LTO Technology & Solutions Introduction

GREE ALTAIRNANO NEW ENERGY INC.

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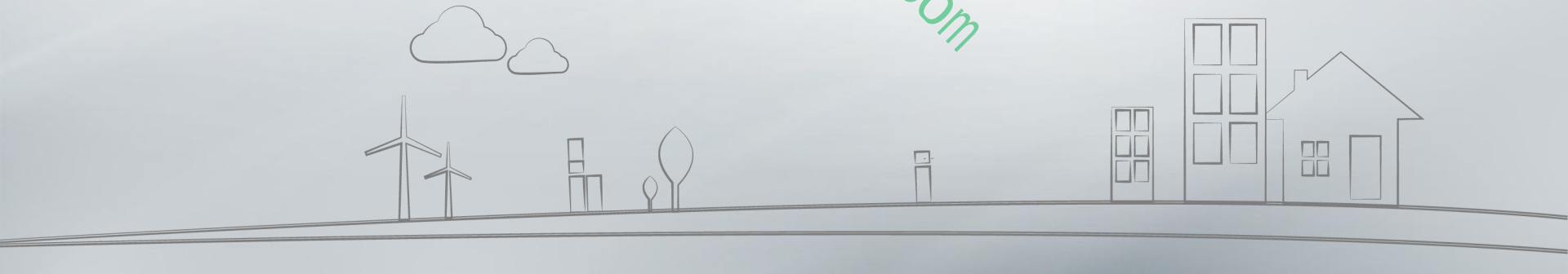

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Company profile

Established in 2008, Gree Altairnano new energy INC is a global comprehensive new energy industrial group company. We dedicated in LTO (nano Lithium Tianate Oxide) technologies, develop and manufacturer high performance LTO material, LTO batteries, battery systems, BMS and fast charging EV buses.

Yinlong 银隆新能源

广通汽车 Guangtong Automobile

奥钛储能 altairnano

8 R&D and Production Facilities

Headquartered in Zhuhai

Handan

Shijiazhuang

Chengdu

Tianjin

Nanjin

Luoyang

Nevada, US

We offer commercial solutions for:

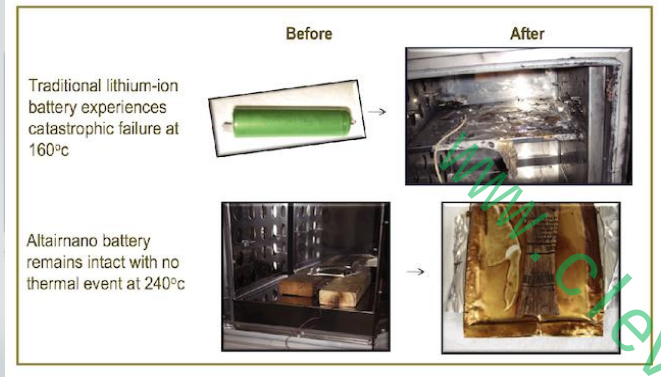
- ✓ **Industry** that demanding long cycle life, rapid charging and discharging capabilities while operating in difficult duty cycles over wide temperature range.
- ✓ **Transportation** supercapacitor-like charging capabilities for capturing regenerative braking energy in hybrid vehicles and rapid charge for full electric vehicles.
- ✓ **Electricity grid, Renewable power integration** high power fast response to help lower energy costs and improve grid stability.
- ✓ **Military** high safety , high power and durability in tough environment.

2

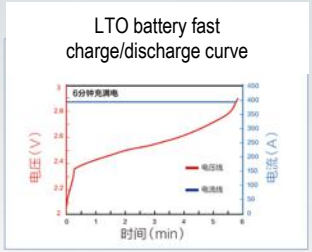
Technical Advantages

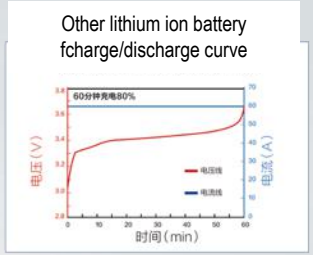
LTO battery's advantages

High Safety



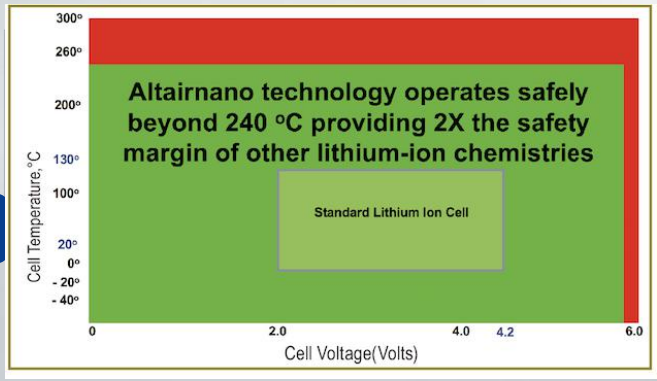
High Power, Rapid Charge





- Charge and discharge 10 times faster than competing technologies
- Regenerative recapture similar to super capacitor

Wide operating temperature range



- Operating range -55° C to 60 ° C
- Wide temperature and voltage ranges provides greater safety margin
- Other lithium-ion chemistries unable to charge below 0 ° C

Long cycle life

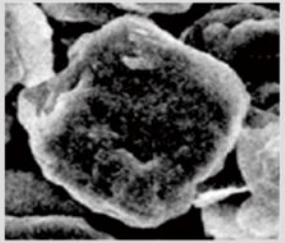
Average cell temperature

DOD (%)	25	30	35	40	45	50	55
	Cycle Life (cycles to 80% of original charge capacity)						
100	25,000	19,847	15,753	12,504	9,925	7,878	6,253
90	30,864	24,503	19,449	15,437	12,253	9,726	7,720
80	39,063	31,011	24,615	19,538	15,508	12,309	9,770
70	51,020	40,504	32,150	25,519	20,255	16,077	12,761
60	69,444	55,131	43,760	34,734	27,569	21,883	17,369
50	100,000	79,388	63,014	50,016	39,700	31,512	25,012
40	156,250	124,044	98,459	78,151	62,031	49,237	39,081
30	277,778	220,523	175,038	138,935	110,278	87,532	69,478
20	625,000	496,178	393,836	312,603	248,125	196,947	156,325
10	2,500,000	1,984,711	1,575,344	1,250,412	992,502	787,788	625,298

- 10~100times longer life than other batteries.
- 25years calendar life
- Lowest cost of whole cycle life in demanding applications

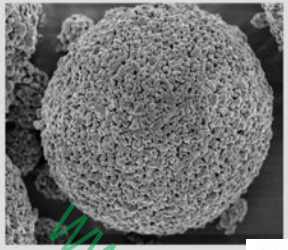
THE DIFFERENCE BEGINS WITH THE MATERIAL PROPERTIES:

- Altair's Proprietary Nano Lithium Titanate primary particles are nanoscale crystals, then fused together to microsphere particles
- Traditional graphite primary particle size is hundreds times of Altair's Proprietary Nano Lithium Titanate



10 microns

Traditional Graphite crystal

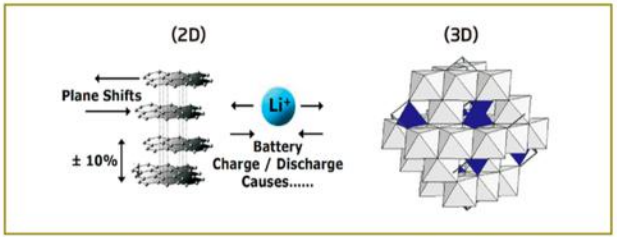


10 microns

Proprietary nano Lithiumtitanate particle has1,000 times the surface area of graphi

When Lithium Ion battery charge and discharge, lithium ion insert and extract from anode material. During this process:

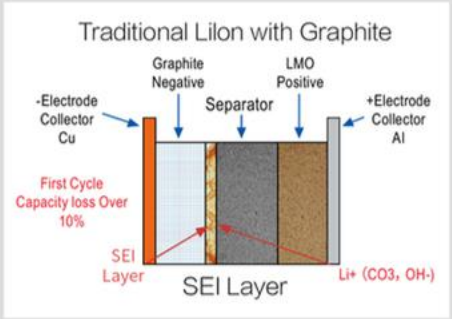
- 2-dimensional graphite undergoes life limiting and poor cycling stability due to stress and strain/ exfoliation caused up to 10% volume change
- 3-dimensional physical stability of Nano Lithium Titanate, has been known as "zero strain structure material" only have less than 0.3% volume change, that maximize cycle life and high charge power capability

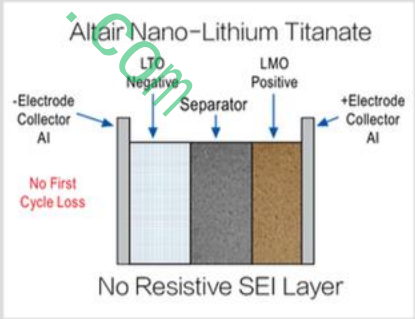


.....Stress and Strain In Graphite Leading To limited Cycle Life

.....No Stress or Strain In nLTO Leading To Long Cycle Life

- Low reactivity with electrolyte eliminates Solid Electrolyte Interface(SEI) layer creating improves thermal stability and safety
- Lithium-titanate capable of absorbing oxygen molecules at very high temperatures from cathode degradation; reduces risk of thermal runaway increasing safety
- Lithium-titanate chemistry eliminates creation of dendrite formation; reduces risk of internal cell short circuits





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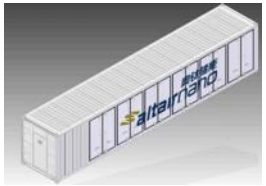
Product Overview

Product Overview

Material	Cell	Module/ PACK / BMS	Battery Cabinet/Battery Rack	ESS/ EV
 nLTO Material				
				
			Motor Control 	EV 

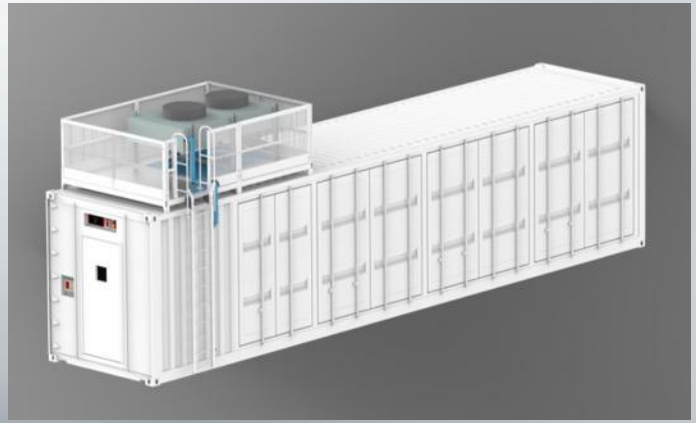
1MWh/3MW—3C Enery Storage System

Provide stabilized Grid

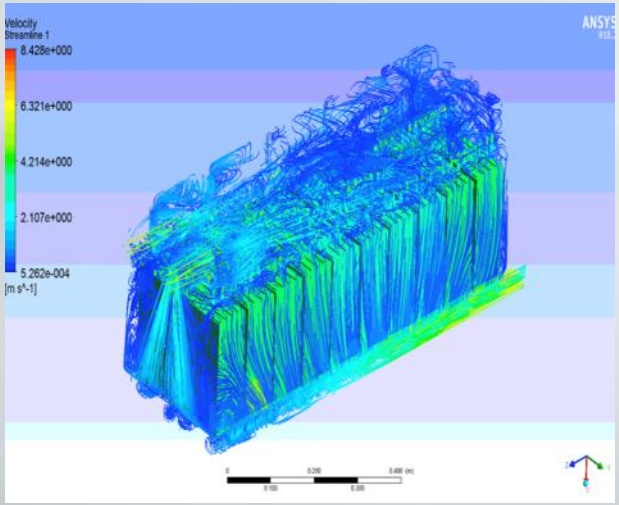
- ✓ Frequency Regulation
- ✓ Renewable power smoothing,

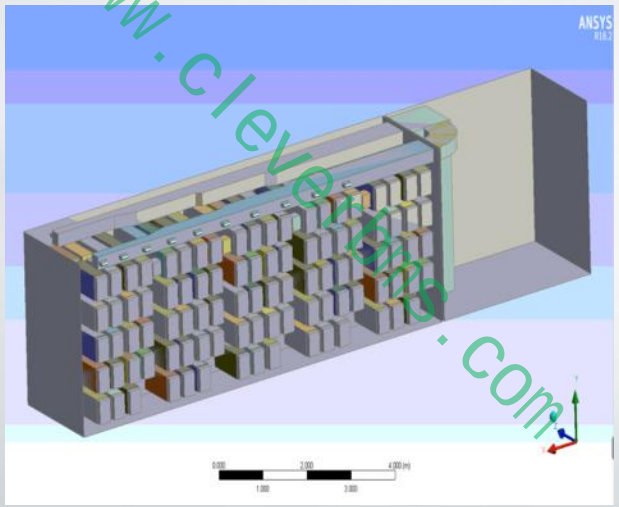
Product feature

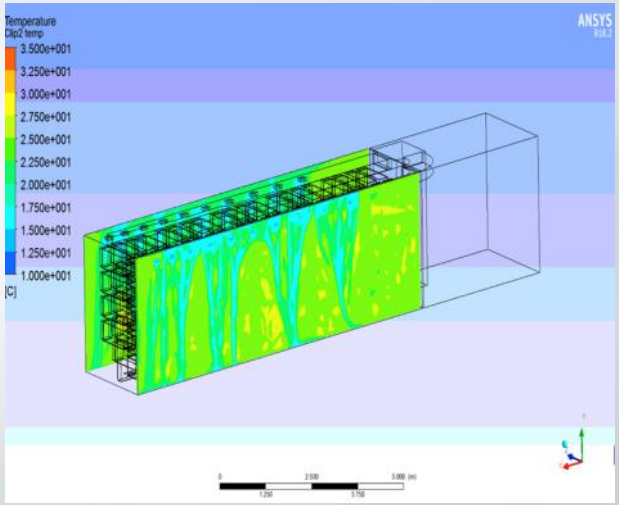
- ✓ 3MW/1MWh;
- ✓ -55℃~60℃;
- ✓ 40'ISO shipping container;
- ✓ Designed life 25years,



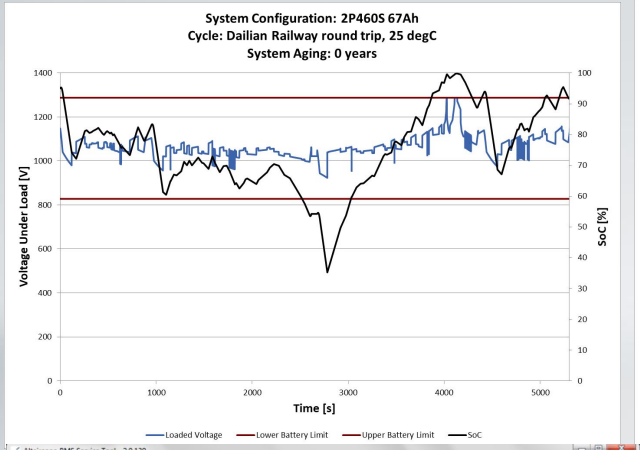
1MWh/3MW—Optimized Thermal Management

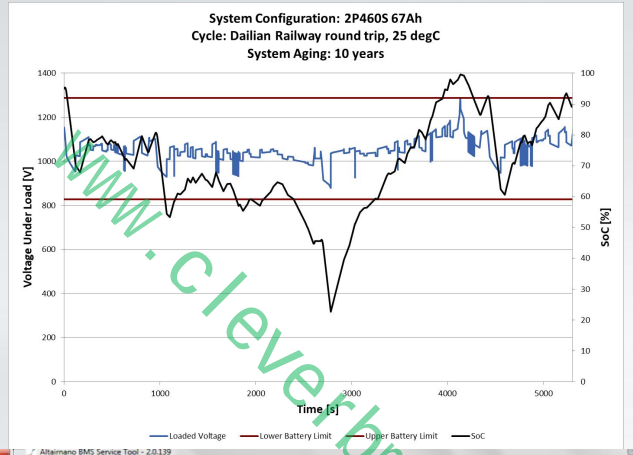


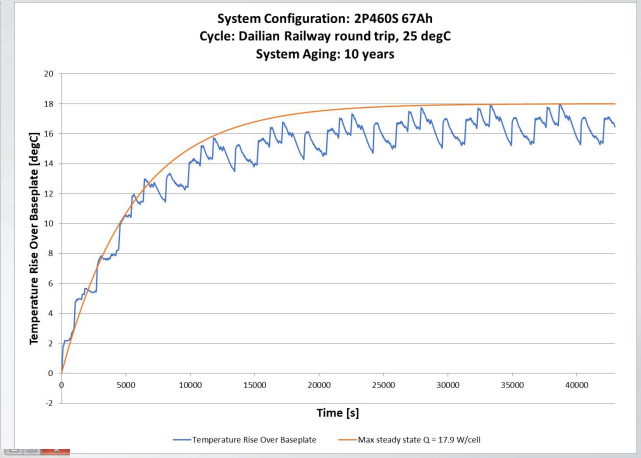


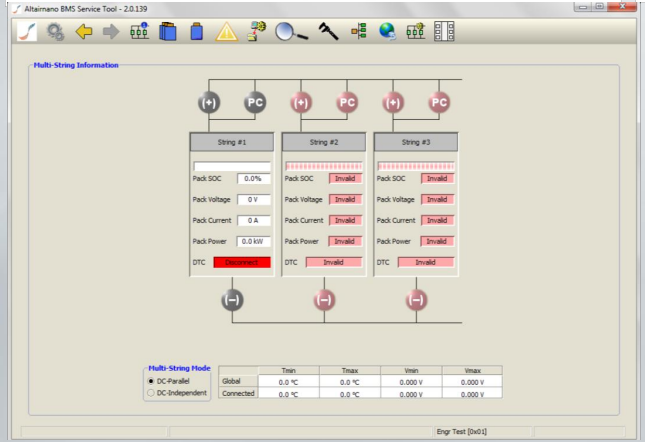


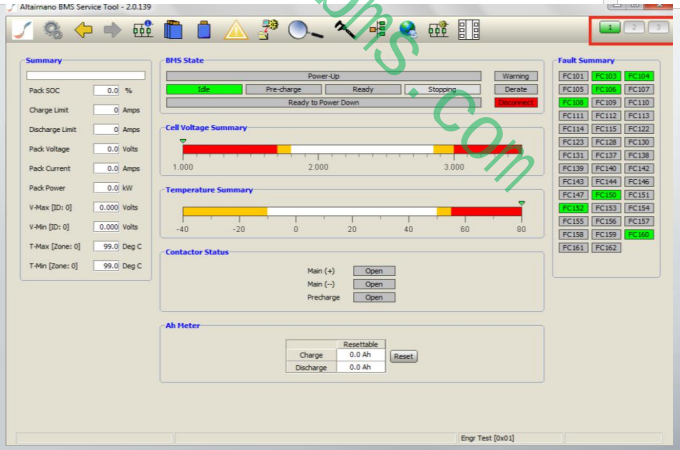
Advanced duty cycle and thermal simulation technology to provide customers with efficient and high-quality system configuration design and thermal management design











International Certification

✓ IEC 62133 International electrotechnical commission standard

✓ SAE J2464 Energy storage safety and abuse in electric and hybrid electric vehicles

✓ ISO 12405 Thermal vibration & Mechanical Shock ISO test specification for lithium ion battery packs and systems - thermal and mechanical vibration

✓ UN38.3 International standard for transportation of lithium ion batteries and battery packs

✓ 2MW KEMA The certified advanced LTO battery energy storage system successfully demonstrates the potential of power grid applications

4

Market Applications

01. Transportation

Supply LTO battery modules and BMS to top three tram/trolley bus manufacturers in Czech Republic since 2014: ***Skoda electric, Ekova and Cegelec***.

Applications require LTO batteries with:

- Safety and long cycle life
- low temperature performance
- high power 3C ~ 6C.

➢ Belgium EMROL—BB Green
Electric passenger ship

- A 20-meter passenger ship, capable of carrying 70-100 passengers
- 20 minutes shore charge time
- The round trip mileage runs in all-electric mode

➢Ultra Fast Charge EV bus

Sweden Hybricon:

Perfect operation at -30℃ in the cold winter of North Europe
3 minutes 6 ~ 8C super fast charging can last for 1 hour

Hybricon 12m & 18m Ultra-fast Charge Electric Bus
3 min 6~8C fast charge, operate for one hour

USA Proterra:

A case study on the success of NREL at the U.S. department of energy's national renewable energy laboratory:

Nevada and California have been operating for more than 8 years
600kw 6C quick charge in 3 ~ 5 minutes

Proterra BE35 Fast Charge Battery Electric Transit Bus (NREL/Leslie Eudy)
Two 600kw fast chargers are located at the Pomona Transit Center
Average 4.99 min charging time/12.5 times /day

➢ABB TOSA Flash Charging Bus

Power and productivity for a better world™

Geneva's first Full Electric Flash Charging bus, has been successfully operated in Geneva, Switzerland, and is now being implemented on a large scale in China. With the high power performance of over 10C of Yinlong LTO battery, the battery can be flash charged in 15 seconds.

The first generation TOSA Bus in Geneva

The second generation TOSA in Geneva

02. Industry

Hybrid Straddle Carrier

Technical Advantage and Economic Analysis of Hybrid Power System from the Customer：

I. Save diesel (30%-40% diesel saved than traditional diesel equipment)

II. Quietness (noise reduction by 50%, comfortable driving environment for drivers, less noise pollution)

III. Lower environmental pollution (reduced carbon emissions, meeting increasingly strict site emission standards)

IV. High efficiency (higher level automation)

V. Reduced maintenance costs (reduced maintenance hours on the engines due to1/3 reduced engine operating time)

VI. Reduced operating cost (savings of nearly $200,000 per year in diesel and maintenance cost)

VII. The investment in battery systems can be recovered for about three years.

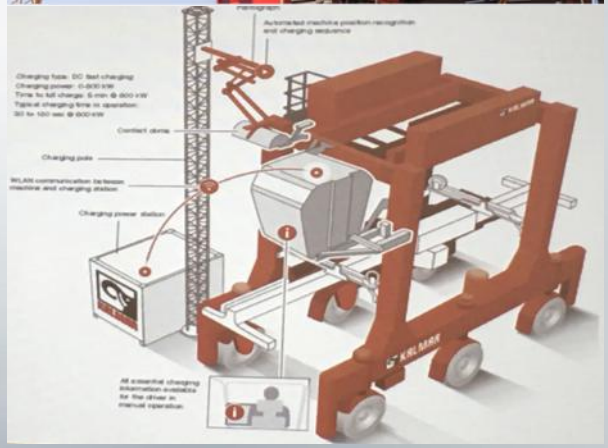
VIII. More than 7 years of mature operation.

35KWh Altairnano LTO battery system feedback energy with 8C rate

➢Cargotec

CARGOTEC
HIAB · KALMAR · MACGREGOR

Full electric Fast Charge Straddle Carrier



The 70kWh battery system with 6C quick charge in 5 minutes, can run continuously in the port for 1 hour

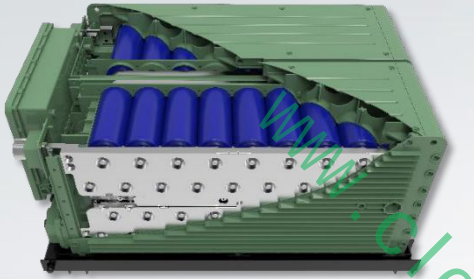
CARGOTEC
HIAB · KALMAR · MACGREGOR

Full electric quick charge AGV

- ✓ Load 70 tons
- ✓ 70kWh battery system
- ✓ Quick charge in 6-10 minutes

➢Full Electric Heavy Tuck Tractor N3 49Ton

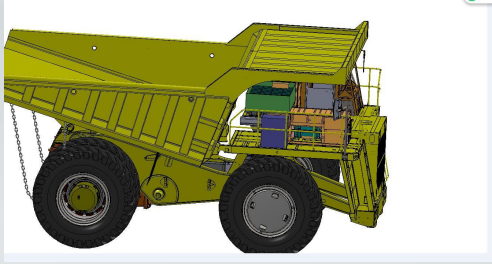
Cell	
Nominal V	1.75~2.75V
Capacity	45 Ah



PACK	
Voltage	27 ~ 50.4V
Capacity	180 Ah
Energy	7.45 kWh

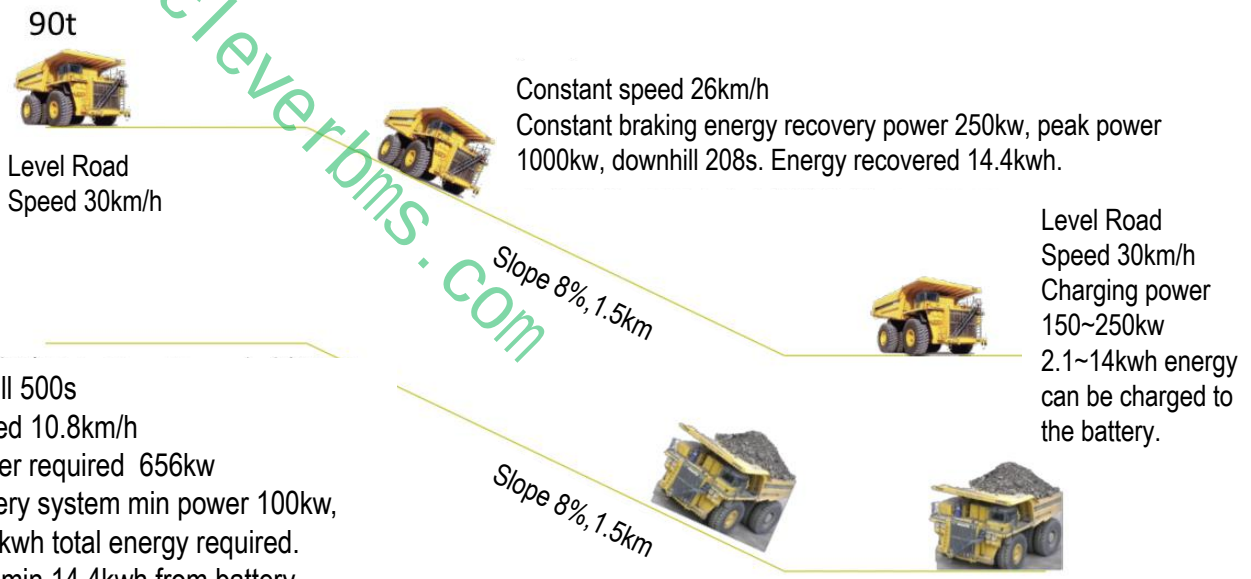
System IP67 4P270S 10 ~ 15min charge/50km	
Nominal V	405 ~ 756 V
Capacity	180 Ah
Energy	111.7 kWh
Max Continuous / Peak(60sec) Charge/discharge current	400A/450A
Dimension	L2498*W960 *H2065mm
Weight	3300kg

➢ Hybrid Dumper Truck 90Ton



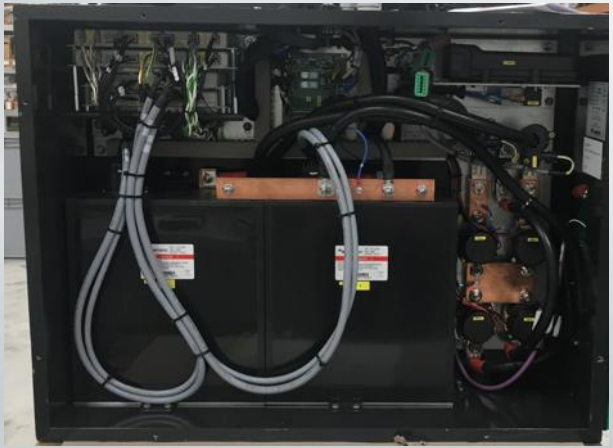
System 50 kWh 540V-840V 1P320S

- Downhill braking energy recovery and charge the battery
- Level road charge the battery
- Uphill discharge the battery and supplement power



➢Indoor AGV： Leclanche

The application requires the high power and fast charging performance of LTO batteries, which can ensure the daily 24hours continuous operation.



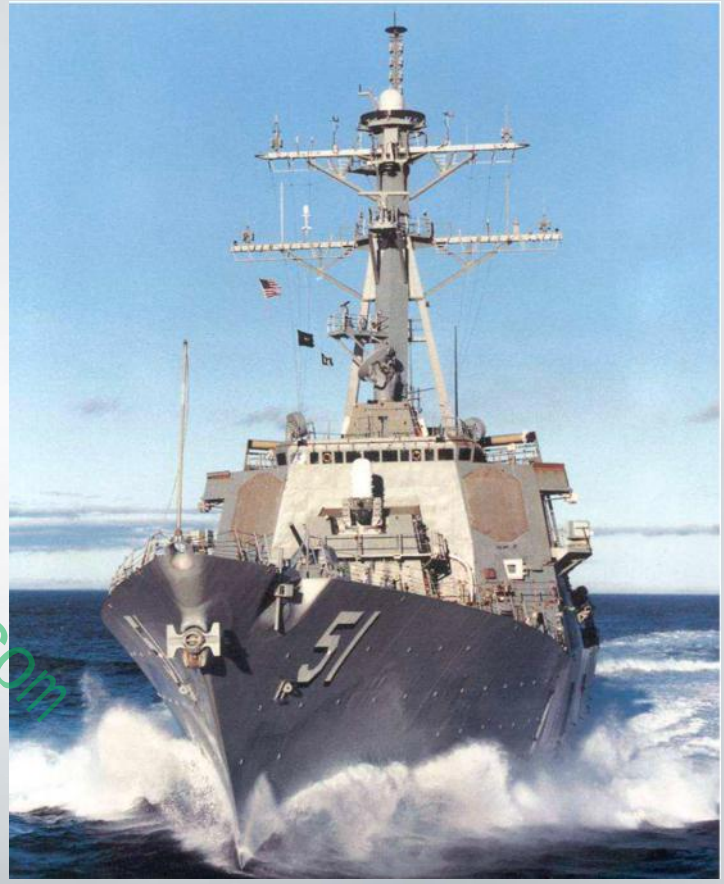
03. Military

- ONR
- Australian DSTO
- UK Submarine

Altairnano 24V 22Ah batteries and integrated battery management system (BMS) are successfully used in weapons, military vehicles, portable power and backup power applications

– U.S. Military and Avionics Research Organization

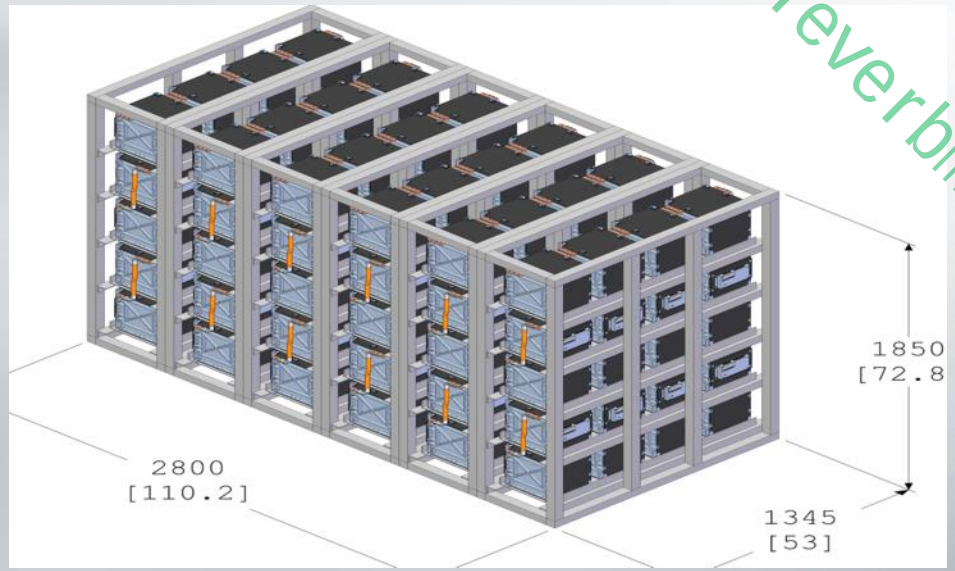
"The 24-volt/22 amp hour battery sports an integrated battery management system (BMS), and is for weapons, military vehicles, portable power, and backup power applications." - Military & Aerospace Electronics

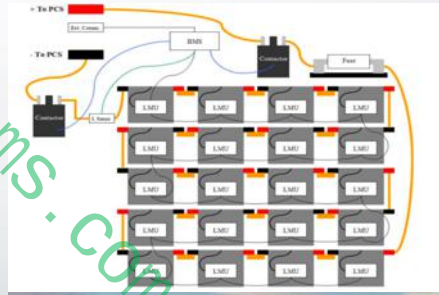


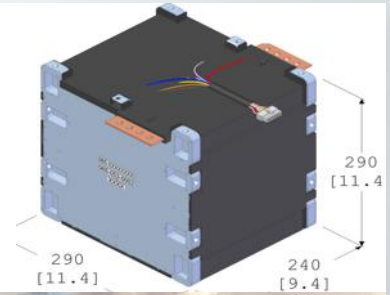
➢Warcraft Back up and black start Battery

Statement from the Piper Jaffray conference on clean technology and renewable energy on 20 February 2008:

The Altairnano battery system will replace the 500KW standby diesel generator set on the U.S. navy's class 2 warship (The NO.52 Arleigh Burke Frigate)

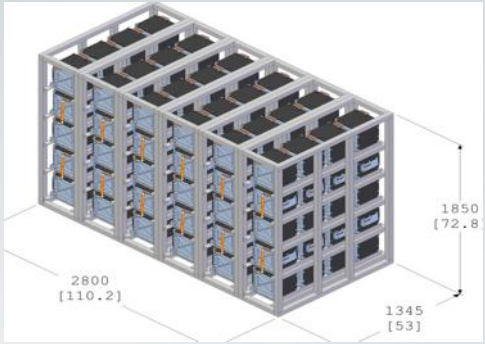






➢The army project

- ✓ARDEC M19 Howitzer
- ✓Nanosensor SBIR
- ✓Micro Grid
  - BAA#19
  - CERL



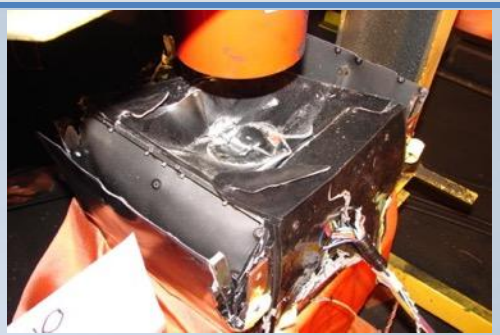
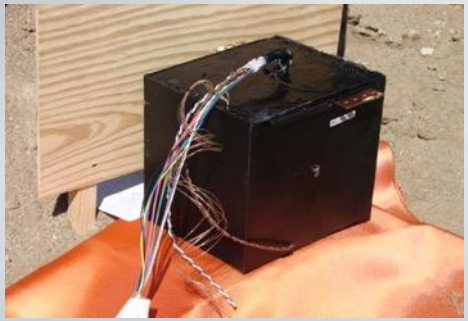

Press Release: 06-Aug- 2008 ALTAIRNANO TO DEVELOP REVOLUTIONARY BATTERY FOR THE U.S. ARMY - An announcement that ALTI has signed a $350,000 contract through the U.S. Army's Picatinny Arsenal in New Jersey to deliver prototype batteries for use in the Army's M119 105mm lightweight gun digitization program.

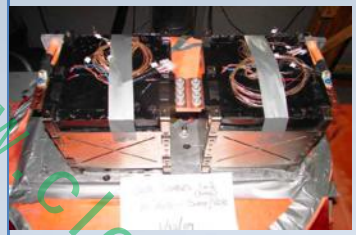
Altairnano batteries have been tested to supply batteries for the U.S. army's M19 105mm light machine gun digitization program.

In October 9th, US Naval Sea Systems did abuse testing on 5 pcs Altairnano 50Ah pouch cell and 5pcs 100Ah 22.4V 2P8S module, and validated Altairnano LTO battery can be safely used on Military projects.

Conclusion

The Altairnano Mk0.5 modules performed better than other similar batteries in regards to possibility of fire. There was no fire during any of the tests performed. There was also no deflagration of the module case and no internal components were ejected from the case. With the exception of the crush test the module was not deformed as a result of any test. With respect to other similar sized lithium ion batteries the testing of this module proved very benign.

7.62mm Bullet	50 Cal Bullet	Crush
		
		
Bullet did not fully pass through module which still had about 19.5 voltage, without fire or explosion	Bullet went through the module that appeared with a gray white smoke, which lasted for about 5 minutes. The voltage dropped to 12.5v and then fell to 9.0Vdc within 3 hours, without fire or explosion	Module emitted a gray white smoke without fire or explosion

Nail Penetration Test	Overcharge	Vibration	Temperature & Humidity	Salt Fog
				
		Vibrate the modules connected by copper bus bar in either axis. No negative effect.	The copper plate-connected pair of modules tested showed no negative effects on electrical or physical properties from ambient temperature and humidity	Tests on a pair of modules connected by copper rows showed only slight corrosion on the surface of the metal and epoxy gum plates, caused by salt crystals left behind by evaporation from the salt spray. No other negative effects on electrical or physical properties.
Produce a lot of smoke, the side plate of the module melts, but there is no visible fire or explosion	Module is overcharged to 40V with white smoke, but no fire or explosion			

04. Grid

Altairnano creates solutions to problems highly specific to the electric grid, and uses our energy storage technology to bring value to utilities, through:

- Frequency regulation
- Renewable integration
- Voltage support
- Distribution level support
- Black start
- Microgrid optimization
- Energy capacity enhancement
- Spinning reserve

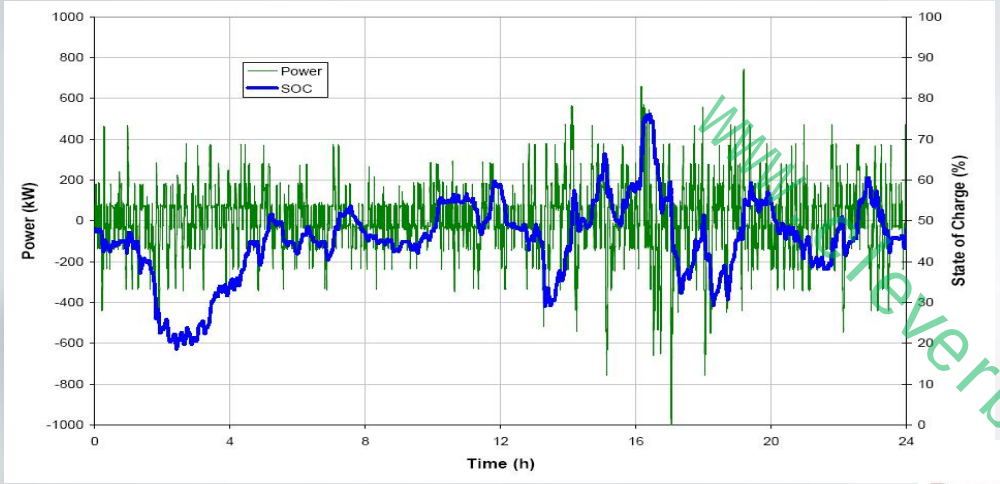
Customer	Configuration	Application	Location	Operation started in
Datong Branch of Institute of thermophysics, Chinese Academy of Sciences	500kw/1MWh	Solar energy complementary and new energy research and development	Datong， Shanxi	2019

Customer	Configuration	Application	Location	Operation started in
Wulate Power Plant	10MW/4MWh	Power Plant Frequency Regulation	Inner Mongolia, China	2020

Customer	Configuration	Application	Location	Operation started in
Hengqin Thermal Power Plant	8MW/3.2MWh	Power Plant Frequency Regulation	Zhuhai, China	2020

Customer	Configuration	Application	Location	Operation started in
AES	1MW/250KWh	Frequency regulation	PJM, America	2009
AES	1MW/250KWh	Frequency regulation	ERCOT, America	2010
Energy Storage Holdings, LLC	1.8MW/300KWh	Frequency Regulation	PJM, US	2013

In 2007, Altairnano delivered two sets of 1MW/250kWh systems to AES in the United States, serving the PJM ISO market. The following data are intercepted from the first two years of operation :



Response AGC commend in 4 seconds

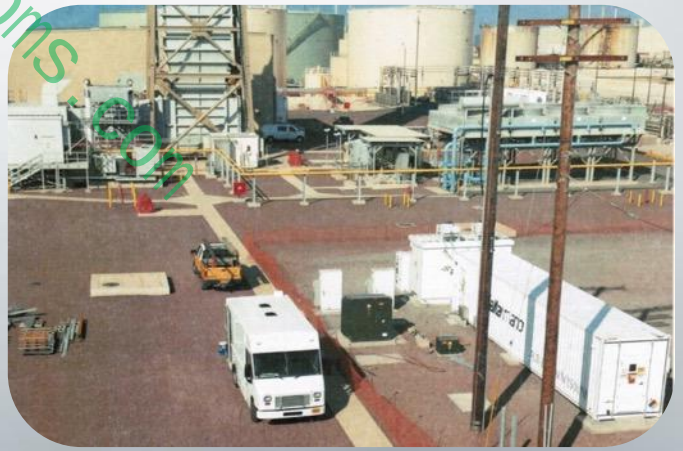
Results of First Two Years of Operation in PJM ISO

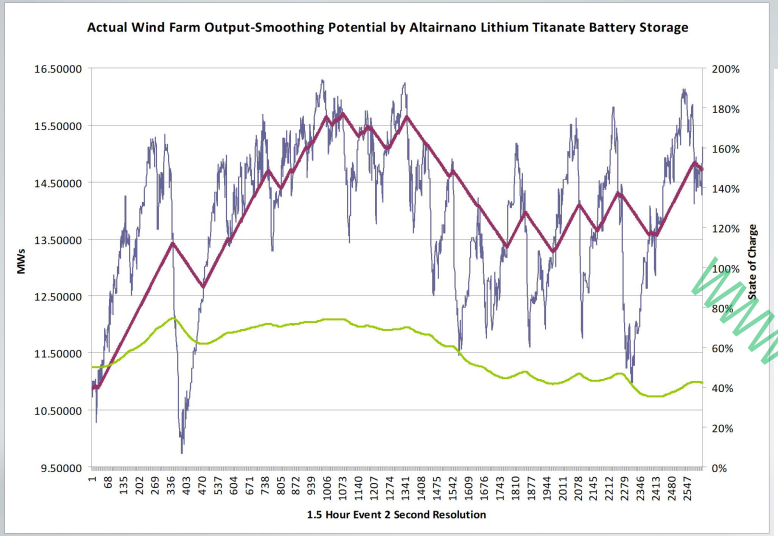
- Reliable operation and interaction with the Grid
- Performed over 500,000 small cycles and charged or discharged over 3,300 MWh
- Availability over 95%, generating revenues in line with plan
- Less than two percent energy capacity degradation and no significant power capacity degradation
- Expected to maintain rated power and energy capacity for over twenty five years without battery replacements or upgrades

Hawaii Electric Light Company

Hawaiian Electric Company

Customer	Configuration	Application	Location	Operation started in
HNEI / HELCO	1MW/250KWh	Wind power Integration & FR	Hawaii	2013
HNEI / HECO	1MW/250KWh	Solar power Integration & FR	Oahu, Hawaii	2016
HNEI /MECO	2MW/397KWh	Solar power Integration & FR	Molokai, Hawaii	2016





Hawaii Natural Energy Institute (HNEI): Wind Integration

- Altairnano to demonstrate wind integration
- 1MW ALTI-ESS energy storage system to integrate 10.5MW Hawi wind farm connected to Hawaii Electric Light Co. utility grid
- $1.8 million; Turnkey scope with 3 years of technical support
- Creates Value by Smoothing Renewable Power Ramp Rates and controlling voltage fluctuations
- Controls ramp rates to 1 MW/min
- Supports Hawaii's targets for wind and solar power
- 25% share by 2020
- 40% share by 2030

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Battery Energy Storage System battery durability and reliability under electric utility grid operations: Analysis of 3 years of real usage

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HIGHLIGHTS

- BESS operational 90% of the time. Stored more than 1.5 GWh of energy in 3 years.
- Cells were cycled an equivalent 5000 times in 3 years.
- Representative battery usage was assessed.

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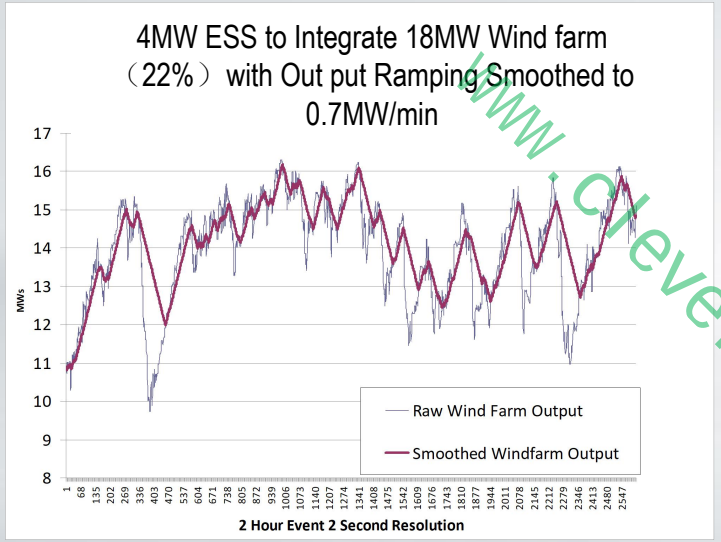
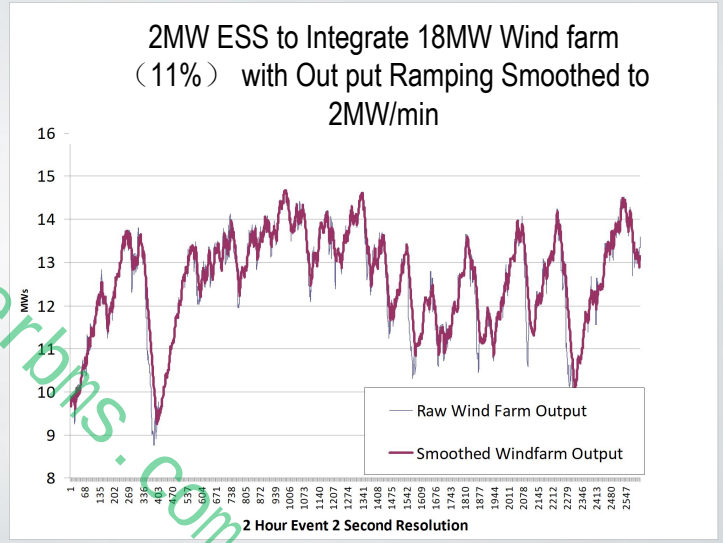
ABSTRACT

Battery Energy Storage Systems (BESSs) show promise to help renewable energy sources integration onto the grid. These systems are expected to last for a decade or more, but the actual battery degradation under different real world conditions is still largely unknown. In this paper we analyze 3 years of usage of a lithium titanate BESS installed and in operation on an island power system in Hawai'i. The BESS was found to be operational 90% of the time and stored a cumulative 1.5 GWh of energy, which represents more than 5000 equivalent full cycles on the cells. This paper presents a statistical analysis of the BESS usage, develops a representative duty cycle, and provides an initial estimate of BESS degradation. The battery duty cycle was characterized based on 5 parameters: pulses duration, pulses intensity (current), SOC swing range, SOC event ramp rate, and temperature.

Customer	Configuration	Application	Location	Operation started in
Vestas	1MW /250KWh	Wind power Integration &FR	Denmark	2014

ESS & Wind Farm Power Ratio





1. Customer expected Smoothing Effect
2. Grid Policy

Customer	System configuration	Application	Location	Operation started in
TSK	2MW/397KWh	Integrated solar power generation	PUERTO RICO, USA	2015

Customer	System configuration	Application	Location	Operation started in
China state grid	2MW/500 KWh	Wind and solar power Integration	Hebei	2015

Micro Grid – Eaton Lawton, Oklahoma, USA Project

Figure 23: 2.5kW Wind Generator

Figure 25: 86kW PV Array

Figure 27: 400kW Power Optimized Storage Battery

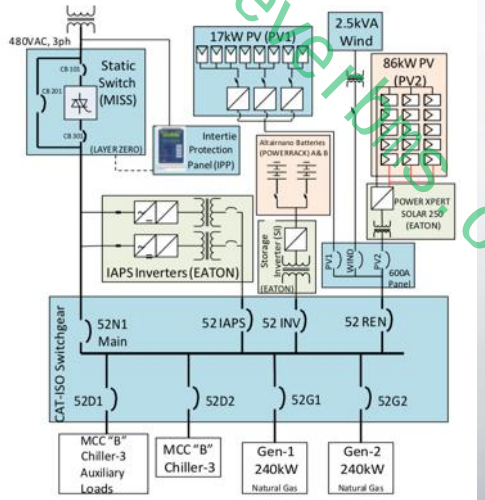


Figure 1: Fort Sill Microgrid System One line Diagram

Successful demonstration on:

- ✓ Altairnano Power Optimised ESS in conjunction with NG generators and renewables, can support an islanded microgrid without loss of power quality
- ✓ The ESS powers the load until generators go online in the case of an unintentional island, where grid is lost and generators were off.
- ✓ with generator synchronization being faster due to the stable bus provided by the storage system.
- ✓ High Penetration PV along with power optimized storage can power an islanded microgrid, and supplement generators while maintaining a stable voltage bus.

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Household ESS	Building Energy Efficiency	Military Field

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THANKS