Narada
An Expert of Energy Storage Solutions

Containerized Battery Energy Storage System (BESS)

EnergCube Series

A Reliable and Promising Energy Storage Solution for Smart Grid

Being global, innovative, green and responsible is our core strategy. We are dedicated to achieve harmonious co-existence and sustainable development between enterprise and environment.

As a leader in ESS industry, Narada is devoted to build a smart energy network based on micro-grid and distributed energy storage solution.

- Chen Bo, CEO of Narada

Introduction

Zhejiang Narada Power Source Co., Ltd. was established in 1994 and has been public listed in Shenzhen Stock Exchange Market since 2010. Narada is specializing in providing energy system integration products, solutions and operation services to Information and Communication Technology (ICT), Renewable Energy Storage, Electric Vehicle (EV) and other energy saving and environmental protection applications. With the development in decades, Narada has become the leader in global industrial batteries section, and “Narada” brand has been the famous and well-known brand in all over the world.

Corporate Culture

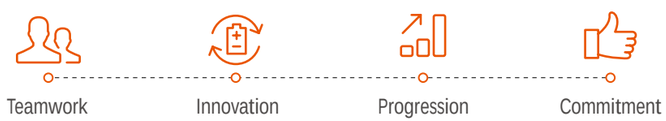
Vision

To be a global leader in stored energy solutions as well as a world class innovative technology provider

Mission

- Focus on customer’s wants and needs
- Develop a culture of integrity and service
- Create value for customers

Value



Milestones

Lithium Battery Manufacturing

2001

Public Listed

2010

Lead Recycling Business

2015

1994

Establishment

2005

First Oversea Branch in Singapore

2014

Wuhan Production Base

2016

Narada Internet+ESS

Global Presence

Distribution in Over 158 Countries

Narada Branches

Leading Research and Development Ability

- Leading the establishment of 20 international and domestic standards include IEC 61427 – Secondary Cells and Batteries for Renewable Energy Storage
- 95 valid Patents include 35 Invention Patents
- Global Leading Innovation Platforms: National Recognized Enterprise Technology Center, CNAS Approved Laboratory, Academician Workstation, Post-doctoral Workstation
- Continuously innovative products and solutions are rolling-out in the market

Production Capability

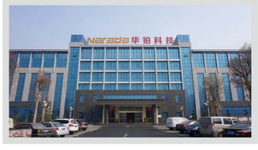
Wuhan Manufacturing Base
VRLA Production Capacity:10 Million kWh

Anhui Manufacturing Base
VRLA Production Capacity:3 Million kWh

Lin'an Manufacturing Base
VRLA Production Capacity:3.5 Million kWh

Chengdu Manufacturing Base
VRLA Production Capacity:2.2 Million kWh

Lin Ping Manufacturing Base
Lithium Production Capacity:1.2 Million kWh
4 Million kWh in planning



Anhui Lead Recyling
Recycling Capacity:210000 Metric Tons

Social Responsibility

Narada is attaching great importance to acting socially and environmentally responsible in all its activities.

For this it respects and preserves the employees' rights and fosters their continued improvement with various training programs and related activities.

It is also fully committed to develop, maintain and apply socially acceptable practices in the workplace as stipulated by the International Standard SA8000 for Social Accountability.

Certificates and Honors

Narada

CERTIFICATES AND HONORS

ISO14001

OHSAS18001

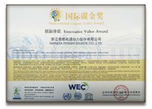
SA8000

ISO9001

Zhejiang
Famous Brand

Vodafone global
approved supplier

Zhejiang Top
export brand



Innovatixe value
of ICA price

Certificate of
credit grade

Excellent Alcatel
supplier award

Best energy
saving product

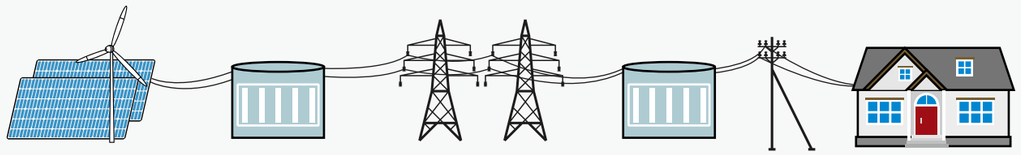
Date center
product award

General Introduction of EnergCube BESS

Narada EnergCube Series Containerized Battery Energy Storage System (BESS) is designed based on international Advanced Lead Carbon Battery Technology, Intelligent Battery Management System, Patented Battery Thermal Management System, All-In-One Containerized System Integration Technology, highly efficient and reliable Power Control and Conversion System, internet-based intelligent Energy Management System. EnergCube BESS is aiming on providing safe, reliable, and stable energy storage solutions for Renewable Energy Firming, Peak Shaving, Frequency Regulation, T&D Investment Deferral, Micro-grid, Distributed Energy and Energy Time-shift at Demand-side.

System Configuration

Typical Application



- Renewable Energy Integration
- Power Supply Capacity

- Frequency Regulation
- Voltage Support
- T&D Upgrade Deferral

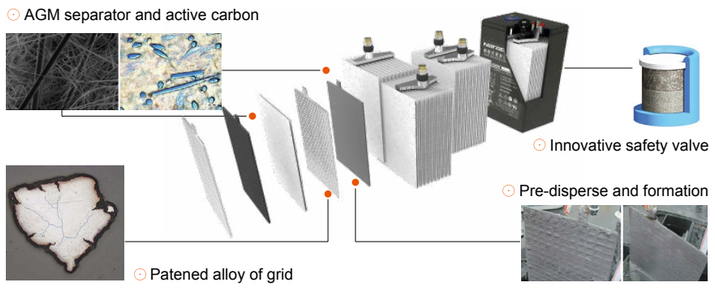
- Energy Time-shift at Customer Side
- Power Reliability
- Demand Charge Management
- Micro-grid/Distributed Energy

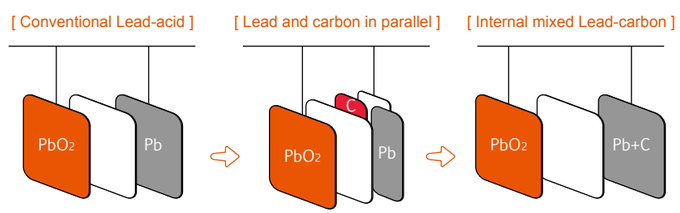
Highlights of EnergCube Series BESS

Advanced Lead Carbon Battery Technology (REX-C Battery)

Narada REX-C Series Advanced Lead Carbon Battery (REX-C Battery) is designed with internationally advanced carbon pre-dispersing and formation technology in battery's negative plates and combining with Narada patented REX deep-cyclic battery technology. REX-C Battery has both the characteristics of deep cycle lead acid battery and high rate supercapacitor, so it has the features and advantages of high safety and reliability, high round-trip-efficiency, long cyclic life, fast charge capability at PSoC condition. Thanks to the high performance and controllable cost of REX-C Battery, Narada Containerized BESS has the advantages on both comprehensive performance and economic-feasibility over other battery technologies in the market.

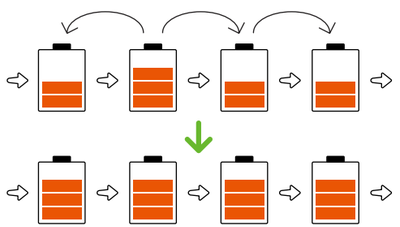
Structure of
Narada Lead
Carbon Battery – REX-C



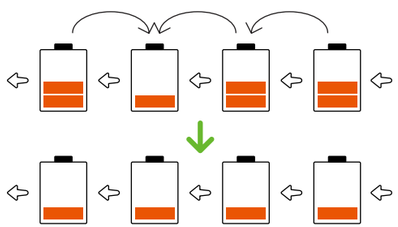


Intelligent Battery Monitoring and Management System (BMS)

Narada Self-developed Intelligent Battery Management System (BMS) is designed and developed based on the deep understanding of the characteristics of REX-C Battery. It can gather battery voltage, current, temperature and other parameters through high accuracy electronic devices, and it has also the ability to provide accurate SoC and SoH conditions according to REX-C Battery's characteristics. In the meantime, thanks to the Active Balancing Technology of BMS, the voltage and capacity of all battery cells can be controlled evenly to ensure the BESS has stable and reliable performance.



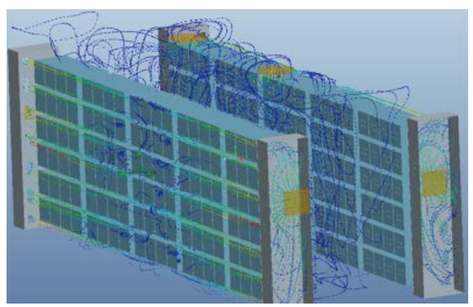
Balancing during Charging



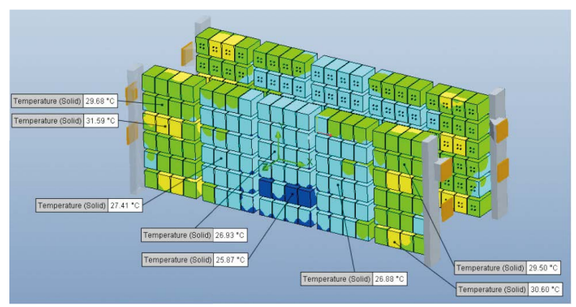
Balancing during Discharging

Patented Thermal Management System (TMS)

Narada patented Thermal Management System (TMS) is designed with an unique temperature control air supply system by adopting theories of Areodynamics and Fluid Mechanics. Narada TMS has been simulation tested on large scale computer system, and thermal management analysis model has been optimized to ensure an even and optimum temperature for each battery cell in the container. This ensures each battery cell is operating consistently and finally improve the round trip efficiency of the whole energy storage system.



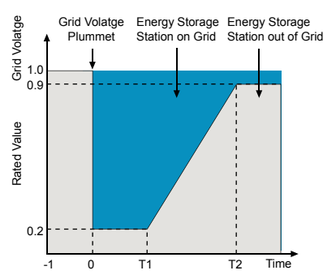
The tracing particles in heat management system



Optimize cell temperature by unique ventilation system

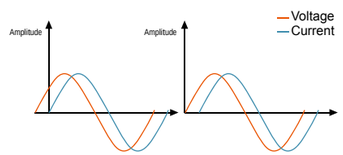
Highly efficient and reliable Power Control and Conversion System (PCS)

Power Control and Conversion System (PCS) has adopted high power bi-directional power conversion technology to achieve the energy conversion between DC side and AC side bi-directionally with up to 98% round-trip-efficiency. By applying suitable controlling strategies, PCS can achieve the management of charging and discharging of the Battery System, load following and voltage control at grid side.



Low voltage ride through capability

Automatic on/off grid switch



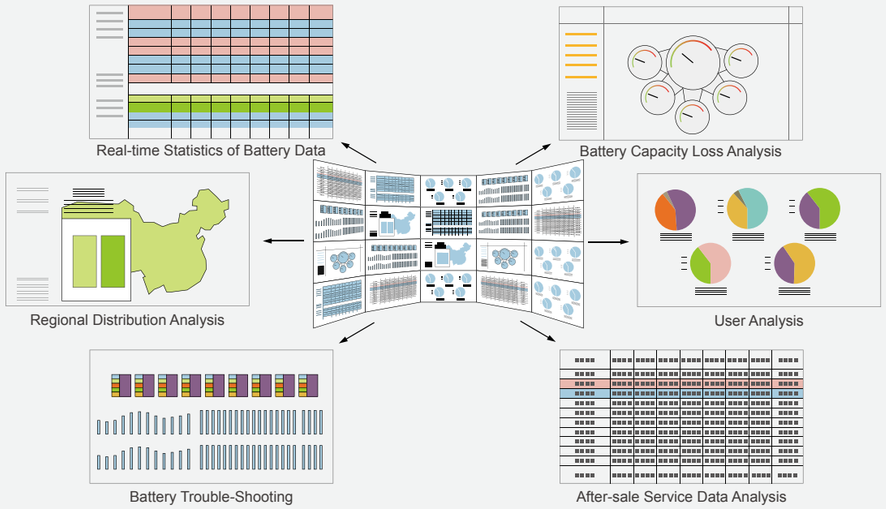
Dynamic reactive power compensation

Intelligent Energy Management System (EMS) and Internet-based SCADA

Narada Intelligent Energy Management System (EMS) adopts advanced open distributed network management technology, object-oriented database, communication middle-ware, WEB technology and international recognized standards to provide supporting platform for dispatching automation and distribution automation of the micro-grid system. By gathering energy data, energy management, network analysis, and by adopting SCADA/EMS/DMS technology, to achieve decentralized control and centralized management of the energy system, to optimize energy dispatch and balance command system, and finally to achieve the management of micro energy source, charge/discharge management of the energy storage unit, and load management.

SCADA system is based on Internet so that real-time monitoring and remote control are available. SCADA system is also provided with friendly man-machine interface, and multiple communication protocols have been integrated in the system to enable extensive accessibility.

EMS Functions



Remote Control and Monitoring SCADA

Modularized EnergCube Container

Narada EnergCube Battery Container is available with 250kWh, 500kWh or 1MWh useable energy capacity by using 10HQ, 20GP or 40HQ containers. Larger energy capacity can be obtained by stacking several modularized EnergCubes to fulfill multiple applications.

Benefits

Modular Design and Scalability
EnergCube is designed with three modular containers and it is easy for scalability.

Plug-and-Play
Highly integrated Battery System enables easy transportation and installation.

Customization
Flexible system configuration makes possibility of customization.

One-Stop Turnkey Solution
EnergCube has integrated with all components including hardware and software to enable user a complete One-Stop Turnkey Solution.

Specification of Battery System

Photo			
Model No.	EnergCube250	EnergCube500	EnergCube1000
Rated Energy Capacity (C10)	336kWh	672kWh	1380kWh
Usable Energy Capacity (C10) * Optimized DoD is considered	250kWh	500kWh	1380kWh
Container Type	10HQ	20GP	40HQ
Dimension	2,991 X 2,438 X 2,896 (mm)	6,058 X 2,438 X 2,591 (mm)	12,192 X 2,438 X 2,896 (mm)
Max. Weight	16 Tonnes	16 Tonnes	65 Tonnes
Battery Technology	Narada REX-C Advanced Lead Carbon Battery	Narada REX-C Advanced Lead Carbon Battery	Narada REX-C Advanced Lead Carbon Battery
Rated DC Voltage	336V	640V	576V
Max. DC Voltage Range	302V to 420V	576V to 800V	518V to 720V
Operating Temperature	-20°Cto 45°C	-20°Cto 45°C	-20°Cto 45°C
Auxiliary AC Voltage	380V, 3 Phase 4 Wire, 50-60Hz	380V, 3 Phase 4 Wire, 50-60Hz	380V, 3 Phase 4 Wire, 50-60Hz
BMS	Intelligent Battery Monitoring and Management System, specially designed for Narada REX-C Lead Carbon Battery	Intelligent Battery Monitoring and Management System, specially designed for Narada REX-C Lead Carbon Battery	Intelligent Battery Monitoring and Management System, specially designed for Narada REX-C Lead Carbon Battery
Communication Protocols	TCP/MODBUS/IEC	TCP/MODBUS/IEC	TCP/MODBUS/IEC
Fire Suppression System	Manual	Manual	Manual or Automatic (Optional)
HVAC (Heating Ventilation Air Conditioning)	Air-Conditioning	Air-Conditioning	Air-Conditioning or Forced Cooling (Optional)
Protection Class	IP54	IP54	IP54
Battery System RTE (DC Side)	≥92%	≥92%	≥92%
Cycle Life	8,000 Cycles@40%DoD	8,000 Cycles@40%DoD	8,000 Cycles@40%DoD
Scalability Method	Series and/or Parallel Connection	Parallel Connection	Parallel Connection
Compliant Standards	Battery Cells: IEC60896-21/22, IEC61427 Battery System: EN 50272 or IEC 61485	Battery Cells: IEC60896-21/22, IEC61427 Battery System: EN 50272 or IEC 61485	Battery Cells: IEC60896-21/22, IEC61427 Battery System: EN 50272 or IEC 61485

Recommended Typical System Configurations

Possible Applications	Backup Time	Options	Recommended EnergCube Configuration at Different Rated Output Power (Single PCS Rated Power)			
			200kW - 300kW	400kW - 600kW	700kW - 900kW	1000kW - 1200kW
Frequency Regulation Voltage Support Power Quality Ramp-rate Control	1 hour	EnergCube250	2 Units	4 Units	6 Units	8 Units
		EnergCube500	1 Unit	2 Units	3 Units	4 Units
		EnergCube1000	/	1 Units	/	2 Units
T&D Congestion Relief T&D Upgrade Deferral Power Reliability Demand Charge Management Renewable Energy Firming	2 hour	EnergCube250	4 Units	8 Units	12 Units	/
		EnergCube500	2 Units	4 Units	6 Units	8 Units
		EnergCube1000	1 Unit	2 Units	3 Units	4 Units
	4 hour	EnergCube250	6 Units	12 Units	/	/
		EnergCube500	3 Units	6 Units	10 Units	12 Units
		EnergCube1000	/	3 Units	5 Units	6 Units
Energy Time-Shift Power Reliability Micro-grid Distributed Generation	6 - 8 hours	EnergCube250	8 Units	/	/	/
		EnergCube500	4 Units	8 Units	12 Units	/
		EnergCube1000	2 Units	2 Units	6 Units	8 Units
Micro-grid Distributed Generation	12hours	EnergCube250	12 Units	/	/	/
		EnergCube500	6 Units	12 Units	/	/
		EnergCube1000	3 Units	6 Units	10 Units	12 Units

- The above recommended configuration is designed for a single BESS unit, and more units can be stacked to form larger power and energy capacity BESS to fit customer's specific requirements.
- The above recommended system configuration is only for customer's reference and a precise BESS can be designed as per customer's requirement in details.
- Power Control and Conversion System (PCS) can be selected based on customer's preference to meet diverse demands.

Typical Application Cases

Dong Fushan Island Micro-Grid Project

Power/Energy: 500kW/960kWh Project: 2010

The 1st Micro-grid BESS project supplied by Narada

Narada Hybrid Power Station with PV and BESS

Power/Energy: 500kW/2MWh Project: 2011

The 1st Pilot Project at Narada Plant

GCL Silicon Factory Project

Power/Energy: 15MW/12MWh Project: 2016

The 1st Commercialized BESS Project implemented in China

Zhenjiang Aico Industrial Zone Project

Power/Energy: 0.75MW/8MWh Project: 2016

The 1st BESS invested and operated by Narada

India National Grid Project

Power/Energy: 1MW/1MWh Project: 2016

The 1st Grid-Scale BESS Project for Oversea Market

Wuxi Singapore Industrial Zone Project

Power/Energy: 20MW/160MWh Project: 2017

The Largest BESS Project in China

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