



Advancion[®] Energy Storage

Building the Clean, Unbreakable Grid

Delivered by

EAT•N



Advancion 4 is AES' fourth generation energy storage platform, developed by industry leaders operating operating the largest fleet of battery based energy storage in the world.

Pictured:

AES WARRIOR RUN | MARYLAND Advancion 4 Array



Delivered by



TWO COMPANIES WITH A SINGULAR GOAL

The alliance agreement between Eaton and AES Energy Storage enables the industry to accelerate the adoption of energy storage and sets the foundation to deliver the most proven storage solution in the market to meet the growing demand for even more customers in Europe, the Middle East, and Africa.

Eaton is supplying the Advancion energy storage system, providing support and ensuring long-term operation directly to utilities, independent power producers and power system operators, as well as to industrial and commercial customers.

By providing market-leading, innovative energy storage systems to commercial, industrial and utility customers, Eaton will be able to mitigate the investment needed for, and the charges and emissions resulting from peak demand infrastructure. The widespread deployment of systems enabling peak capacity, flexible generation and grid services, coupled with the easy consumption of renewables, will help a smarter grid and consumers meet environmental targets.

Eaton is a power management company with 2015 sales of \$20.9 billion.

Eaton provides energy-efficient solutions that help customers effectively manage electrical, hydraulic and mechanical power more efficiently, safely and sustainably. Eaton has approximately 97,000 employees and sells products to customers in more than 175 countries.



Advancion[®] leverages more than 30 years of experience serving utility customers.

Representing nearly a decade of commercial energy storage development and operations, Advancion delivers the most proven, safe and reliable, and best performing battery-based energy storage solution in the industry.

Advancion is built for the long-term owner-operator, leveraging the knowledge and deep experience gained from managing power assets globally, and practical use of battery based storage for grid services. Started in 2006 with a vision for a better way to serve the needs of the electric grid, Advancion was developed at a time when no complete storage solutions were available. AES Energy Storage worked with leading component suppliers to create a storage solution to meet its vision. Now, ten years later, we offer the 4th generation of this proven platform.

We have combined everything we have learned about designing, developing, and operating energy storage into one complete platform: AES Advancion.

Solving the Energy Equation

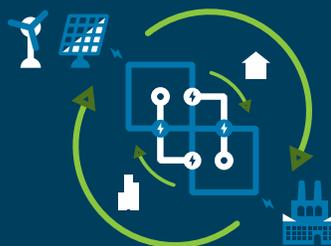
Utilities, system operators, generators, and large load centers need new energy technology that is flexible, available, and clean. The convergence of global electrification, decarbonization, and decentralization of power generation is creating a need to redesign and modernize the energy grid. Choosing traditional forms of energy to provide new capacity results in an underutilized and inefficient energy infrastructure.

Battery-based energy storage addresses this need in a way that is distinct from other generation technologies. It provides unmatched operational flexibility, enabling the most efficient use of transmission resources and generating plants, lowering cost and emissions, while supporting the ongoing addition of renewable power sources. Storing and redistributing energy, these adaptive technologies strengthen and modernize the energy grid.

This new modern architecture is the key to building a clean and unbreakable energy grid. Battery storage fortifies current infrastructure while preparing for the future of power consumption: a resilient network that operates seamlessly in the face of weather events or accidents, no matter where you are or when you need it, providing clean, abundant energy.

the benefits

OF ENERGY STORAGE 



GRID EFFICIENCY

Allows other grid resources to operate at optimal output.

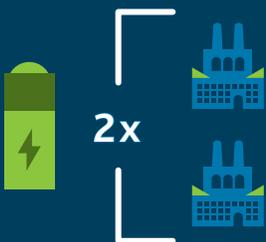
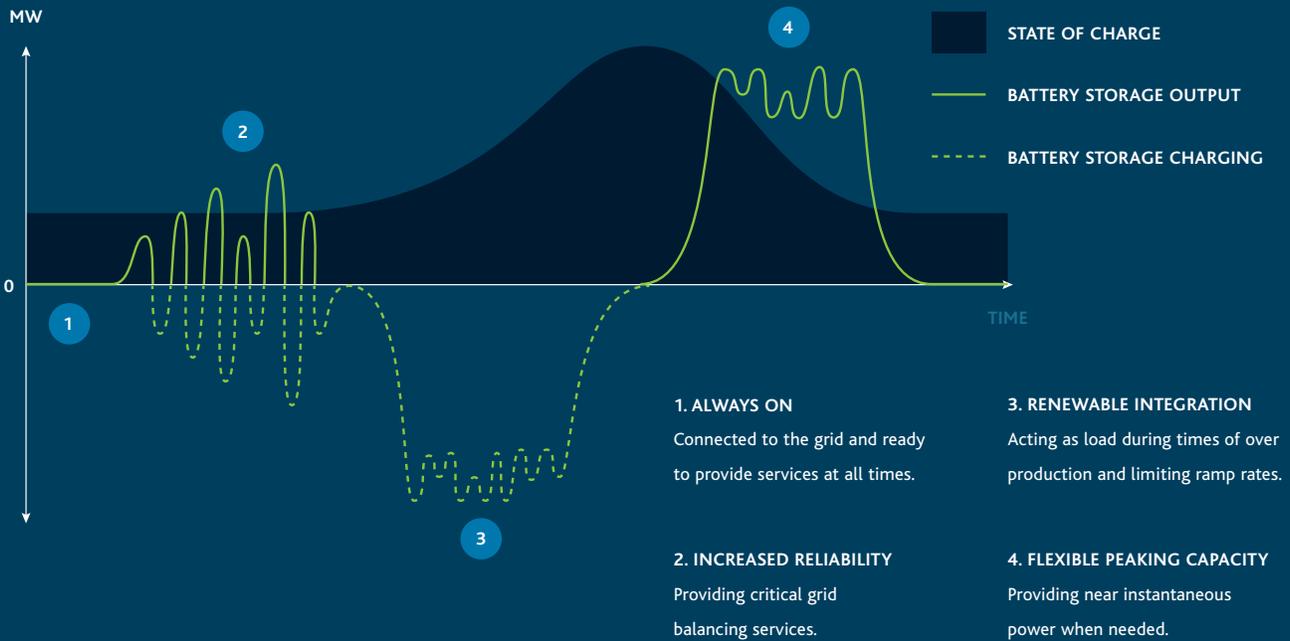


CLEAN ENERGY

Helps cut emissions by taking load off fossil-fuel generation.

BUILDING THE BALANCE

Advancion brings flexibility to the power grid by providing a range of services that support the modernization of the grid. A resource that is always available, it can balance electricity demand and supply, integrate renewable sources of energy, and respond immediately to peak power demands. Its scalable nature allows systems to be built to meet the need of any network.



TWICE THE RESOURCES

Providing generation and load, storage offers twice the flexibility of a peaker.



INCREASED RELIABILITY

Annual US cost of power outages is as much as \$130 billion.

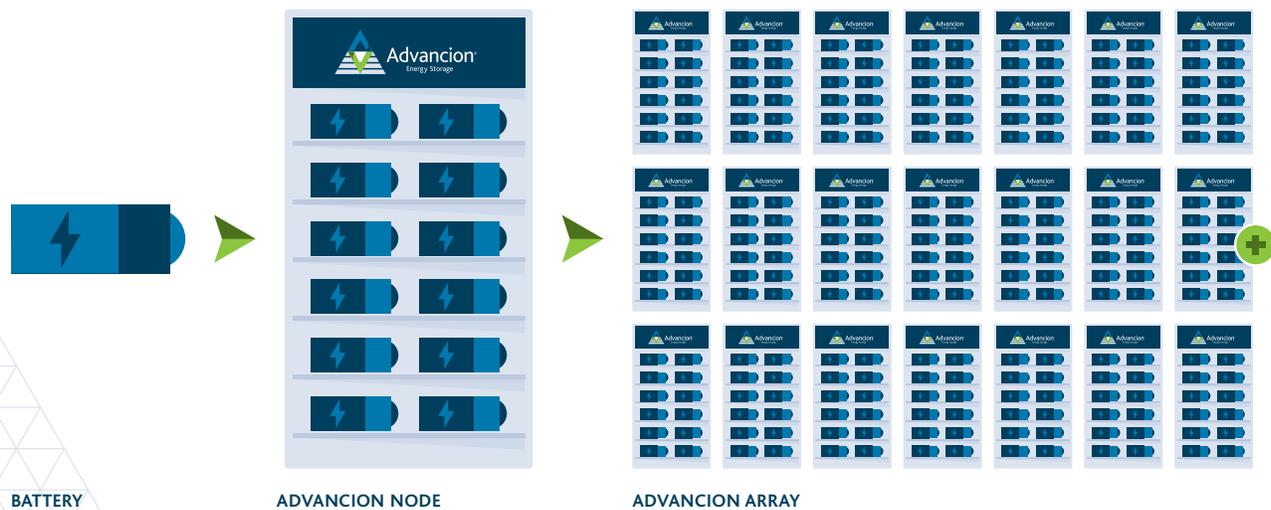


RENEWABLE INTEGRATION

Balances inherent variability from renewable sources of energy.

Advancion®

As a forerunner in the development of energy solutions, AES Advancion's nodal architecture represents the most advanced technology in the industry.



BATTERY

ADVANCION NODE

ADVANCION ARRAY



OPTIMIZED DESIGN

Nodal Architecture

Advancion delivers unmatched operational flexibility. Unique to the platform is its next-generation nodal architecture, providing compact, autonomous units of control. This architecture enables planned array augmentation, allowing sites to grow over time, incorporating the latest battery technology from multiple suppliers.

FUTURE PROOF

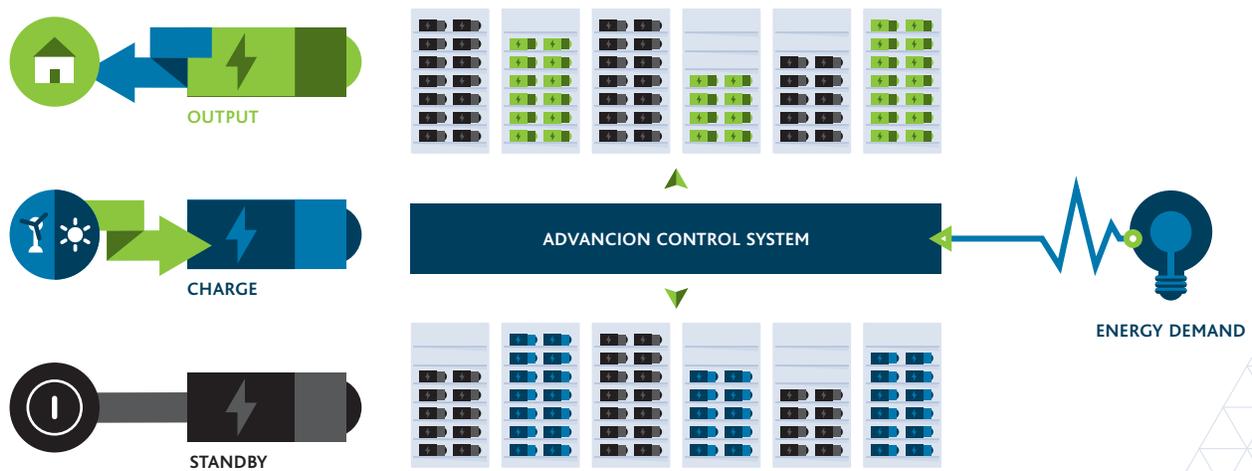
Built to take advantage of the current and future supply chain for energy storage, Advancion is designed to incorporate new technology over time.

SCALABLE

Advancion arrays are modular, making them scalable to hundreds of MW of capacity and allowing the architecture to grow with customers' unique needs, kilowatt by kilowatt.

ADVANCION CONTROL SYSTEM FOR DISPATCH

Batteries on the grid are always plugged in, so they are always on. They can act as both generation and load, providing multiple services that allow for more efficient use of transmission resources, generating assets, and large load centers. The patented Advancion Control System dispatches individual nodes in the array according to energy demand and node state.



UNPRECEDENTED FLEXIBILITY

Advancion[®] Control System

A proprietary control system unlocks the full value of the nodal architecture, allowing for simultaneous operations across the array, reducing auxiliary power consumption, and optimizing battery performance and life.

SIMULTANEOUS OPERATIONS

Built for the distributed world, Advancion's nodal design provides unprecedented control, allowing for multiple services within the same array or across distributed arrays.

DEPENDABLE

Grid battery arrays use massively parallel architectures to provide industry-leading reliability and optimized serviceability of the array.



ESTABLISHED FLEET

Designed by Industry Leaders

Designed by and for owner-operators, leveraging deep industry expertise to pinpoint and solve problems on the grid. The resulting platform is designed to be scalable and rapidly deployable, and serve the long term needs of operators.



AES KILROOT IN NORTHERN IRELAND Advancion 4 Array



PROVEN SUPPLY CHAIN

Advancion® Certification Program

Advancion's certification program leverages relationships with the world's leading equipment manufacturers to create standardization that allows for scalability and simple implementation.



Lowest Total Cost of Ownership

Combining an industry leading supply chain, standardized system deployment, improved serviceability, higher availability, and a proprietary control system, Advancion provides the highest return for its customers.

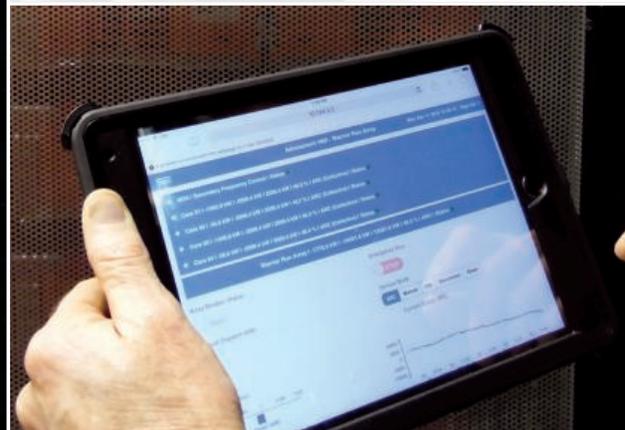
ADVANCION NODES IN AN ARRAY AES Netherlands, Zeeland, The Netherlands



ADVANCION NODE CONTROLLER



BATTERIES IN AN ADVANCION NODE



HMI CONTROL SCREEN



Global Energy Innovators

Advancion is backed by a decade of research and multiple generations of product. The platform is available worldwide, installed directly by AES or through a network of leading partners.



OVER 3 MILLION MEGAWATT-HOURS DELIVERED SERVICE

The most comprehensive and advanced fleet
of battery-based energy storage in the world.



FOURTH GENERATION TECHNOLOGY

Incorporating over 8 years of
real-world commercial experience.

Setting the Standard

Advancion deployments have marked milestones in the industry. We work with our customers to develop power solutions that are dependable, cost-competitive, and smart in order to meet their needs and complement existing assets.

394 TOTAL
mw*



15 LOCATIONS



IN

7 DIFFERENT COUNTRIES



**In operation, construction, or late stage development.*





10 MW Interconnected | Online November 2015 AES WARRIOR RUN, CUMBERLAND, MARYLAND



10 MW Interconnected | Online December 2015 AES NETHERLANDS, ZEELAND, THE NETHERLANDS



10 MW Interconnected | Online December 2015 AES KILROOT, CARRICKFERGUS, NORTHERN IRELAND

Secure and Sustainable Solutions

Advancion allows customers to avoid complicated and costly environmental permitting, procurement is simple, and once implemented Advancion improves network efficiency across all energy assets.

FREQUENCY REGULATION

Providing critical grid balancing, Advancion provides frequency response in less than a second to stabilize an interconnection.

FREQUENCY REGULATION CASE STUDY | AES LAUREL MOUNTAIN

The AES Laurel Mountain Storage Array enables a 98 MW wind farm to be among the first wind generation facilities to supply critical grid stability services. It has consistently been selected for regulation service among competitively bid offerings in PJM, serving as a low cost, better performing, zero-emissions, renewable energy alternative to traditional power generation.



AES LAUREL MOUNTAIN | BELINGTON, WV



32 ^M_W
INTERCONNECTED
64 ^M_W
RESOURCE

CAPACITY RELEASE

By shifting reserve capacity to battery storage, generators sell more power from the same plant. System reliability is increased through generation and regulating that is online and can begin responding immediately.

CAPACITY RELEASE CASE STUDY | AES GENER POWER PLANT

The AES Angamos Storage Array integrates 20MW of energy storage with a 544MW thermal power plant to provide advanced reserve capacity. The storage enables AES Gener's Angamos plant to increase power generation by 4% to serve an important mining region in the country.



AES GENER POWER PLANT | ANGAMOS, CHILE



20 ^M_W
INTERCONNECTED
40 ^M_W
RESOURCE



ALAMITOS POWER CENTER | ALAMITOS, CA



100 M^W
INTERCONNECTED
200 M^W
RESOURCE

FLEXIBLE PEAKING CAPACITY

Locating Advancion in a critical load pocket, utilities can meet peak demand needs and receive twice the flexible range of a peaker plant to integrate renewable generation, while reducing system-wide emission.

FLEXIBLE PEAKING CAPACITY CASE STUDY | ALAMITOS POWER CENTER

Resulting from a three year process (2012 through 2014 — part of California's Long Term Procurement Plan), that fully considered the value of storage for peaking capacity needs while accounting for changing system conditions, SCE's unconstrained economic models identified 400-900 MW of grid-scale storage as the most optimal resource. No gas peakers were found to be economic.



PANASONIC TECHNOPARK | JHAJJAR, INDIA



10 M^W
INTERCONNECTED
20 M^W
RESOURCE

COMMERCIAL AND INDUSTRIAL APPLICATIONS

Providing demand charge reduction and critical backup power to large facilities that create the products and services that are essential to our daily lives, Advancion is well suited for "behind the meter" applications. Advancion adds reliability for the end user and relieves utilities from costly upgrades required to support these large facilities.

C+I APPLICATION CASE STUDY | PANASONIC TECHNOPARK

Panasonic and AES will construct a 10 MW energy storage array at Panasonic's Technopark manufacturing facility in Jhajjar, Haryana. This joint project is the first large-scale battery-based energy storage project in India. The storage will provide daily reliability and back-up to the manufacturing facility, while demonstrating grid stability and renewable integration services in the region.

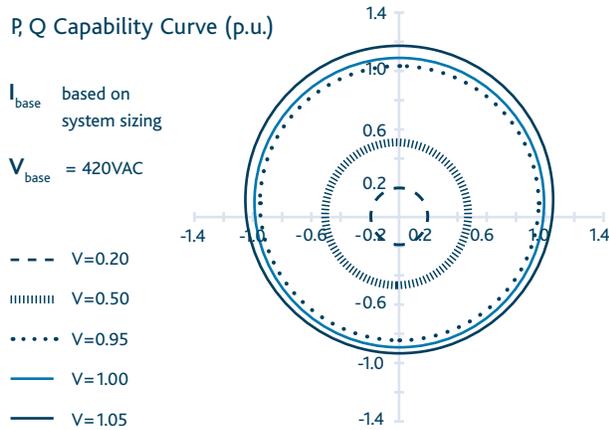
Advancion® Technical Specifications

Advancion Arrays are modular and scalable configurations of Advancion Core and scale to thousands of MWs controlled by a patent-pending hardware and software control aggregation platform.

POWER	100kW to 2 MW per Core; from 1 to 1024 Cores per Array
FLEXIBLE RANGE	2x Interconnected Nameplate Power
VOLTAGE	420 VAC (Isolation transformer to selectable voltage)
REACTIVE POWER	Adjustable based on application, up to 0.85 leading to 0.85 lagging (reactive capability available over full real power range)
RAMP CAPABILITY	Max capacity change in <1 second
DURATION	30 min 1 hr 2 hrs 4 hrs
ROUND TRIP EFFICIENCY (AC to AC including isolation transformer)	>85% >88% >89% >90%
AUXILIARY POWER USAGE	20 kW/MW typical (application dependent)
EQUIVALENT AVAILABILITY FACTOR	>97.0%
OPERATING TEMPERATURE	-20C to 50C
ALTITUDE	De-rated over 5,000 ft
SEISMIC RATING	Available ratings up to Zone 4
RIDE-THROUGH	Low/high voltage ride-through Low/high frequency ride-through (settable thresholds)
STANDARDS COMPLIANCE	Meets or exceeds industry standards, including IEEE519, NEC, UL1741, UL1642, UL1973
CONTROL & MONITORING	Advancion Control includes HMI, SCADA, Data Historian, Application Agents, and Patented Performance Algorithms
EXTERNAL CONTROL INTERFACE	SCADA and EMS integration available via DNP3 or comparable
BATTERY CHEMISTRY	Advanced lithium ion sealed cells or similar

REACTIVE POWER CAPABILITY

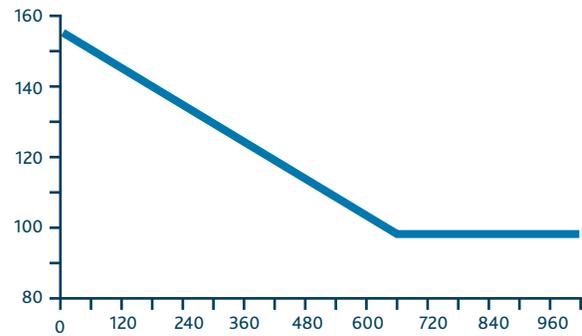
P, Q Capability Curve (p.u.)



- 4 quadrant real and reactive power capability
- Up to the total MVA rating of the system as determined by the MW and power factor ratings set at time of configuration
- Full and reactive power capability is available in both droop and isochronous modes
- Operation from fully leading to fully lagging power factor at rated power to provide voltage support at the point-of-interconnection

OVERRATE CAPABILITY

Overrate Level Available For A Given Overrate Duration



- Capability varies based on desired overrate duration
- 150% of rated MW capacity available for overrate durations of 60 seconds or less

OPERATION MODES AND APPLICATION SERVICES

The Advancion Array Control System has 3 main Modes of Operation: Automatic Resource Control (ARC), Autonomous Dispatch, and Manual Dispatch. Each Array also has multiple, unique, and fully customizable Application Services definable at the Array or Core-group (Unit) level.

ADVANCION CONTROL SYSTEM MAIN OPERATING MODES AND CORRESPONDING APPLICATION SERVICES

APPLICATION SERVICES	OPERATING MODES		
	Automatic Resource Control ¹	Autonomous Dispatch	Manual Dispatch ²
Real and Reactive Power Dispatch	•		•
Primary Frequency Control (Droop Response)		•	•
Secondary Frequency Control (Automatic Generation Control)	•		•
Contingency Response		•	•
Spinning Reserves	•		•
Automatic Voltage Regulation (Voltage Droop)		•	•
Constant Power Factor			•
Renewable Ramp Limiting		•	•
Black Start	•		•
Isochronous Operation	•		•
Transmission & Distribution Deferral		•	•

¹ Similar to Automatic Generation Control via Modbus TCP or DNP 3

² Via the Advancion HMI on a workstation or touch interface



Delivered by



Discover how Eaton can help solve your power management and energy storage challenges.

WWW.EATON.EU/ENERGYSTORAGE | ENERGYSTORAGE@EATON.COM