Better Energy

COMPANY OVERVIEW



COMPANY INTRODUCTION

- Established in 2015 in New York City by Omer Ghani, Waseem Qureshi and Chip Seibert
- Our objective is to commercialize technologies developed by Waseem Qureshi
- Our mission is to develop solutions to the world's energy problems
- Currently commercializing
 - Sirius Supercap-based Energy Storage
 - Centauri Energy Server
- Based in New York (commercial & home office), Dubai (R&D lab) and China (manufacturing)
- Shifting R&D lab to our recently acquired New York facility
- Distribution in South Africa, Australia, Pakistan and Indonesia
- Concluding distribution agreements in Italy and Spain

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PRODUCT PORTFOLIO

Product	Application	Status			
Supercap-based Energy Storage					
7.1kWh48VDC	Cell tower, solar	In production			
3.55kWh48VDC	Cell tower, solar	In production			
1000Wh12VDC	Solar street lights	In production			
Under Development					
6.7kWh48VDC	Cell tower	Ready for production			
Rapid Charge (<1min)	EV, forklift, club car	Manufacturing planned for Q1 2018			
12V Series	Lead Acid Market	Manufacturing planned for Q1 2018			
192V & 384V Series	UPS, Containerized	Manufacturing planned for Q1 2018			
Centauri Energy Server					
Single Phase (2.5kW – 10kW)	Residential	In production			
3-phase (20kW to MW)	Microgrid	In production			



COMMERCIAL ACTIVITY SNAPSHOT

- Cell tower storage to MTN, South Africa (tender)
- Off-grid Server + Storage in South Africa
- Hybrid Solar + Storage in South Africa
- Residential Storage in Australia
- UPS and telecom Storage in Pakistan
- Cell tower storage pilot in Indonesia

POC ACTIVITY SNAPSHOT

- Con Ed testing and evaluation of Sever + Storage by EPRI, USA
- Duke Energy testing and evaluation of Server + Storage in USA
- DNV testing and validation of storage in USA
- Greenfox various POC's of storage for street lights, and solar + storage in South Africa

SIRIUS SUPERCAP BASED STORAGE TECHNOLOGY AND PRODUCTS



SUPERCAP-BASED STORAGE: TECHNOLOGY

- Power electronics
 - Algorithm-based current balancing circuit actively balances an assembly of supercaps connected in series without compromising capacity
 - Algorithm-based charge control circuit controls rate of discharge (flat voltage curve)
 - ✓ Algorithm-based charge retention circuit controls self-discharge
- Materials
 - ✓ Enriched graphene-based materials delivers an energy density of 70-80Wh/kg at the supercap cell level

SUPERCAP-BASED STORAGE: IMPACT OF TECHNOLOGY

- Active balancing circuit
 - allows supercaps to be connected in series to achieve commercial voltages without compromising capacity or performance
 - allows scaling by being able to connect modules in series
- Charge control circuit
 - allows supercap-based modules to be deployed in long duration discharge applications
 - makes the supercap-based module a singular solution for all types of load profiles (fast, medium, long duration)
- Charge retention circuit
 - controls self-discharge to 5% in 25 days, making it commercially acceptable in most use cases
- Energy density:
 - enables the form factor of supercap-based modules to be commercially viable in most use cases



PERFORMANCE HIGHLIGHTS

- Projected cell cycle life of 1,000,000 cycles at 100% DOD
- Flat discharge curve so suitable for storage applications
- Fast charge/discharge capability with no effect on cycle life or capacity
- Operating temperature range -30°C to 85 °C
- 99%+ DC-to-DC round-trip efficiency*
- Minimal heat generation during charge/discharge cycle
- Safe, non-toxic, non-flammable, mobile
- Commercially acceptable form factor equivalent to chemical batteries
- Scalable, economical manufacturing process using off-the-shelf components
- Lower cost of ownership when compared to chemical batteries *at room temperature



28.4kWh384VDC Storage Bank



7.1kWh48VDC MODULE



3.55kWh48VDC MODULE



Solar Street Light



EV RETROFITTED WITH SUPERCAP-BASED STORAGE

CENTAURI ENERGY SERVER TECHNOLOGY AND PRODUCTS

BACKGROUND

- Renewable energy is generated and fed into the grid network (95% of renewable based generation is grid tied)
- There is a very small amount of renewable generation that is deployed to power the load directly
 - ✓ Effective and economical storage has been a limiting factor
 - ✓ Limitations in power electronics have prevented the ability to effectively use distributed renewable generation to operate renewable based microgrids, reduce congestion in existing networks and address new opportunities in the grid of the future

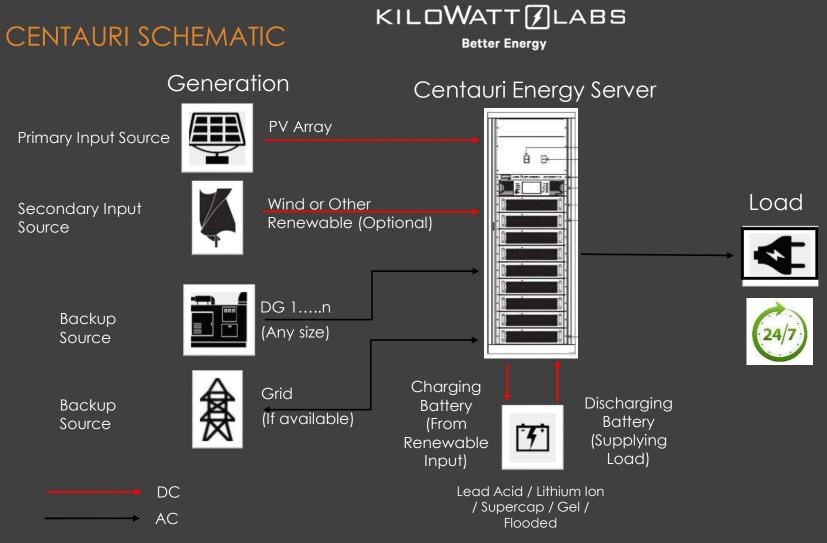
POWER ELECTRONICS REQUIRED

- To effectively deploy solar + storage based microrgids, the power electronics must perform the following functions:
 - ✓ Handle torque load to support the starting of motors, compressors, and all forms of inductive loads with surge currents
 - \checkmark Accept 5x 6x renewable input without oversizing
 - ✓ Connect to storage
 - ✓ Handle renewable intermittency by switching seamlessly between renewable generation and storage
 - ✓ Supply to the load directly and concurrently charge storage
 - ✓ Include functionality enabling connection to other sources of power
 - Ability to switch between the various input sources seamlessly without destabilizing the load
 - ✓ Correct power factor losses on the circuit caused by inductive and capacitive loads
 - ✓ Include built-in safeties, data logging, monitoring and control
 - Include flexible protocols to communicate with the network and respond to signals from the network



CENTAURI FUNCTIONALITY

- Stand-alone, plug-and-play platform with complete built-in functionality that does not require integration with any additional hardware
- Peak load handling (up to 1000% for 2s)
- Multiple generation input sources
- Automatic seamless switching between input sources
- High system DC to AC efficiency (97%+)
- Renewable input capability of 5x rated capacity enabling storage charging
- Multiple battery chemistry input capability
- Battery balancing and optimization functionality
- Power factor correction on load of 1
- Harmonics filtering on load
- Auto gen set start stop
- Monitoring and control
- Islanding / anti-islanding (bi-directional)
- Built-in safeties
- Modular and Scalable



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HOW DOES IT WORK

CENTAURI **Energy Server**

PV solar panels generate electricity from sunlight for 4 to 6 hours a day



2 The electricity from the PV solar panels is fed to the Centauri **Energy Server**

Low PV gen days



3 The Centauri, connected directly to the home or office or factory, delivers safe and regulated power

Load



6 When PV generation is low, the grid or a diesel genset charges the batteries. The Centauri automatically manages the switching, control and regulation



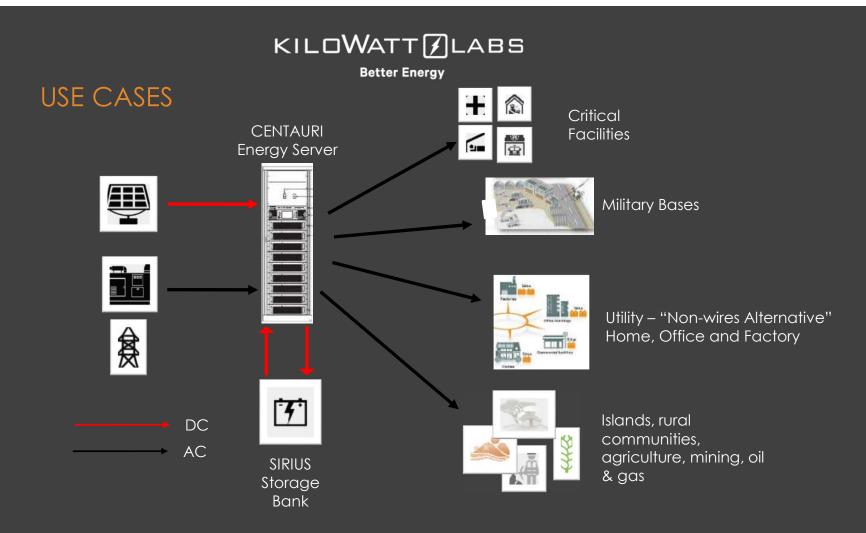
5 When the PV panels stop generating, the Centauri seamlessly switches to energy from the charged batteries for the remainder of the day



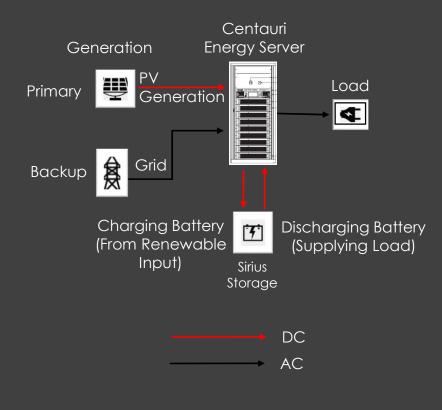
4 The Centauri charges the Sirius battery with excess energy generated from the PV panels

DC AC

SIRIUS Storage Bank



Utility of the future CUSTOMER SITED POWER



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Utility of the Future - how does the grid benefit?

Average home: 5kW load, 11,000kWh/year consumption

Every 1000 homes migrated to the system:

- ✓ Permanently reduces energy demand of 11GWh/year
- ✓ Permanently reduces peak demand from the grid by 5MW
- ✓ Permanently adds 8MW of renewable generation
- ✓ Permanently reduces 1.5MW of fossil fuel generation and associated GHG emissions
- Eliminates maintenance opex associated with "poles + wires" infrastructure
- Eliminates subsidy-based programs (FIT, NEM, DR)
- Is a long term asset (25 year)
- Optimizes capital allocation from forecast-based long-term to demand-based short-term
- Improves ROI (unlevered IRR on capital deployed is better than regulated utility return in most cases)



160kW Centauri Server (supports 800kW of panels)

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COMPARISON WITH CHEMICAL BATTERIES

Attribute	Sirius	Lithium-Ion	Lead Acid	Flow	Sirius Advantage
Projected Cycle Life (cycles)	1 million*	200 – 4,000	200 – 4,000	10,000	Highest cycle life in the industry
DC TO dc Round trip Efficiency	99.1%	~90%	~70%	65% - 75%	Lowest opex in the industry
Depth-of-Discharge (DOD)	100%	80%	50%-60%	100%	Name-plate capacity is useable
Temperature Effect	<85⁰C	<50ºC	<27⁰C	<50ºC	Useable in almost any location
Charge Current Limitation	1.35C**	0.2C	0.1C	Limited	Reduce opex
Discharge Current Limitation	45 min**	2 hours	10 – 20 hours	2 – 10 hours	Reduce opex
Thermal Stability	Stable	High Risk	Minimal	Stable	Reduces costs by eliminating the need for auxiliary cooling systems
Energy Density	High	High	Medium	Low	Effective form factor
Non-Flammable/Non- toxic	Yes	No	No	No	Safe

* Supercap cell ** On 48V models, other models may vary

COMPARISON WITH LEGACY SYSTEM

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Feature	Centauri	Legacy System	
Torque Load Handling (handles surge currents enabling it to independently run all types of loads, inductive, resistive and capacitive)	1,000% for 2 sec 999% to 200% for next 8 sec 125% for next 1800 sec	~250% - 300% for 15 sec	
System efficiency (generation to output)	96.7% - 99.1%	60% - 80%	
Charge storage from PV	Yes (connects 5x PV capacity)	No (0.5-1.3x PV capacity)	
Battery charging inverter, flexibility in type of battery connectivity	Built-in	No – to be purchased separately	
Power factor correction of load and harmonics filtering	Yes	No	
Power line conditioning	Yes	No	
Multiple source input, sequential or blended output, seamless switching	Yes	No	
Auto genset start / control	Yes	No	
Remote monitoring and control	Yes	No	
Islanding / anti-islanding	Yes	No	
Bi-directional option available	Yes	Yes	
Built-in safeties and BOS	Yes	No	
Modular	Yes	No	
Plug-and-play (no external systems required)	Yes	No	
Installed system cost (\$/W)	Better economics than any other system		

Solutions for: Microgrids | C&I and Residential Solar | Electric Vehicles | Utility Grade Storage

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