REVOV

LiFePo-Battery Offering

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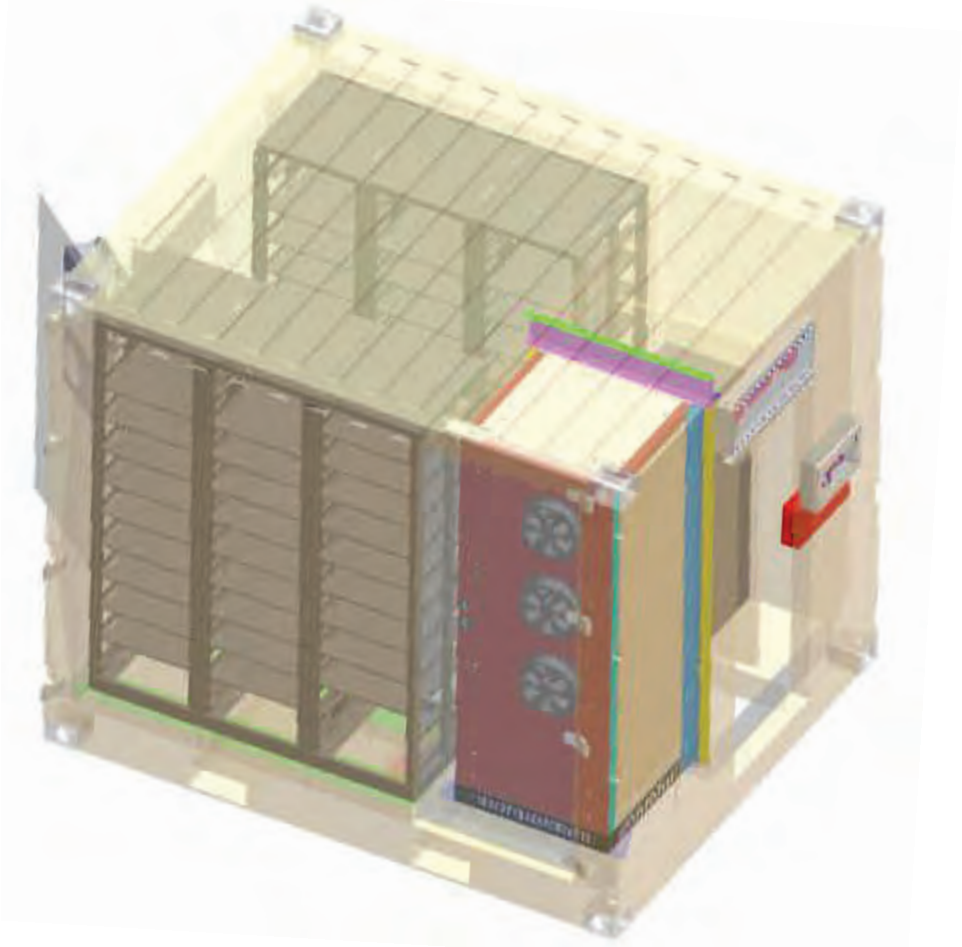

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1. The Introduction as why “Li-Ferro-PO” is the best for Africa
2. Revov paradigm shift
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1. The Battery Conundrum

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- Sites need backup power
- Batteries are heavy, in-efficient, unreliable
- They need cooling to have a useful life
- High TCO, Need to be replaced often
- Functional degradation over time
- Lead, in varying guises, is the traditional solution
- Lead is attractive to thieves, 12 v arrangement makes it even more so

1. Solution – Lithium Iron (Ferro) Phosphate ($LiFePo_4$)

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- Lithium is the lightest Metal
- Was developed for electric vehicles
- Can be charged from any state without damage
- All $LiFePo_4$ Cells are “deep Cycle”
- Energy Density 2,5 times Valve Regulated Lead Acid (Wh/L)
- Energy 4 times VRLA (Wh/kg)
- Acceptable performance up to 45^oC (VRLA only up to 25^oC) Significantly better hot climate performance (33^oC)
- The absence of lead removes some of the motivation for theft, lower recycling value
- 19” Rack mountable
- They have a 15 year float life at 25^oC
- Up to 7 000 cycles
- Operate at -20 to +70^o C

Life expectancy under continuous charge

1. Battery Technology – The Iron-phosphate Battery

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Long life cycle

Retention rate capacity is still over **70% after 10,000 charging cycles**

Safe and reliable

The Iron-Phosphate Battery undergoes extremely harsh tests – flames, short circuit, prodding, striking, extreme heat, extrusion and overcharge. It does not burn or explode even when put into the fire.


Flames


Short Circuit


Prodding


Striking


Extreme Heat


Extrusion

Environmentally Friendly

No Pollution throughout the whole production process!

2. Revov Specializes In LiFePo Battery

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Calls upon **20-year** battery manufacturing experience. Sources from 4 top-tier suppliers.

The world's **largest** Iron-phosphate battery output capacity, covering **20%** of the global capacity.

2. Paradigm shift – 2nd Life

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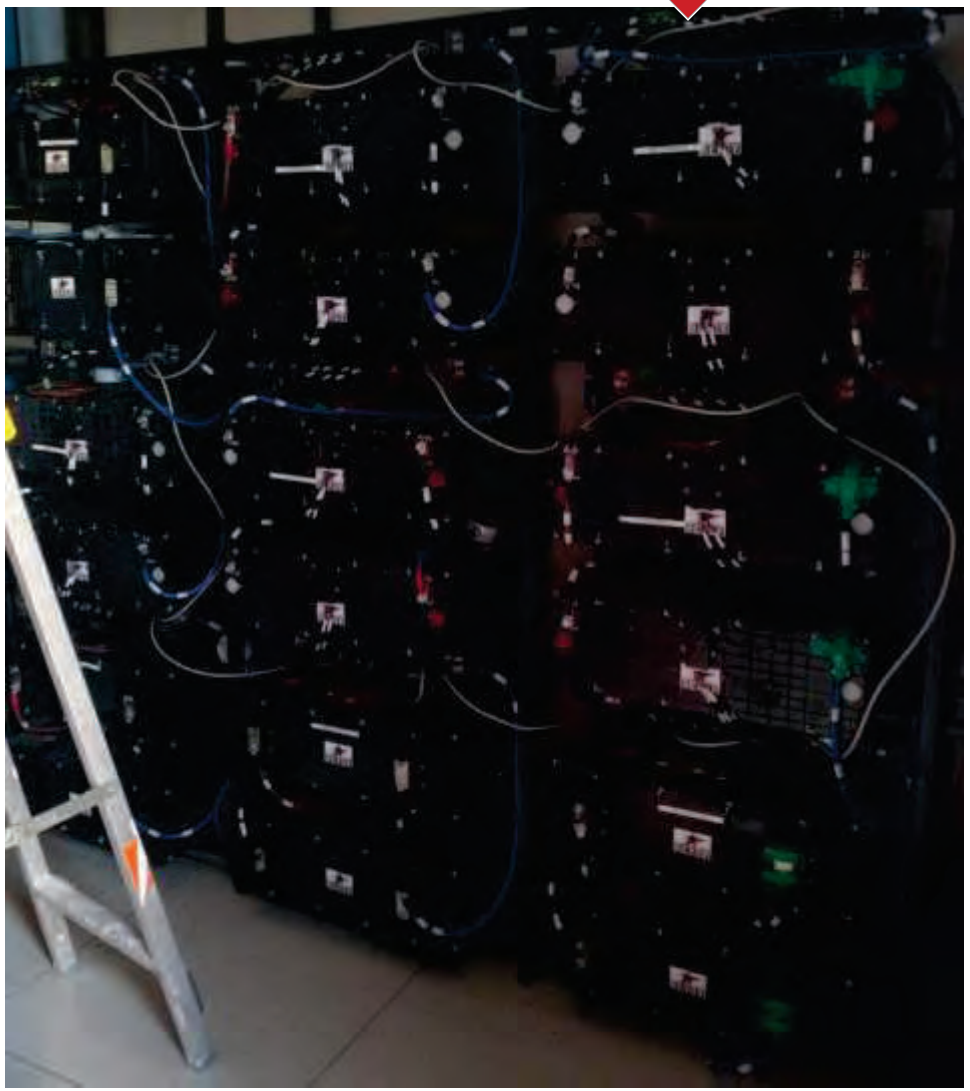
- Batteries in EV start to become heavy, in-efficient, after time. But still have 14-15 years of useful power available
- Recycling is not advanced
- A New BMS to control the more consistent power
- Smooth power delivery and regulated
- Rugged battery and safe chemistry – high draw allowed
- Weight and electronic control make theft cumbersome
- Greener than Green as no additional carbon required or used
- Improved pricing



2. Revov Battery Offering

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Battery Model	Features (all batteries can be *stacked* for larger power needs)
LiFePo K9	Pure EV battery, repurposed, and with external BMS
LiFePo R9	Pure EV battery, repurposed, and rehoused for appearance and strength, with external BMS
LiFePo Life	New cell LiFePo battery from Tier-1 supplier, and housed for appearance and strength, with external BMS
LiFePo Life Pro	New cell LiFePo battery from Tier-1 supplier, and housed for appearance and strength, with built-in BMS

4. Large Applications – China Mobile

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Telecom Switch building core computer room application case:

Telecom Hub (switch) building - 48V 4000AH backup application

Project date: From Oct,2012 to Nov,2013 .

Battery Type: Standard 3U battery /200pcs

Installation Area: $6m^2$

Total capacity: 4000AH

Max. discharge current: 2000A

4. Application in Typical RBS

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Emerson
rectifiers

Revov
BATTERY

5. Test System To Replaced Lead Batteries

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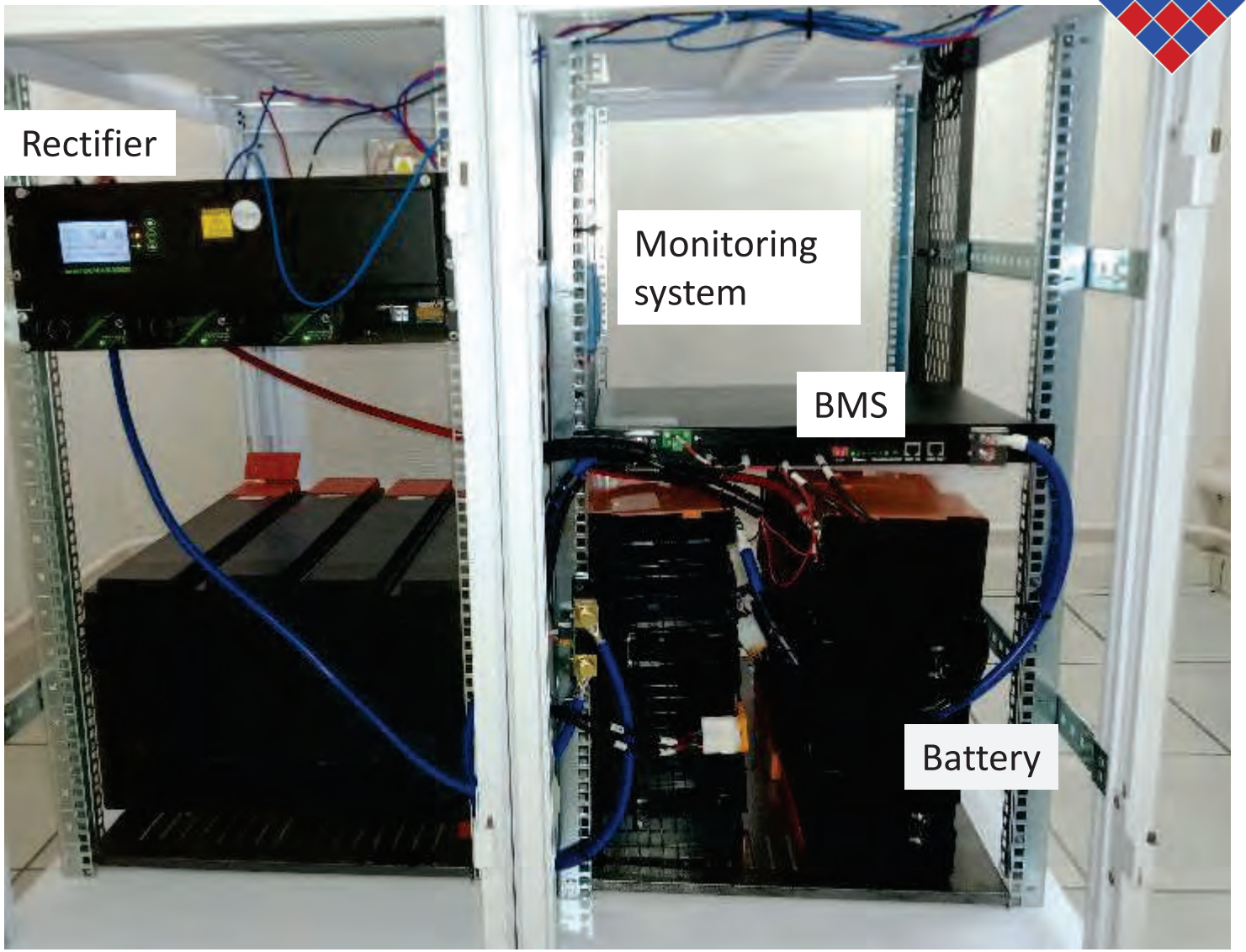

5. Replacement System Test

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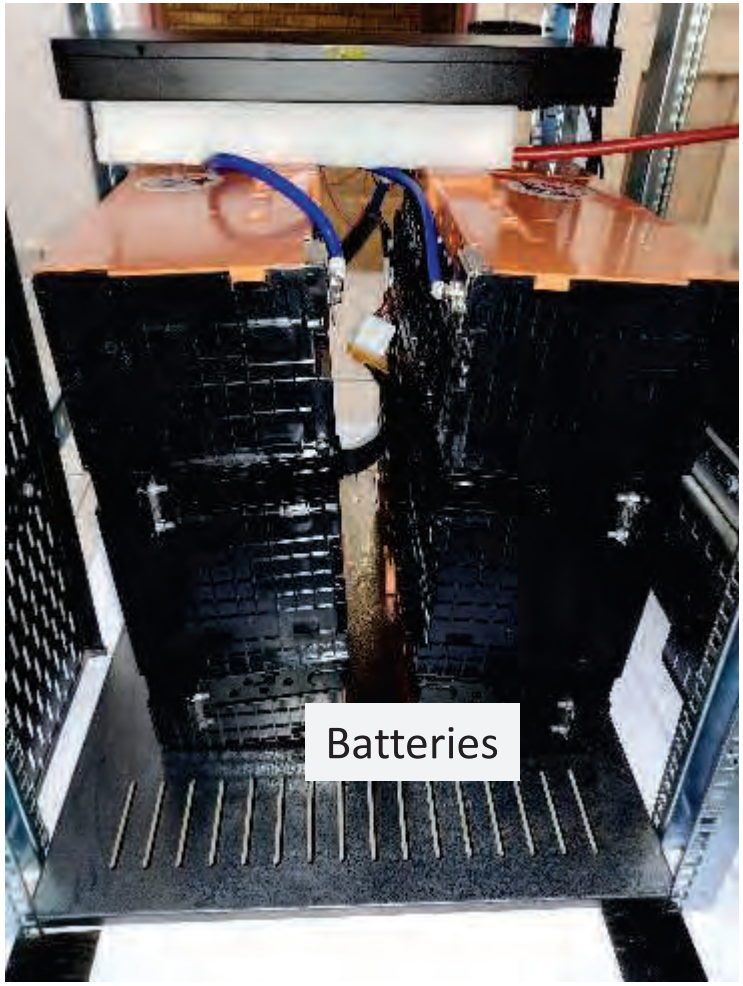
Monitoring system



5. Replacement Design

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Lead Acid Calculation of battery capacity, c-rate, charge and discharge current

	Rated N/A	DoD 60%	LFP200B48VR 99%
Voltage of one battery = V	12 V	12 V	25.1 V
Rated capacity of one battery : Ah = Wh	200 Ah	200 Ah	200 Ah
Capacity =	2400 Wh	1440 Wh	4969.8 Wh
C-rate : or Charge or discharge current I : A	0.1 C	0.1 C	0.1 C
Time of charge or discharge t (run-time) = h	10 h	6 h	9.9 h
Time of charge or discharge in minutes (run-time) = min	600 Minutes	360 Minutes	594 Minutes

Calculation of energy stored, current and voltage for a set of batteries in series and parallel

Number of batteries in a series = elements	4 Batteries	4 Batteries	2 Batteries
Number of series in parallel = series	1 String	1 String	1 String
Voltage of the storage system = volt	48 V	48 V	50.2 V
Current of the storage system = ampere	20 Amps	20 Amps	20 Amps
Capacity of the storage system (energy stored) = Ah = kWh	200 Ah	120 Ah	198 Ah
	9.6 kWh	5.76 kWh	9.9396 kWh

https://power-calculation.com/battery-storage-calculator.php

5. Replacement Battery Actual

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Lead Acid Calculation of battery capacity, c-rate,

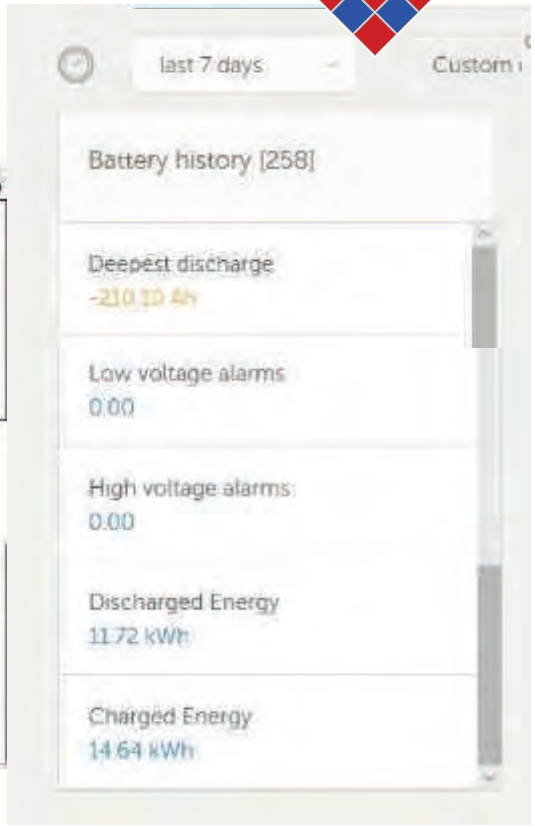
Voltage of one battery = V
Rated capacity of one battery : Ah = Wh
Capacity =
C-rate : or Charge or discharge current I : A
Time of charge or discharge t (run-time) = h
Time of charge or discharge in minutes (run-time) = min

LFPZ00B48VR	99%
25.1	V
200	Ah
4969.8	Wh
0.1	C
9.9	h
594	Minutes

Calculation of energy stored, current and voltage

Number of batteries in a series = elements
Number of series in parallel = series
Voltage of the storage system = volt
Current of the storage system = ampere
Capacity of the storage system (energy stored) = Ah = kWh

2	Batteries
1	String
50.2	V
20	Amps
198	Ah
9.9396	kWh



5. Test Results - Current

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5. Test Results – Power Delivery - Consistency

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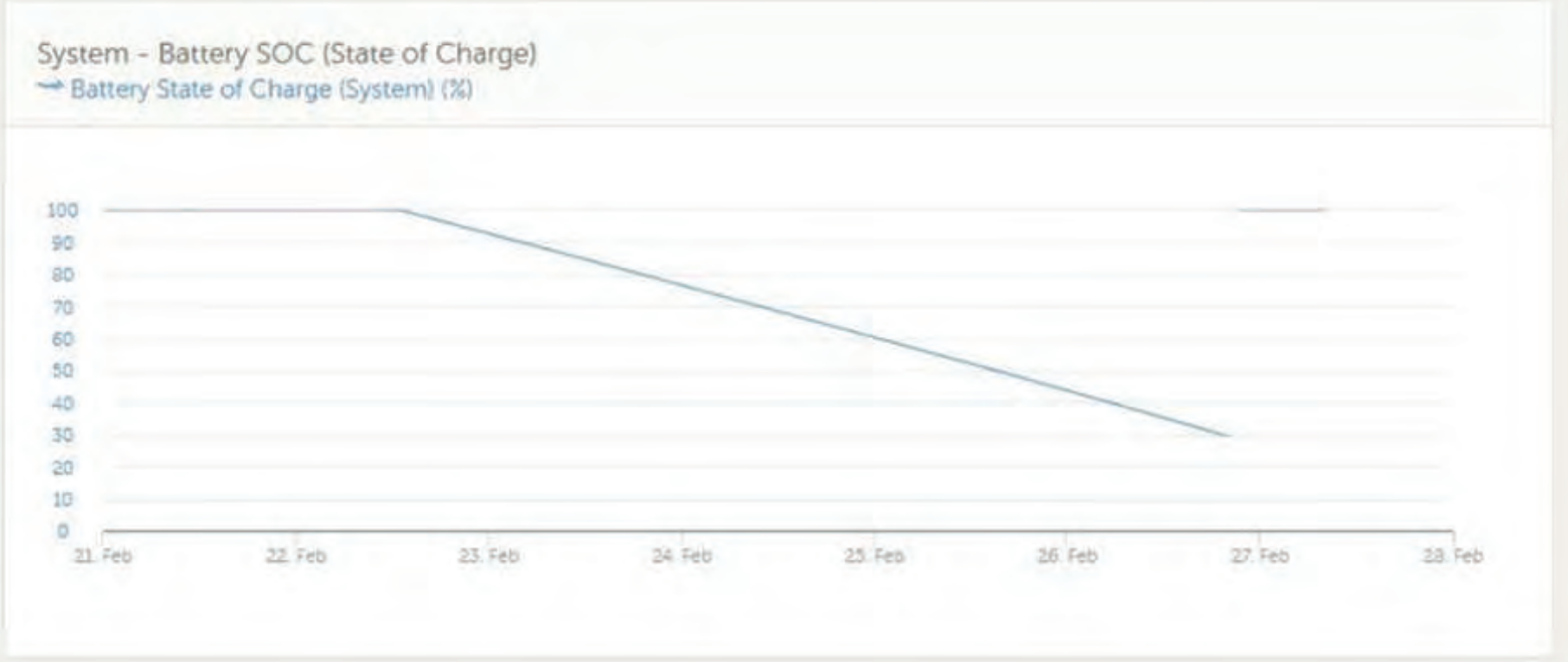

5. Test Results – Recharge Fast return to Readiness

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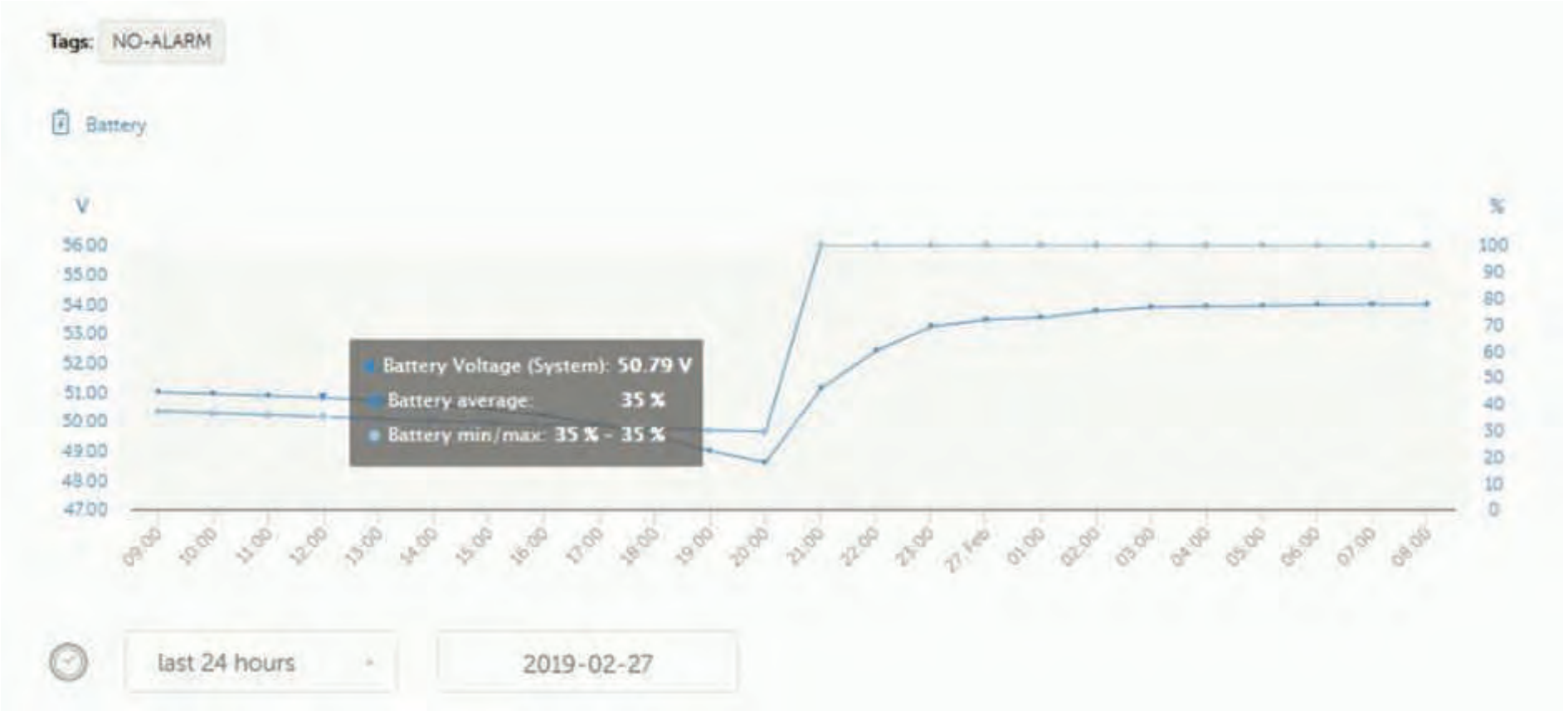

6. Lithium-Iron Conclusion

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More capacity – effectively 11kWh.
Recharge Rate – was recharged at 1C. Will need to be reduced by programming the Rectifier
Consistency – improves reliability
Battery monitoring systems – Remote monitoring is worthwhile.
Safety – All current systems in the site were unchanged.
Thermal – No thermal addition to the site environment
Noise – No noise addition to the site environment
Forgiving in a wide range of temps – LiFePo batteries can withstand a wider temperature range than VRLA batteries. **Reduced cooling requirements** - set to 20^0C.

Safer – LiFePo batteries do not explode, leak, burn until 700^0C. Reduce theft attraction as no operation without BMS
Longer life expectancy – Lithium-ion technology can double or triple battery service life, reducing the risks of downtime or load interruption.

Revov is 30% cheaper.

End – Take it from here …

Appendix Lithium Options

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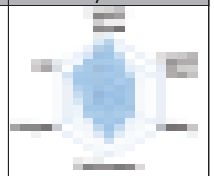
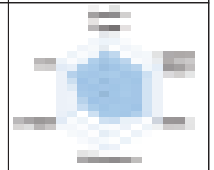
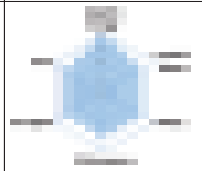
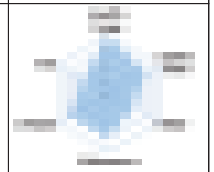
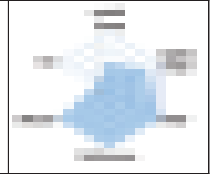
	Type	Pros and Cons	Comments	Applications	Summary
	Lithium Cobalt Oxide(LiCoO2)	Specific energy (Wh/kg) Dangerous chemistry Limited Lifespan	Very high specific energy, limited specific power. Cobalt is expensive. Serves as Energy Cell. Market share has stabilized	Mobile Phones, laptops digital cameras	
	Lithium Manganese Oxide (LiMn2O4)	Low thermal stability Limited load capabilities (specific power) Limited Lifespan	High power but less capacity; safer than Li-cobalt; commonly mixed with NMC to improve performance.	Power tools, medical devices, electric powertrains	
	Lithium Nickel Manganese Cobalt Oxide (LiNiMnCoO2 or NMC)	Specific energy (Wh/kg) Safety Limited Lifespan	The secret of NMC lies in combining nickel and manganese Provides high capacity and high power. Serves as Hybrid Cell. Favorite chemistry for many uses; market share is increasing.	E-bikes, medical devices, EVs, industrial	
	Lithium Iron Phosphate(LiFePO4)	Excellent lifespan High level of safety Specific power (W/kg) High number of charging cycles Specific energy (Wh/kg) Cost	The key benefits are high current rating and long cycle life, besides good thermal stability, enhanced safety and tolerance if abused. Very flat voltage discharge curve but low capacity. Regarded as the safest Lithium battery	Portable and stationary needing high load currents and endurance	
	Lithium Nickel Cobalt Aluminum Oxide (LiNiCoAlO2)	Specific energy (Wh/kg) Specific power (W/kg) Dangerous chemistry Cost	Shares similarities with Li-cobalt. Serves as Energy Cell	Medical devices, industrial, electric powertrain (Tesla)	
	Lithium Titanate (Li4Ti5O12)	Long Life Fast Charging Cost Specific Energy (Wh/kg)	Long life, fast charge, wide temperature range but low specific energy and expensive. Among safest Li-ion batteries.	UPS, electric powertrain (Mitsubishi i-MiEV, Honda Fit EV), solar-powered street lighting	

Appendix Battery Technology

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	LiCoO2	LiMn2O4	Li（NiCoMn）O2	LiFePO4
Heat Stability	Resolve and release O_2 at 180℃	Melting temperature is higher than LiCoO2	unstable under high temperatures and Co is scarce	Stable structure even at 600℃. No O_2 release
Energy Density	150-160 Wh/kg	Lower than LiCoO2, and higher than LiFePO4 battery	150-160 Wh/kg	100-110 Wh/kg
Applicability	Cell phone, laptop	Vehicles (Japanese cars)	laptop, Vehicles (Japanese cars)	Vehicles, energy storage stations
Chemical Principle & Lifetime		Under 50 degrees, the cathode material Mn will melt into electrolyte, shortening its lifetime		Ferric iron is very stable and will not undergo chemical changes. Long lasting lifetime

* Currently, there are four kinds of Lithium -ion batteries

* Battery safety is categorized into "electricity safety" and “heat safety”

Revov Has Chosen the Iron-Phosphate Battery to Ensure the Safety

Revov Iron-Phosphate battery capacity: 10GWh (and getting larger)

Appendix Temperature Performance

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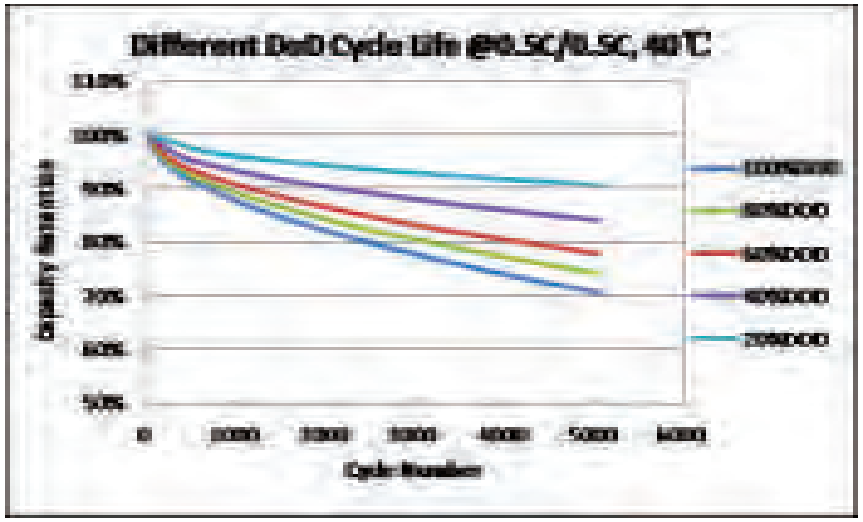
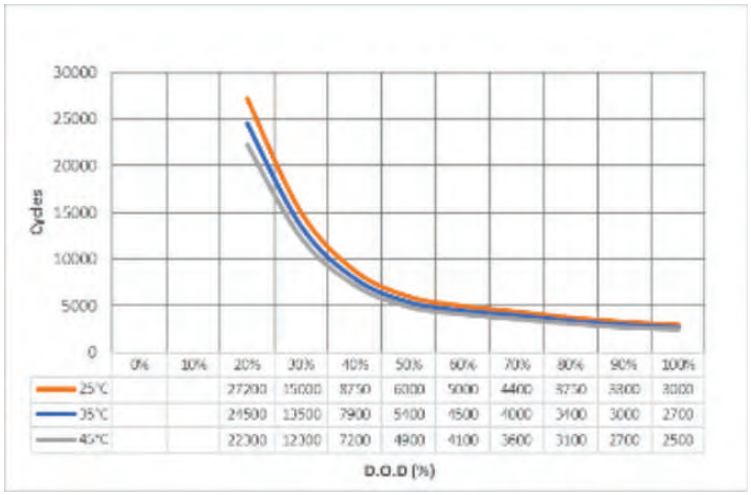
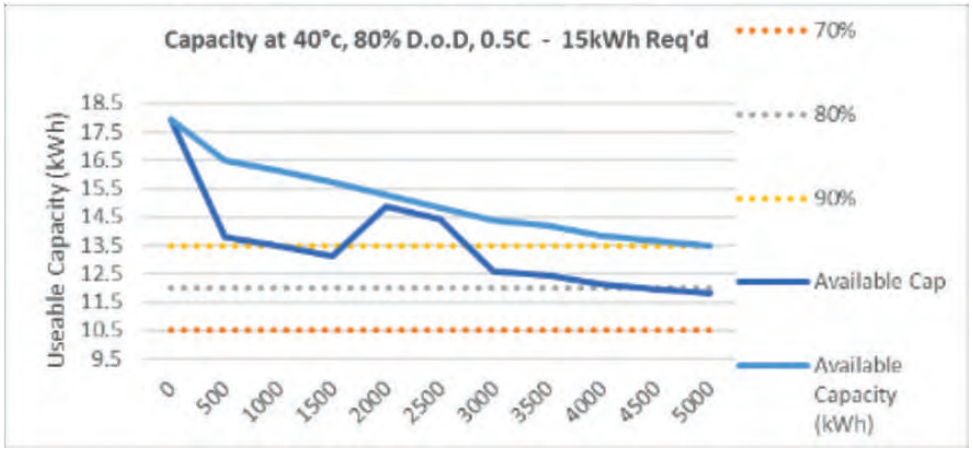


- Official BYD curves
- At 35°c and 80% D.o.D, 80% Capacity is reached at +- 3 500 cycles
- Temperatures are ambient temps
- With LiFePo4 it is possible to add capacity to the bank as required to delay Capex and improve NPV





Appendix TCO Performance

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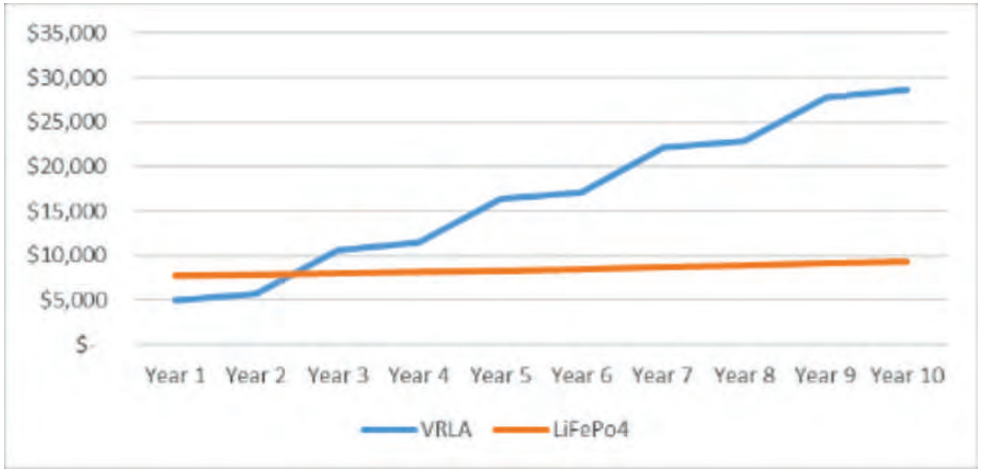
- 60% increase in upfront cost
- 5 year TCO 49% less than Lead Acid
- 10 year TCO 67% less than Lead Acid
- 5 year NPV 33% less than Lead Acid
- 10 year NPV 49% less than Lead Acid
- Effectively break even as soon as Lead Acid cells get replaced for the first time



Appendix Home Storage Revov 10kWh Stela

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Appendix Home Solutions
Revov 5kWh Stela

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