Can Zinc Batteries Challenge Lithium-Ion in the Market

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NiZn Comparison to PbA and Li-ion

- ZAF's approach to the NiZn opportunity is to challenge lead-acid.
- However, some areas of the market where Li-ion is making inroads against lead-acid, NiZn can as well. Examples:
  - 48V
  - Data Centers
  - Bonus: Trolling Motors

Battery Type	Specific Energy	Energy Density	Specific Power	Cycle Durability
Lead Acid Battery	33–42 Wh/kg	60–110 Wh/l	180 W/kg	500–800 cycles
Lithium-Ion	100–265 Wh/kg (0.36–0.95 MJ/kg)	250–620 Wh/L (0.90–2.23 MJ/L)	~250-~340 W/kg	400–1200 cycles
Nickel Zinc	100 Wh/kg	280 Wh/L	> 3000 W/kg	400–1000 cycles

Source: https://greentransportation.info/energy-transportation/energy-density.html

Vehicles ***are*** moving to 48V.

- “Many cars will soon have 48-volt electrical systems. They’ll power stop-start motors, hybrid motors, and turbochargers, allowing for smaller engines with better fuel economy and performance. They’ll handle accessories ranging from mechanical or hydraulic power to electric power such as power steering, power brakes, water pump, radiator cooling, and air conditioning.”

Why Cars Are Moving to 48-Volt Electrical Systems

By Bill Howard

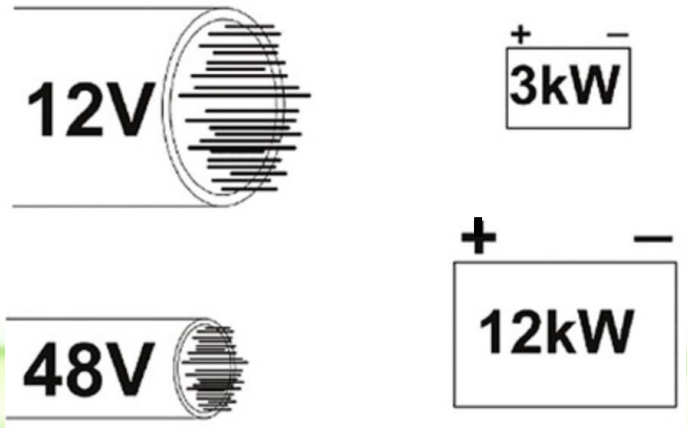
https://www.extremetech.com/extreme/247889-cars-moving-48-volt-electrical-systems

- “Current electrical demand on a typical on-highway truck is about 3-5 kW, but that is projected to increase to 40 kW by 2030.”

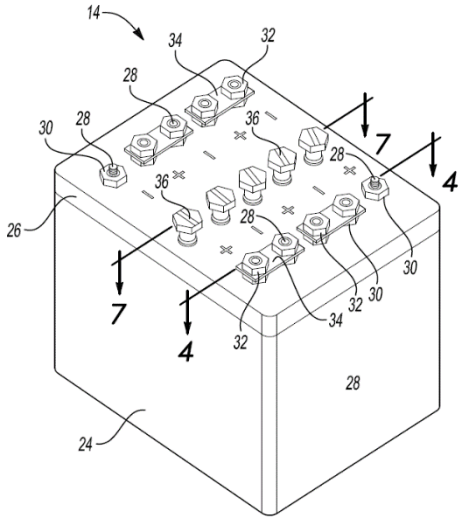
The Future of Electrical Systems on Heavy Duty Trucks

by Jim Park

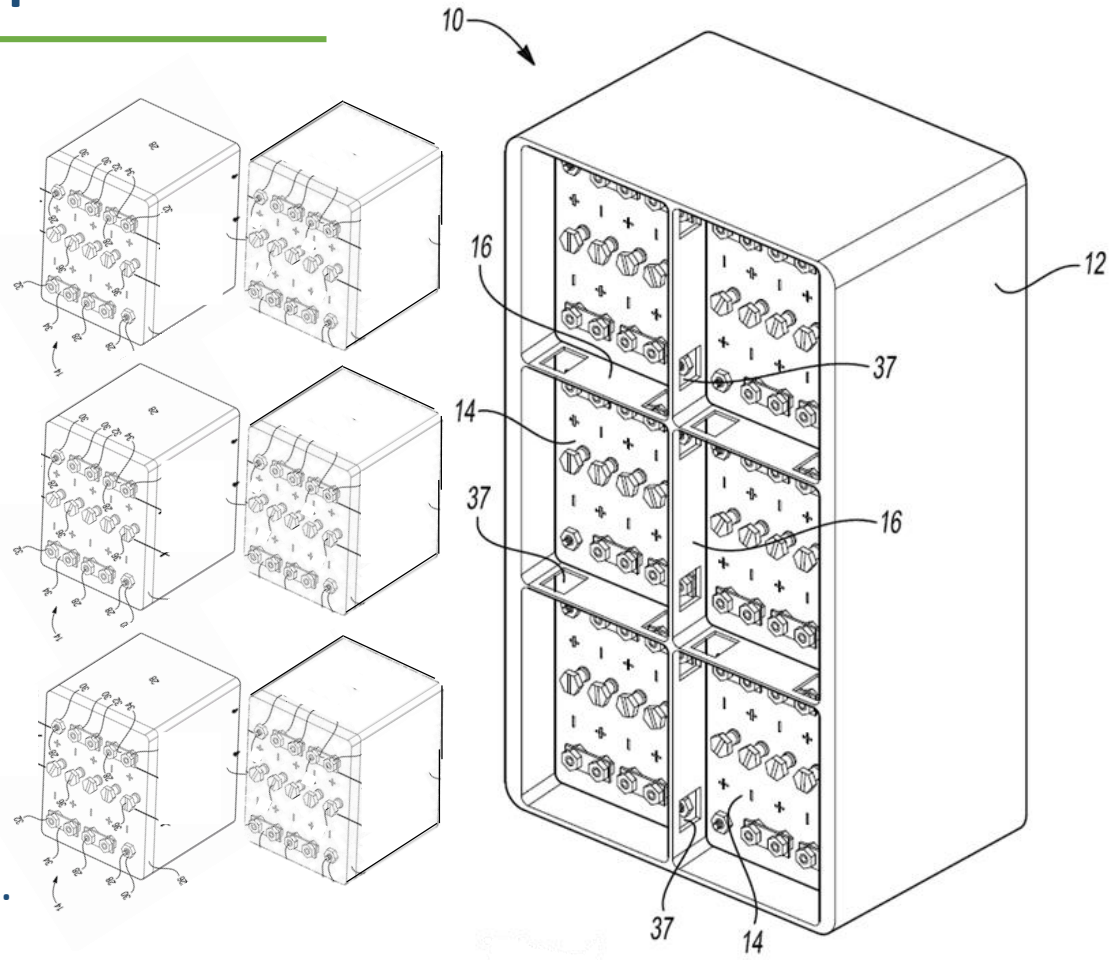
https://www.truckinginfo.com/157933/the-future-of-electrical-systems-on-heavy-duty-trucks



48V From Design to Rapid Prototype



The first five-cell subcell produced and tested by ZAF.



Today when someone talks about 48V batteries for vehicles, they're talking li-ion.
Lead-acid 48V are difficult and can't handle regen.
NiZn batteries are less expensive to make, don't require a BMS, and can handle regen.

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8D Format Rapid Prototype

Nickle electrode

Populated subcells (rear)

Wrapped electrodes (fore)

8.5v subcell ready for activation

Populated 48V 8D (fore) and sealed (activation ready) 8.5V subcell (rear)

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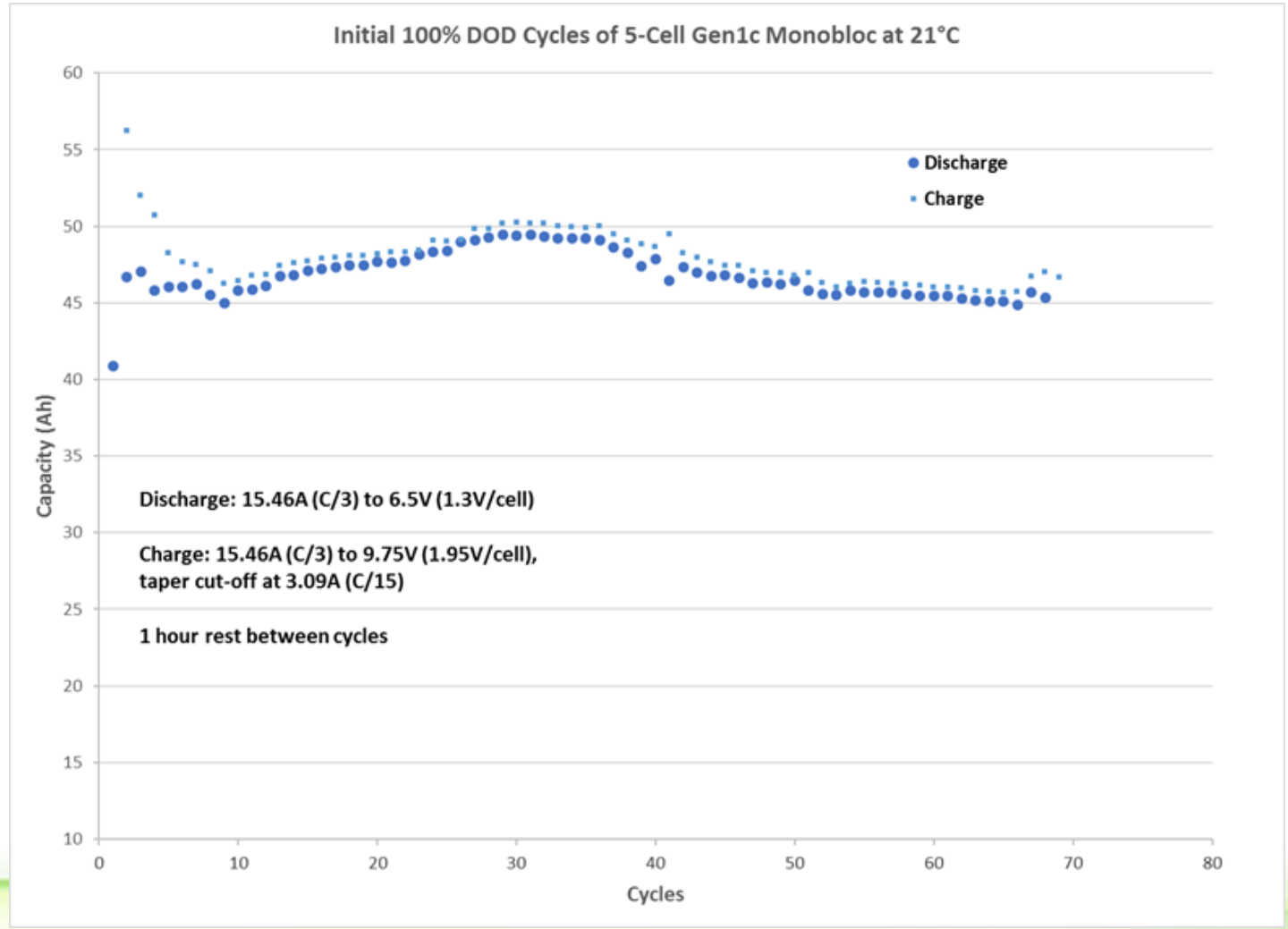
Initial Cycling Shows Promise



Subcell cyclic testing conducted in the January timeframe resulted at 100% DOD which shows cycle performance through cycle 68.

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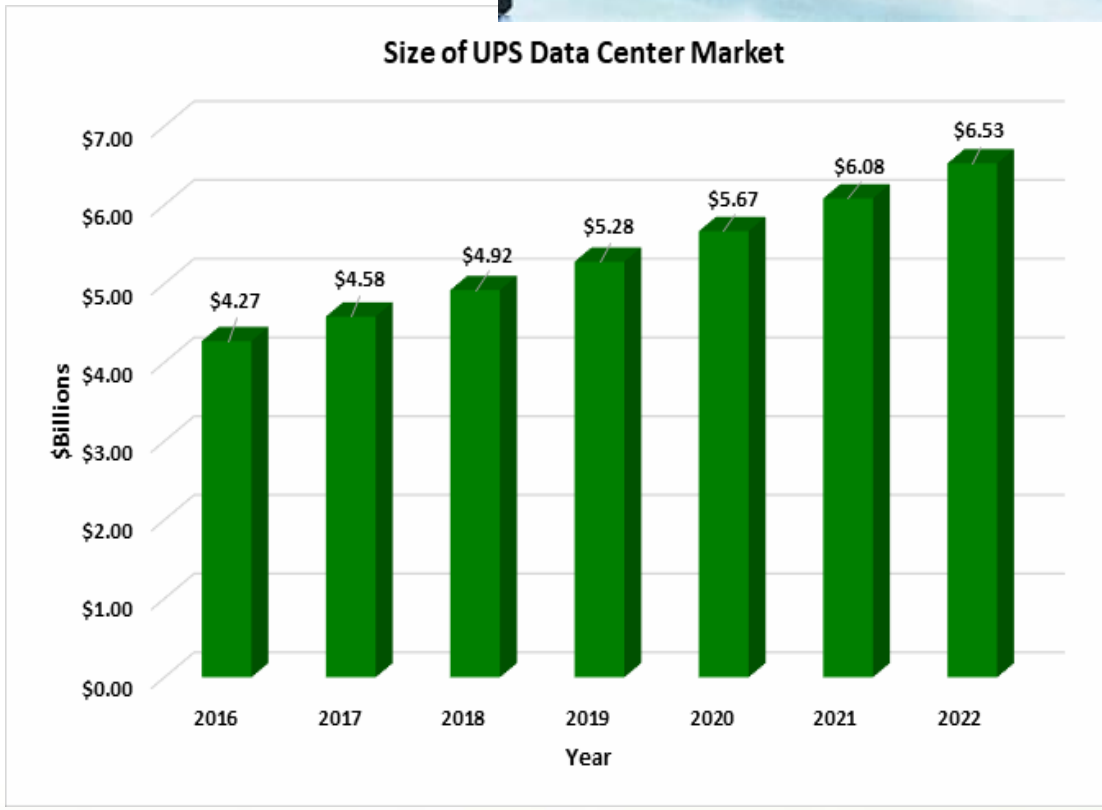
Target Market – Data Centers

$6.53 billion by 2022

- Low Battery CapEx – NiZn provides lowest cost for new builds or retrofitting existing facilities
- Reliable – Engineered for 10 year data center operation
- Reduced footprint – Up to 40% reduction
- Robust – operates at higher temperatures (85°F) to allow co-location with PCS
- Safe – No expensive BMS, fire suppression or air handling equipment beyond current requirements
- Simple – drop in replacement solution for lead acid using existing PCS, controls and safety systems



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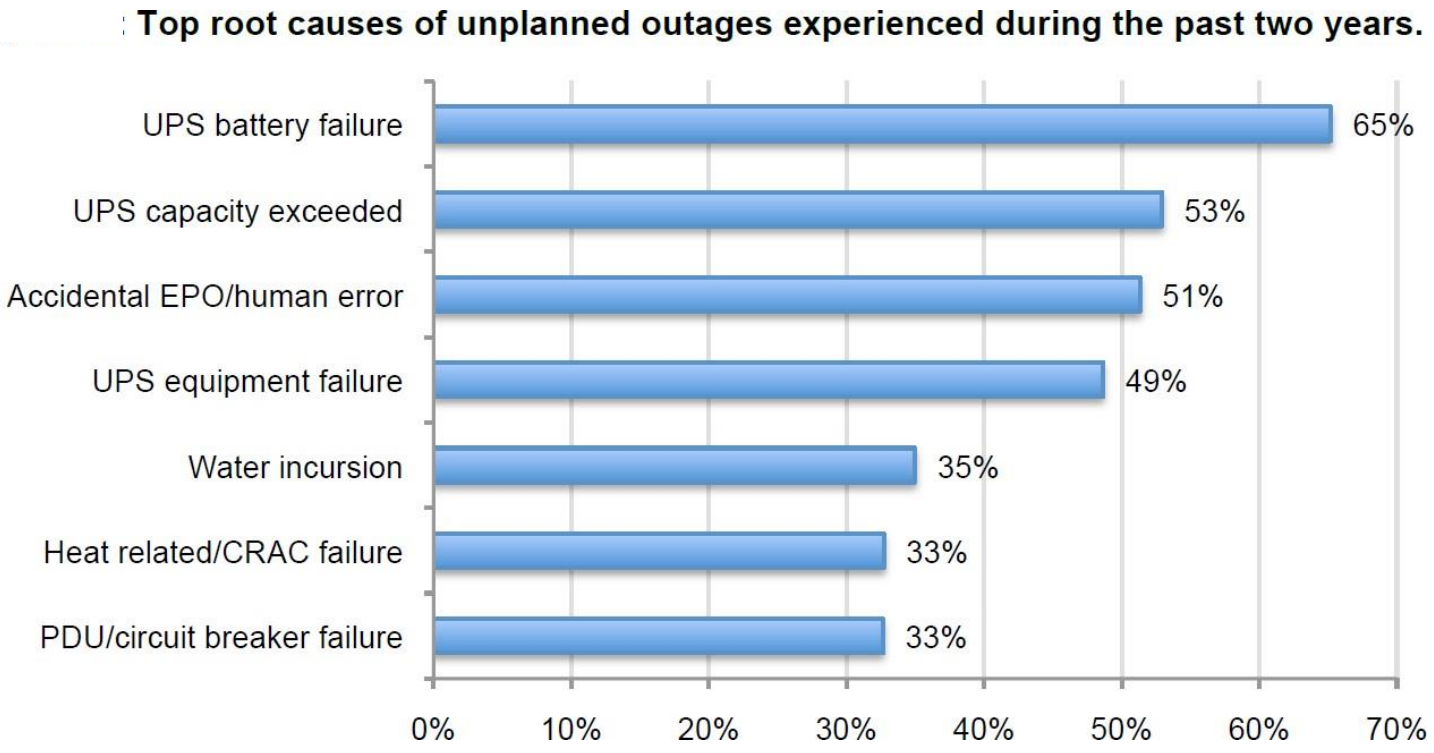
Data Centers – Batteries are Key



- Batteries are the critical technology for UPS systems in Data Centers
- Batteries are the largest failure mode although lead acid is a 100+ year industry
- Value proposition for NiZn batteries include:
  - Better Battery Reliability
  - Less Weight
  - Easier Battery Replacement
  - Smaller Size
  - Longer Life
  - Accommodating to Higher Temperatures
  - Longer Shelf Life
  - Low Cost of Ownership

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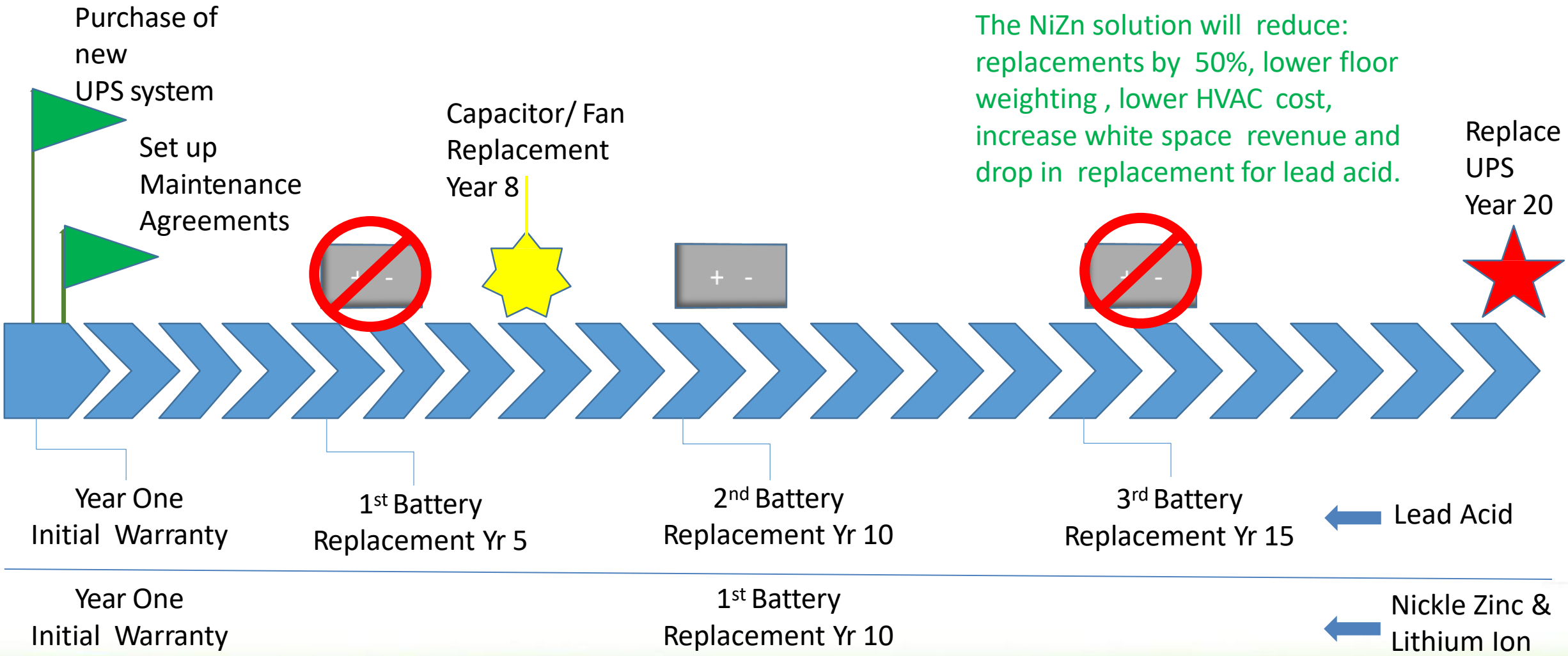
Life Cycle of Typical Data Center UPS



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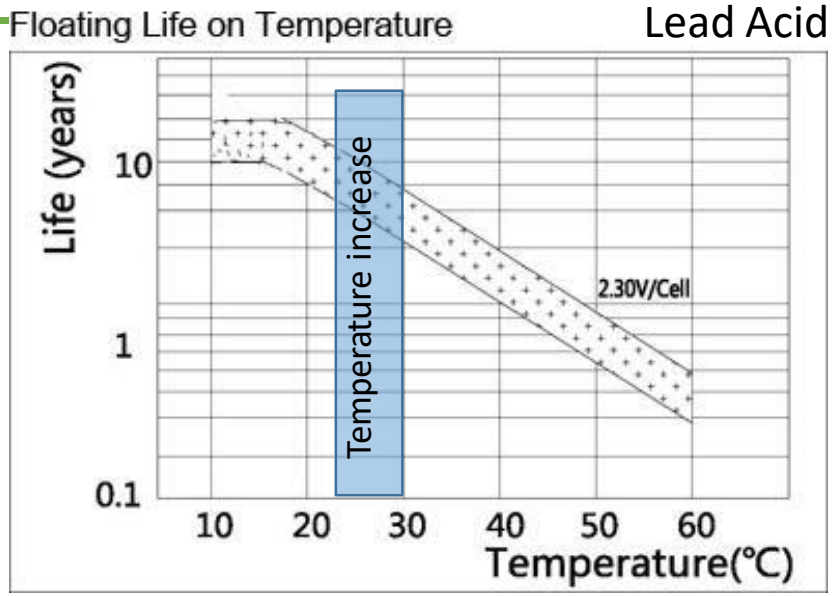
Temperature Matters

10 year warranty at 85°F room temperature

- For every 15°F increase over 77° you will cut the life of lead acid batteries by 50%
- Co-locate batteries with PCS to reduce complexity and cost
- Reduced HVAC expense
- Reduced maintenance on batteries and balance of plant
- Safe – No potential of thermal runaway
- SAE J2801 Test Profile: (high temperature)
  - Cycling the battery through a series of charge-discharge cycles at 75°C.
  - Exceeded lead acid performance by 100%
- Long term float tests at NAVSEA (US Navy) underway



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Data Center Value Proposition

	Lead Acid AGM	Lead Acid Pure / Bi-Polar	Lithium	ZAF Nickel Zinc
Total Initial CapEx	$7,200,000	$9,120,000	$8,800,000	$6,880,000
Total Cost of Maintenance	$18,480,000	$9,360,000	$9,480,000	$9,480,000
Battery Replacement Cost	$14,400,000	$13,440,000	$6,000,000	$5,280,000
Replacement Labor	$1,600,000	$1,600,000	$400,000	$800,000
Replacement Racks	$0	$0	$2,400,000	$0
Total OpEx	$34,480,000	$24,400,000	$18,280,000	$15,560,000
Total Cost of Ownership	$41,680,000	$33,520,000	$27,080,000	$22,440,000
Warranty	5 year limited	7 year limited	10 year full	10 year ltd
Max Temperature	75° F	85° F	75° F	85° F
Co-locate with PCS	No	Yes	No	Yes
Safety Concerns	Low	Low	High	Low

NiZn is a Clear Winner

- Lowest Cost solution over 20 year life
  - ***HALF*** the cost of lead acid
  - 33% lower cost than new pure lead acid
  - 20% lower cost than lithium
- Operates at higher temperatures reducing air handling and safety requirements
- **Reliable** – 10 year warranty
- **SAFE** – non-toxic, non-combustible, non-explosive, RoHS compliant, fully recyclable
- **Highest IRR** – Combination of performance, reliability and cost provides the best value
- ***Increased White Space Revenue***

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Bonus: Trolling Motor Battery Market

12V 100AH Lithium Trolling Motor Battery
Price: $1,299.99 (x4 $5,199.96)
Weight: 28 LBs (x4 112 LBs)
Lifespan: 4-5 Years

12V 100AH AGM Trolling Motor Battery
Price: $324.95 (x4 $1,299.80)
Weight: 75 LBs (x4 300 LBs)
Lifespan: 18 Months – 2.5 Years

12V 170AH NiZn Trolling Motor Battery
Price: $650 (x4 $2,600)
Weight: 56 LBs (x4 224 LBs)
Lifespan: 4-5 Years

US Market Size (Lead Acid)

- 4.5M Boats (+100K/Year)
- 2 Year Avg Battery Life
- 2.5 Batteries/Boat
- 5.6M Batteries
- $200/Battery
- $1.1B Market

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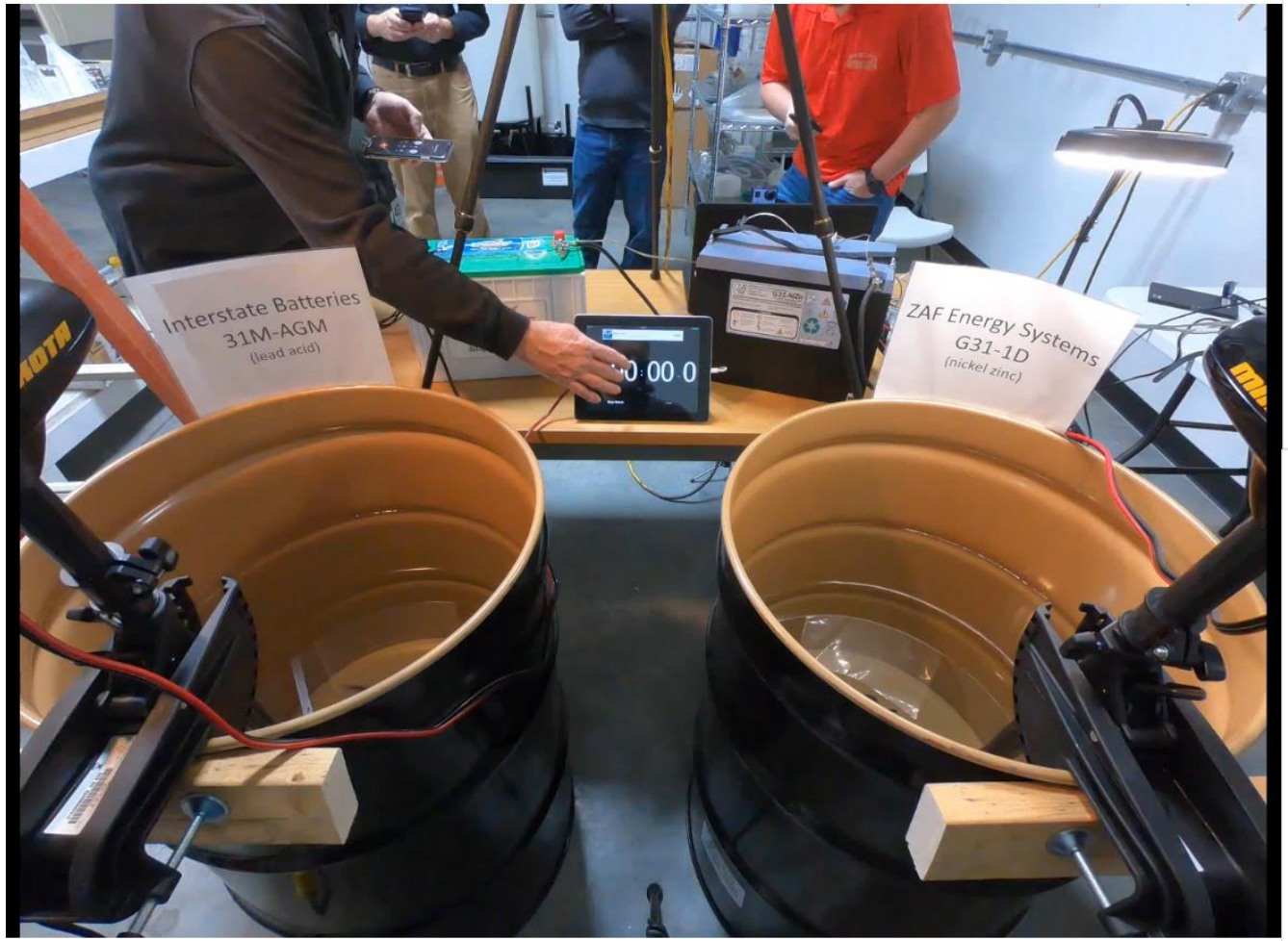
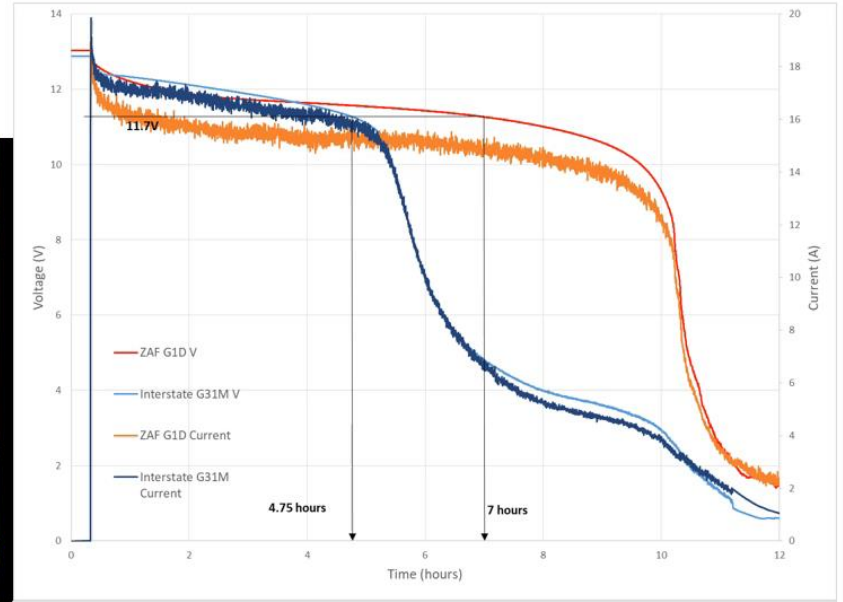
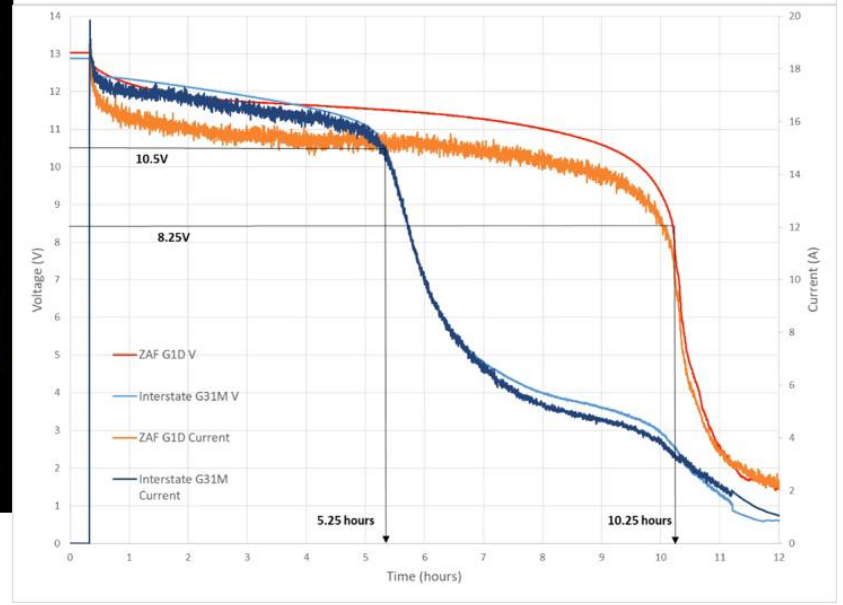
Trolling Motor Test: Ni-Zn vs PbA







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Questions re NiZn vs. Li-ion in the Market

Can NiZn take over the entire Lithium-Ion market?

ABSOLUTELY NOT

Can NiZn compete in certain parts of the Lithium-Ion market?

ABSOLUTELY

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Thank You

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