



# Remote Microgrids with Advanced Bipolar Lead Energy Storage

North and South Manitou Islands, Michigan

Mission-Critical Off-Grid Energy Storage | Sleeping Bear Dunes National Lakeshore

**720 kWh**

Total Energy Storage

**98 kW**

Combined Solar PV

**200 kW**

Diesel Generation

**180 kW**

Hybrid Inverters

**2025-2026**

Deployment



CLIENT

**National Park Service**

Sleeping Bear Dunes National Lakeshore

North and South Manitou Islands, Michigan

ENGINEER OF RECORD

**Affiliated Engineers, Inc. (AEI)**

Madison, WI | Founded 1978

800+ Engineers | aeieng.com



## PROJECT BACKGROUND

The Manitou Islands have operated off-grid microgrids powered by standard lead-acid battery banks and diesel generators for decades. With growing load profiles from expanded visitor services, ranger operations, and historic preservation facilities, the existing systems required revitalization with modern distributed energy resources. The National Park Service selected Advanced Battery Concepts to supply the next-generation energy storage backbone as part of this critical infrastructure modernization at Sleeping Bear Dunes National Lakeshore. Following a detailed technical review by Affiliated Engineers, Inc. (the Engineer of Record), the Park Service approved ABC's CEES™-R battery energy storage system for deployment in advanced microgrid configurations with diesel generators and solar PV across both North and South Manitou Islands.

Located within Lake Michigan's Manitou Passage with no utility interconnection, the islands depend entirely on on-site generation. The legacy lead-acid systems suffered from limited cycle life, frequent maintenance, and insufficient capacity to support the islands' growing energy demands. The new hybrid microgrids replace aging battery infrastructure with a combined 98 kW of solar, 720 kWh of ABC CEES™-R energy storage, 200 kW of diesel generation, and 180 kW of hybrid solar inverters to dramatically reduce diesel dependency while meeting expanded load requirements. North Manitou Island deployed 288 kWh with 43 kW solar and two 40 kW diesel gensets in September 2025; South Manitou Island deploys 432 kWh with 55 kW solar and two 60 kW diesel gensets in April 2026.

## WHY ADVANCED BIPOLAR LEAD OVER LITHIUM-ION

The Engineer of Record evaluated multiple battery chemistries for this deployment. ABC's advanced bipolar lead-acid technology was selected over lithium-ion for the following reasons:

### ■ Extreme Temperature Performance Without HVAC

CEES™ operates from -40°C to 55°C on convection cooling alone. The Manitou Islands experience Lake Michigan weather extremes, from sub-zero winters to humid summers. Lithium-ion would require climate-controlled enclosures with significant parasitic energy load, a critical liability on diesel-dependent off-grid islands where every kilowatt-hour of HVAC load increases fuel consumption and logistics cost.

### ■ Non-Flammable Chemistry in an Environmentally Sensitive Location

The aqueous sulfuric acid electrolyte in ABC's CEES™ cannot support thermal runaway or fire propagation. On a remote island within a protected National Lakeshore, the consequences of a lithium-ion thermal event would be catastrophic: limited fire response capability, no fire department access, and irreplaceable natural habitat at risk. CEES™ eliminates this failure mode entirely.

### ■ 20-Year Design Life with No Capacity Augmentation

ABC's bipolar lead-acid chemistry delivers less than 0.1% annual capacity fade with no measurable degradation over the design life. The 720 kWh combined system will maintain nameplate capacity for 20 to 25 years without augmentation. Lithium-ion would require mid-life battery replacement or augmentation, a logistical and financial burden amplified by the islands' remote, boat-access-only locations.

### ■ 15-Year Daily Cycle Warranty

ABC provides a 15-year daily cycle warranty backed by proven electrochemistry and 54+ granted patents. This warranty period covers the operational planning horizon for the National Park Service, providing bankable performance assurance without the degradation uncertainty of lithium-ion.



# Bipolar Architecture Advantage

How GreenSeal® Technology is Transforming Lead-Acid Energy Storage

## BIPOLAR VS. MONOPOLAR: A STRUCTURAL REVOLUTION

The advantages of bipolar battery architecture have been understood but commercially unrealized. Advanced Battery Concepts solved the manufacturing challenges with patented GreenSeal® technology, enabling bipolar lead-acid batteries to compete with and outperform lithium-ion in critical infrastructure applications.

### HOW BIPOLAR ARCHITECTURE WORKS

- Instead of conventional lead metal grids, ABC produces a plastic bipolar electrode using patented technology
- Current flows uniformly through the face of each electrode, not through top connectors, creating uniform current density across the entire active surface
- Pasted bipolar electrodes are stacked with separator sheets between them, then compressed and locked with ViaLock® rods
- Eliminates the case, lid, element stuffing, inter-cell welds, and cast-on straps required in conventional monopolar construction
- Uses 46% less lead than traditional prismatic lead batteries while delivering higher energy and power density

### PERFORMANCE ADVANTAGES

- **Uniform Current Density**  
Eliminates hot spots and uneven discharge patterns that degrade conventional lead-acid batteries prematurely
- **Higher Energy Density**  
Bipolar design eliminates top-level lead and improves paste utilization, packing more energy into less space and weight
- **Higher Power Density**  
Simplified, direct current paths deliver higher peak power output than equivalent monopolar configurations
- **Extended Cycle Life**  
Uniform paste weights and compression result in significantly higher cycle life than today's conventional lead batteries
- **Extreme Vibration Resistance**  
ViaLock® technology provides structural support for the harshest vibration and shock environments
- **100% Recyclable**  
All materials are the same as those used in today's established lead recycling processes with 99%+ recovery rates

85+

Granted Patents

60+

Patents Pending

45+

Trade Secrets

46%

Less Lead Used

Clare, MI

U.S. Manufacturing

## INSTALLATION: NORTH MANITOU ISLAND



CEES™ units stacked and bolted, direct installation



Battery room with CEES™ row and inverter integration



Sol-Ark hybrid inverter array with conduit routing



Overhead conduit running from batteries to power conversion system



# System Specifications

720 kWh CEES™-R Energy Storage | Advanced Hybrid Microgrid

## MICROGRID ARCHITECTURE

The Manitou Islands microgrids each integrate four primary subsystems into coordinated energy management platforms. The systems are designed to maximize solar utilization, minimize diesel fuel consumption, and deliver continuous, reliable power to all island infrastructure including ranger stations, historic lighthouses, and visitor facilities.

ENERGY STORAGE	
Technology	ABC CEES™-R (Bipolar Lead-Acid)
Total Capacity	720 kWh (North: 288 kWh / South: 432 kWh)
Nominal Voltage	Flexible: 48V, 192V, 288V, 384V
Chemistry	Advanced Bipolar Lead, GreenSeal®
Operating Range	-40°C to 55°C, no HVAC required
Annual Degradation	<0.1%/yr, no measurable fade
Design Life	20-25 years
Warranty	15-year daily cycle, 262 MWh throughput per unit
Fire Safety	Non-flammable, zero thermal runaway
CEES™ Unit Dimensions	52.3L x 45.8W x 40H in
CEES™-R Dimensions	52.3L x 45.8W x 80H in (two modules stacked)
SOLAR PV	
North Manitou	43 kW DC, ballasted ground mount
South Manitou	55 kW DC, structurally mounted
Combined Capacity	98 kW DC
DIESEL GENERATION	
North Manitou	Two 40 kW gensets (80 kW total)
South Manitou	Two 60 kW gensets (120 kW total)
Combined Capacity	200 kW total
Role	Backup and extended low-solar periods
POWER CONVERSION	
Inverter Capacity	180 kW hybrid solar inverters
Configuration	Balanced three-phase 208V
Integration	Two inverters per phase (Sol-Ark)
Output	Full island infrastructure support

## DEPLOYMENT TIMELINE

2024-2025

### Engineering Review

- Affiliated Engineers, Inc. completes technical evaluation and approves ABC CEES™-R for deployment

September 2025

### North Manitou Island

- 288 kWh CEES™-R system installed on North Manitou Island (companion project)

April 2026

### South Manitou Island

- 432 kWh CEES™-R system deployment with full microgrid commissioning

Summer 2026

### Full Operation

- Complete hybrid microgrid operational, delivering continuous off-grid power

## Proven Performance in the Hardest Environments

ABC's CEES™-R delivers fade-free, fire-safe energy storage designed to outlast every other component in the system.

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