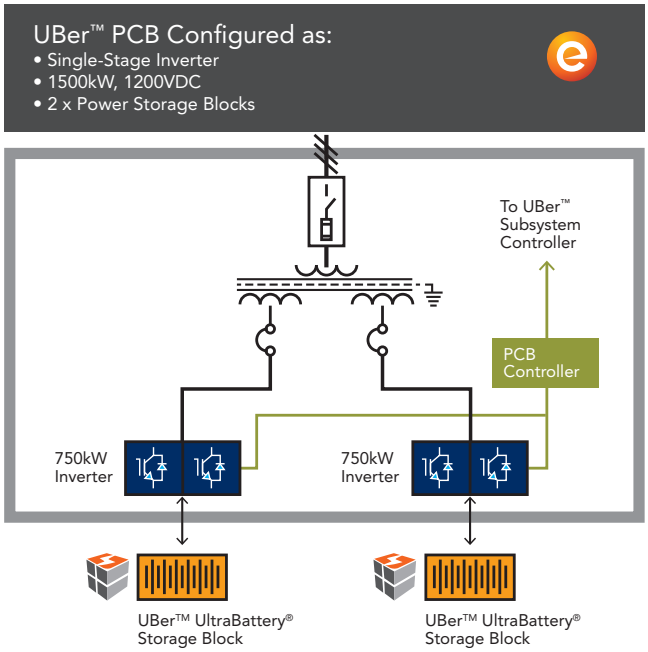
Power Conversion Block

UBer™ PCB-480-1500kW-SS



The UBer™ PCB-480-1500kW-SS Power Conversion Block (PCB) comprises four bidirectional converter modules for use with an integrated epoxy cast resin transformer. The output of the PCB is designed for 15kV class AC interconnection. It is composed of:

- A multiple winding transformer with a 15kV class primary and multiple secondary windings, complete with a fused load-break isolation switch and surge protection
- Four bi-directional converter modules, each equipped complete with an AC breaker for grid-side protections including anti-islanding (if required), a DC contactor, and inverter protections
- A high speed DSP controller for power (P) regulation and reactive power (Q) regulation of each Inverter, and supervisory control and protection with sub cycle response times
- A human–machine interface (HMI).



The PCB is designed such that different energy storage blocks may be controlled by the individual inverters. In addition, a PCB may be interconnected with up to 7 other PCBs (a total of 8 PCBs) on a single 15kV class feeder to a centralized substation for interconnection to the main grid.

Manufactured by Dynapower for Ecoult

Single-Stage Design – 1500kW, designed for use with UBer™ Storage Blocks comprising 480 cells

AC RATING	
Nominal AC Voltage	15kV class (34kV class on request)
Termination	Grounded Delta or Grounded Wye
Frequency	50/60 Hz
Volt-Amps	1500 kVA continuous
Power	1500 kW continuous
Short-Term Rating	120% for 10 seconds repeated every 60 seconds
Voltage Variation	+/- 5% with +/- 10% transients
Voltage Unbalance	+/- 2%
Interconnection Protections	Compliant with IEEE1547
DC RATING OF EACH INVERTER (4 IN TOTAL)	
Maximum DC Voltage	1200VDC
Power	375 kW over operating voltage range configurable for parallel operation for a single 750 kW input
Grounding Configuration	Center point grounded at battery
OPERATING CONDITIONS	
Installation	Outdoor and indoor designs
Altitude	1000 meters
Ambient Air	-25˚C to +45˚C (-13˚F to +113˚F), 0% to 100% relative humidity, condensing
GENERAL FEATURES	
Cooling Means	Inverters: closed-loop liquid cooling with liquid-to-air heat exchanger Control section: air conditioned
Efficiency	96.5% at full load
Protections	AC under/over-voltage, AC under/over-frequency, over-current limit and trip, transformer over-temperature, transformer primary fusing, high-speed inverter fusing, inverter/converter over-temperature
Construction	Constructed to UL1741 standards, testing and certification upon request
Auxiliary Power	120 VAC UPS for control power
Options	Revenue grade meter, indoor and outdoor designs, de-rating for higher altitudes and temperatures
Storage Conditions	-40˚C to +60˚C (-40˚F to +140˚F), 15% to 85% relative humidity, non-condensing

Case Study

PJM Interconnection (PA, US)

Regulation Services

Background

Ecoult is currently completing the implementation of a system which will provide 3 MW of regulation services on the grid of PJM Interconnection, the largest of 10 RTOs/ISOs in the US. The system will also be used for peak demand management.

Customer Challenge

With renewable portfolio standards coming into effect, the large-scale integration of intermittent wind and solar generation will affect the physical operation of the modern grid, resulting in an increasing need for regulation services.

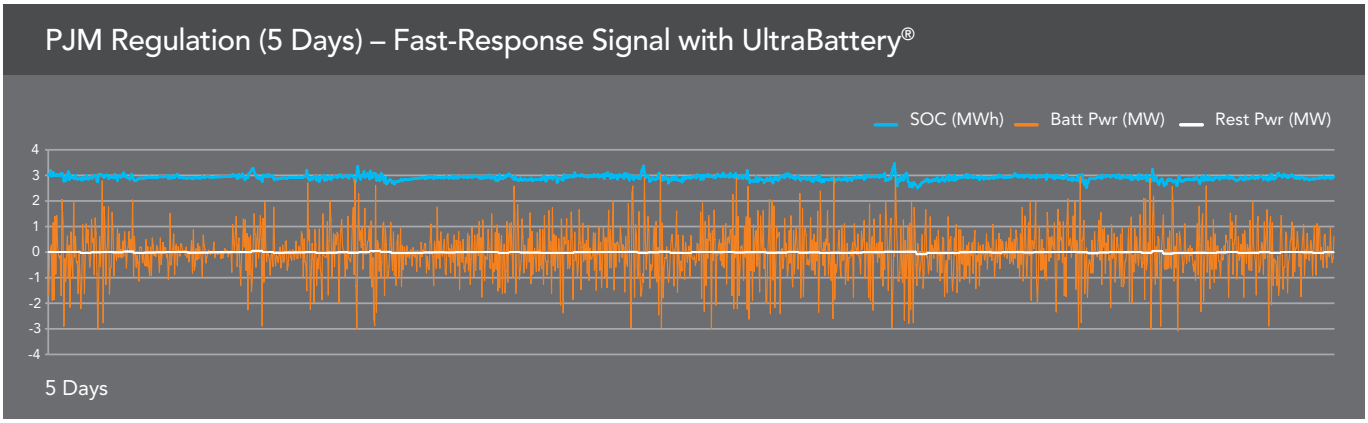
Regulation services are necessary to provide fine tuning in real time for the network to match supply and demand and to that end keep a constant frequency. The energy store responds to a signal provided from the market operator, PJM.

The project objective is to demonstrate the outperformance of the UBer™ (UltraBattery® Energy Resource) in the provision of regulation services. The fast-responding UltraBattery® technology can manage regulation services more efficiently. It is faster, more accurate, cheaper, and cleaner than the incumbent gas peakers often used for regulation services. The UBer™ is therefore able to displace fossil fuel generation methods in the provision of regulation services and to complement fossil fuel generation in the provision of other ancillary services.

Solution Provided

The Ecoult 3 MW UBer™ will be implemented both in a building and in a containerized format to demonstrate flexibility in approach for prospective adopters. It uses four strings of UltraBattery® cells and connects to the grid from inside the East Penn Manufacturing site in Lyon Station, Pennsylvania.

The project will provide continuous frequency regulation services bidding into the open market on PJM. The system will be responding to PJM's fast response signal.



Case Study

PNM (NM, US)

Solar Smoothing and Shifting

Background

PNM, the leading electric utility company in New Mexico, US, has integrated an Ecoult UBer™ (UltraBattery® Energy Resource) with a solar energy-generating farm to demonstrate smoothing and shifting of volatile solar power and the ability to use the combination as a dispatchable renewable resource. The project is the first solar storage facility in the US that is fully integrated into a utility's power grid. It features one of the largest combinations of battery storage and photovoltaic energy in the US.

Customer Challenge

Increasing levels of renewable energy penetration poses integration challenges for grids. In the case of New Mexico, there were two particular objectives:

- To better manage the misalignment between PV output and utility distribution grid and system peaks
- To better manage intermittency and the volatile ramp rates of renewable energy sources that cause voltage fluctuations.

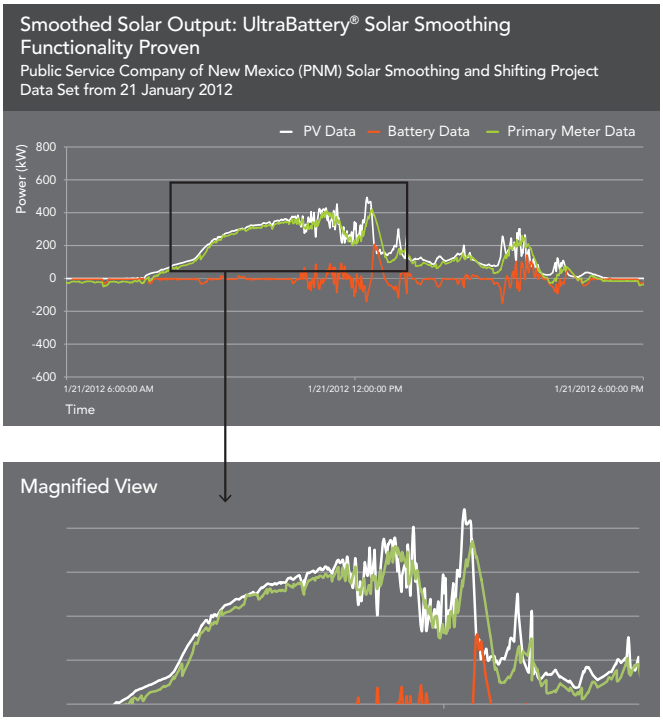
Ecoult worked closely with PNM, Sandia National Laboratories, the University of New Mexico and a number of other contractors to demonstrate:

- Peak shaving, targeting elimination of 15% of the feeder peak – benefit defined by avoided industry standard costs of substation and feeder expansion
- Smoothing of PV ramp rates and minimizing of voltage fluctuations – benefit defined by avoided cost of system upgrades that would be installed with high-penetration PV
- Demonstration of dispatchable renewable resource – benefit defined by contrasting the cost of an equivalently dispatched combustion turbine, allocating fuel, operation and maintenance, and capital to an LCOE (levelized cost of energy) comparison and noting an allowance for CO_2 emission avoidance.

Solution Provided

The UBer™ provides 500KW of energy-smoothing capability (utilizing UltraBattery®) and 250kW/1MWh of energy-shifting capability (utilizing Deka Synergy®). The UBer™ is successfully

smoothing and shifting PV output and demonstrating the ability to combine PV with a storage system, providing multiple benefits to making renewable resources reliable and dispatchable. Initial results indicate that targeted objectives are easily being met.



Case Study

Hampton Wind Farm (NSW, Australia)

Wind Smoothing

Background

Wind energy is clean and has the potential to supply many times the total current global energy production. Although wind energy is reasonably predictable, it is significantly variable. The ramp rate that can be associated with generation of wind energy can create integration challenges for utilities and ISOs/RTOs and limit progress by wind farm developers.

Customer Challenge

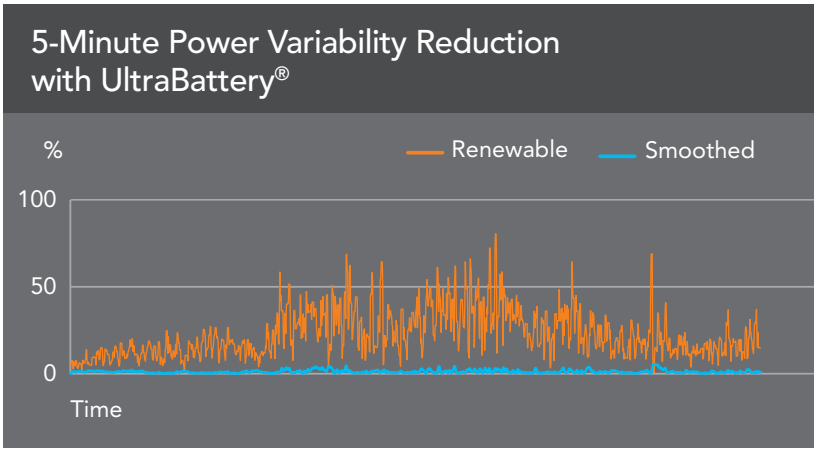
Wind power cannot be controlled. Wind farms exhibit greater uncertainty and variability in their output compared to conventional generation. In power systems, which already manage a large degree of uncertainty due to the need for generation and loads to be equal, demand is constantly matched with generation to maintain system frequency. The variability and uncertainty of wind power further increases uncertainty in the system, affecting its physical operations.

Further challenges with supporting increased penetration of intermittent resources are related to congestion issues in the transmission and distribution system as well as the mismatch between wind availability and prevailing demand. Often, local networks are constrained, with renewable energy being forced to be curtailed.

An immediate solution to wind integration challenges is to control the ramp rate of wind output. The project objective is to demonstrate and optimize methods of applying UltraBattery® storage to constrain the 5-minute ramp rate of renewable output from the Hampton Wind Farm before presenting it to the grid. The impact objective is to achieve higher penetration of wind and renewable energy in grid systems.

Solution Provided

Ecoult provided and integrated a MW scale smoothing system using UltraBattery® technology. Ecoult has been able to demonstrate the ability to limit the 5-minute ramp rate to 1/10 of the raw output while applying storage with a usable capacity (in kWhs) 1/10 the rated output of the farm (in kW).



Customer Specification Requirement Form

ecoult
energy storage solutions

What can we do for you?

Please fill out the form and return it to Ecoult, Suite 402, Grafton Bond Building, 201 Kent Street, Sydney NSW 2000 Australia. Alternatively you can fill out the form online on our website www.ecoult.com.

Ancillary Services

- ☐ Frequency-regulation services
- ☐ Spinning reserve
- ☐ Flexible ramping
- ☐ Power quality/UPS

Renewables Integration

- ☐ Power smoothing
- ☐ Energy time-shift
- ☐ Back-up for renewable generation deficits

Microgrid

- ☐ Power smoothing
- ☐ Energy time-shift
- ☐ Back-up for renewables generation deficits
- ☐ Frequency response
- ☐ Voltage support service

Requested Products

- ☐ UBer™ (including Storage Blocks, Master and Subsystem Controllers, Secure Communications Framework and Battery Management and Monitoring System)
- ☐ UBer™ Power Conversion Blocks

Requested Services

- ☐ Storage Applications and Algorithms Development
- ☐ UBer™ System Configuration, Installation, Commissioning and Operation
- ☐ UBer™ Lifecycle Management – Monitoring and Alerts
- ☐ UBer™ Lifecycle Management – Maintenance and Recycling Services
- ☐ Other (please specify):

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Project Details

Power requirements: ..... MW

Energy requirements: ..... MWh

Existing infrastructure: .....

Project objectives: .....

Project location (country): .....

State/region: .....

Maximum temperature (F): .....

Average temperature (F): .....

Minimum temperature (F): .....

Elevation (ft): .....

Estimated budget: .....

Estimated timeline: .....

Contact Details

Company: .....

Contact name: .....

Position: .....

Phone number: .....

Email: .....

Comments: .....

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passion

Ecoult Corporate Profile

Our passion for energy storage is deep. We believe that energy storage has the ability to make renewable energy a reliable, dispatchable energy source, i.e. making it available wherever and whenever it is needed. Even more, we believe that energy storage is now a prime determinant of how quickly society can effectively shift from dependency on fossil fuel consumption to an economy that is more renewables biased. We at Ecoult and the great team of partners we have assembled together aim to do our bit to be a significant contributor to the innovation and transformation process necessary to transition to a renewables-based economy by making energy storage simple, safe, and economical – just one more tool in a utility network architect's and engineer's toolkit.

Our energy storage solutions enable the continuous management of energy intermittencies and shifting of energy. Based on the hybrid, long-life lead-acid UltraBattery® technology, Ecoult's solutions are practical, safe, and environmentally sound – the number-one choice for wind and solar farms, grid ancillary services, and remote microgrid systems.

Formed in 2007 by the CSIRO, Ecoult was acquired by the US-based East Penn Manufacturing Company Inc. in 2010. Ecoult utilizes its rights to the UltraBattery® technology and intelligent energy management systems developed by the CSIRO, and its own development efforts, to provide complete energy storage solutions and modules that are ready for custom integration.

Below are just some of the reasons why Ecoult is the provider of choice for intermittency management and energy shifting.

We do what we say we do. We are committed to operational excellence, from design and development to production and implementation of our UBer™ (UltraBattery® Energy Resource). Ecoult gathers the most knowledgeable and passionate energy storage experts in the industry and partners with leading Australian research organization CSIRO and world's leading battery manufacturer East Penn Manufacturing to offer customers breakthrough, cost-effective, quality energy storage solutions that exceed customer's performance, safety, and reliability standards.

Game-changing technology with highest efficiency. The UltraBattery® technology is a completely new class of the most tried and tested lead-acid battery technology: it is the first of its kind able to work continuously and highly efficiently in Partial State of Charge use, crucial for energy smoothing and shifting applications. UltraBattery® can cycle more energy during its life than any other lead-acid battery, offers highest safety standards, and is recyclable.

Commitment for life. We accompany our customers through the entire lifecycle of the energy storage solution: after identifying the best solution for individual customer requirements and providing simple, safe, and complete storage platforms that are ready for custom integration, we continuously monitor the performance of the energy storage solution and at the end of the project offer to buy back the battery units and recycle the battery cells.

Ready for your large-scale energy projects. Backed by our parent company East Penn Manufacturing, one of the world's leading battery manufacturers, Ecoult has the ability to deliver high volumes of flexible scalable, standard energy storage modules and solutions to energize large-scale energy projects and the smart grid of the future.

Our first priority: safety. Our UltraBattery® technology is the safest battery technology currently available: the UltraBattery® has the abuse tolerance, versatility, and track record of dependability critical for a large amount of battery power in one location. It is manufactured by East Penn Manufacturing whose quality and environmental management systems are certified to ISO 9001:2008, ISO/TS 16949:2009, and ISO 14001:2004. Unlike most other battery technologies, it is rated non-hazardous material according to IATA/DOT certification, classifying the UltraBattery® as risk free for transportation. Further, we monitor the State of Health of every individual battery unit at all times, enabling us to maintain highest performance, safety, and reliability of the storage solution.

Ecoult wishes to acknowledge the support of the Australian Government Department of Resources, Energy and Tourism via its Advanced Electricity Storage Technologies Program, and the NSW Government's support via the Office of Environment and Heritage Climate Change Funding Program for the Hampton Project.

The process of bringing UltraBattery® to market has also been supported by AusIndustry, a specialist program delivery division within the Department of Innovation, Industry, Science and Research of the Australian Government (under its Climate Ready Program and its Commercialising Emerging Technologies Program).

Ecoult further wishes to acknowledge support from the US Government's Department of Energy (DOE) for UltraBattery® by way of its grant to East Penn Manufacturing to demonstrate a 3MW UltraBattery® energy storage facility for the provision of regulation services on PJM, its grant to the Public Service Company of New Mexico for the demonstration of a 500kW/1MWh UltraBattery® storage facility to turn a 500kW solar PV installation into a reliable, dispatchable distributed generation resource, and finally the DOE's further support via Sandia National Laboratory under the Smart Grid Storage Demonstration Program.

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