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Zinc Battery Markets Discussion

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Total Market

- Market for primary and secondary batteries is forecasted to be US$120 billion in 2019 growing at 7.7% CAGR.[1]
  - Fastest growth and largest segment lies in secondary (rechargeable) batteries.[2]
    - The demand is driven by mobile phones and tablets. Earlier estimations for the demand for electric vehicles have since been adjusted downwards.
  - Demand for primary batteries is declining.[2]
    - Non-rechargeable batteries are used in watches, electronic keys, remote controls, toys, flashlights, beacons, and military devices in combat.

Relative Share Among Types

- Secondary >85%[5]
  - Lead-Acid and Lithium-Ion Dominate the Market
- Primary <15%[5]
  - Alkaline (ZnMn)
  - Zinc-Air: Batteries Market to Reach US$ 2.8B by 2026 (up from $1.4B in ‘17)
    - Increased Use of Zinc–Air Batteries in Hearing Aids to Drive Market

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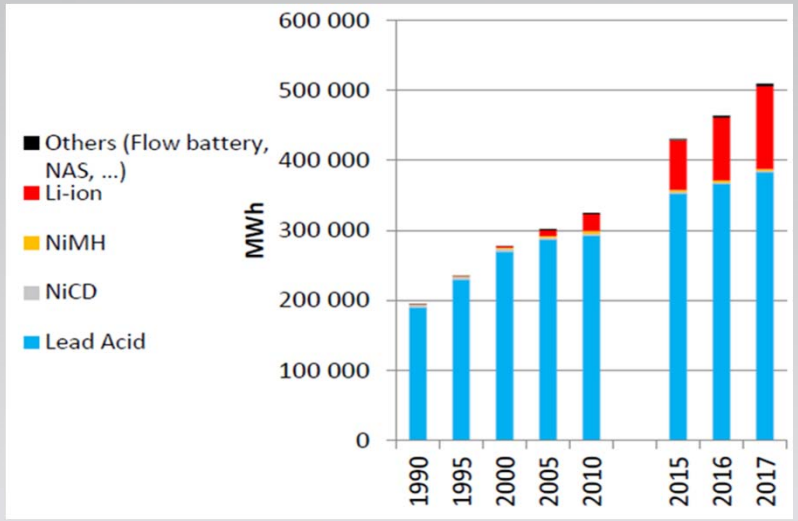

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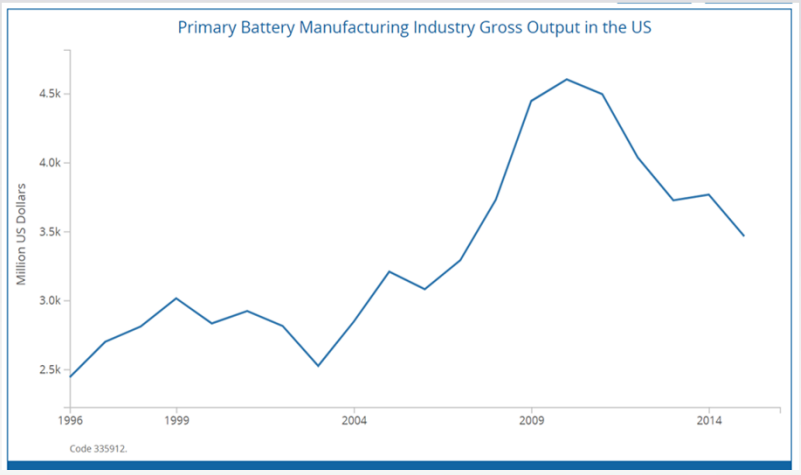
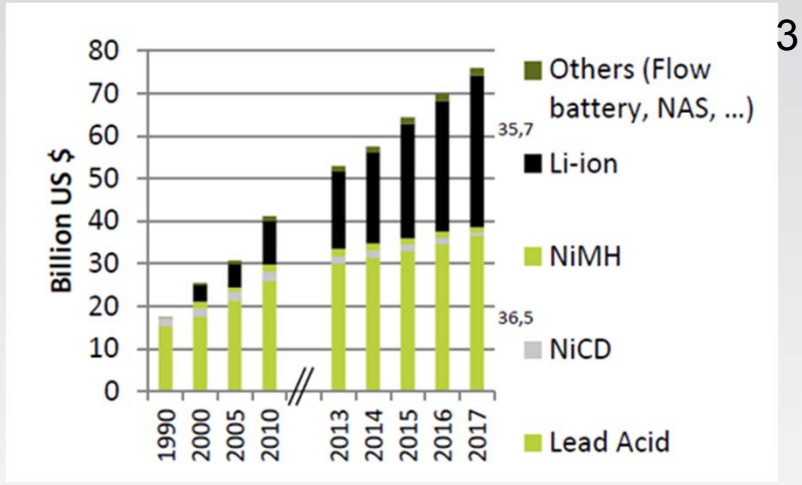


Dollars and Industries for Secondaries

- $75B in 2017
  - PbA and Li-ion very close with 95% secondary market.
  - Li-ion growing at 22-25% CAGR
  - PbA Browing at 5-7%



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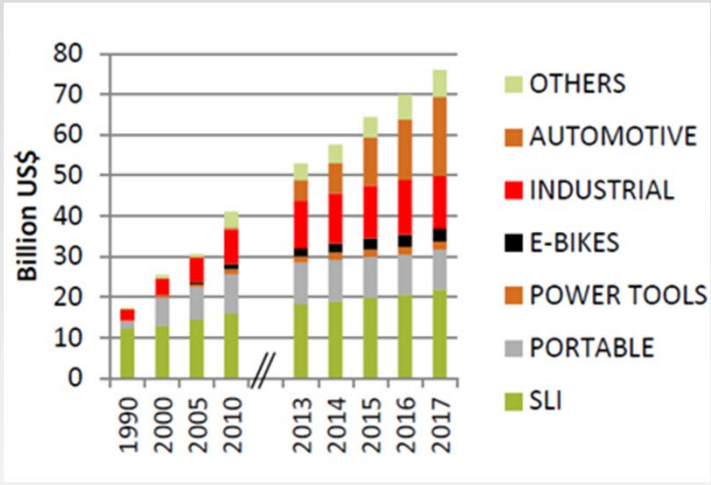

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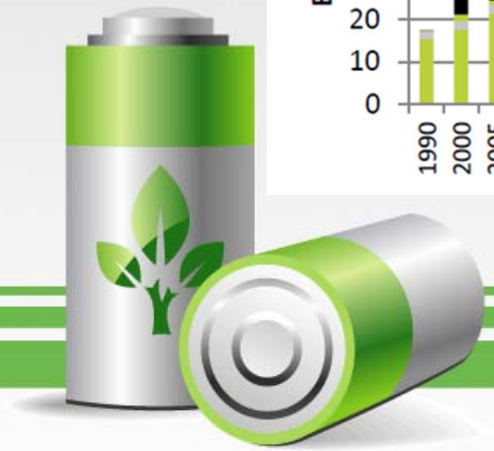
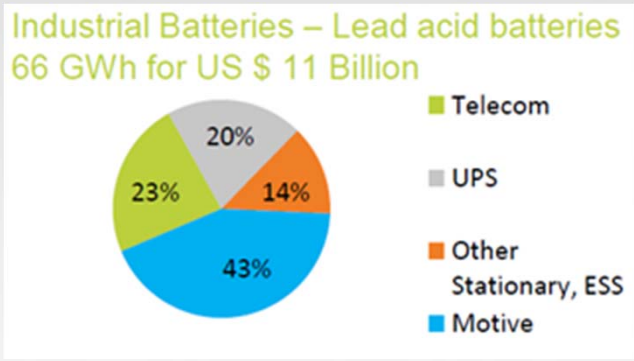


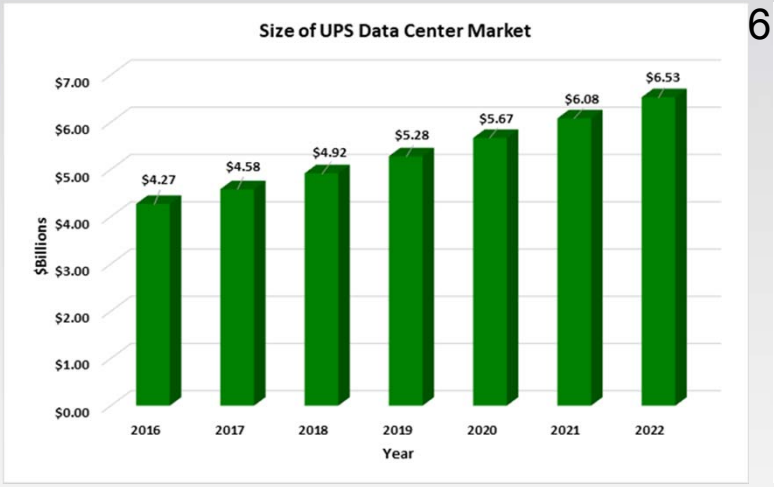
Nickel-Zinc Select High Value Market Opportunities

- **Industrial Batteries – $11B Existing[3]**
  - UPS – Data Center, Industrial/Commercial, Residential
  - Motive - Trucking APU, Liftgates, forklifts, robotics
  - Telecom – cell towers, monitoring stations
  - Other – medical gensets, emergency lighting, switchgear
- Automotive – Start/Stop, HEV, PHEV, EV
- Aerospace and Defense



Select Target Markets – Data Centers

- Data Centers - $4.5B[6]
  - Data centers are one of the fastest growing markets for energy storage.
  - The global data center UPS market size is $4.58B,
  - Anticipated to reach USD $6.5B-to-$9.2B by 2022; $13.9B by 2025



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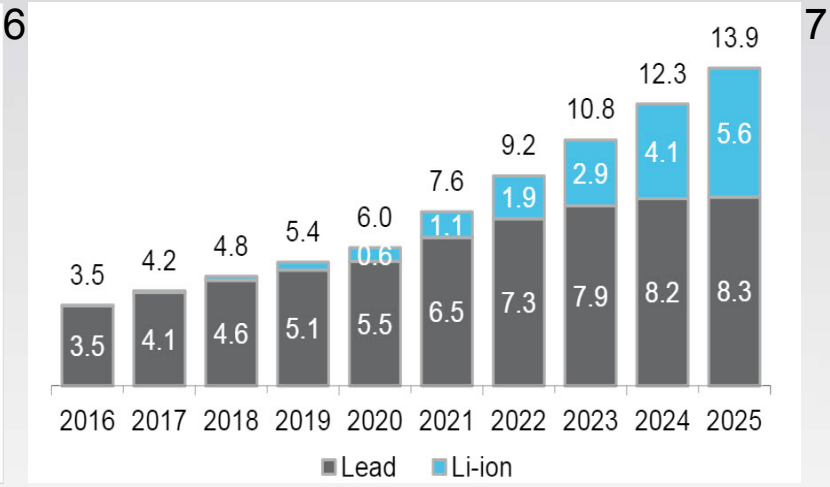

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Data Center Details

	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***

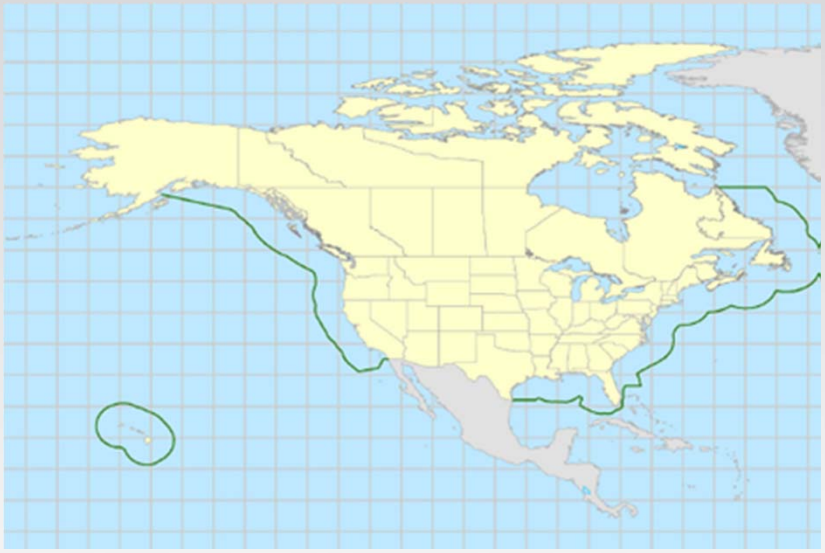
Select Target Markets – Trucking

- Industrial Motive (Trucking) - $2.5B[3]
  - Old Driver
    - PbA Capacity Shortfall
  - New drivers
    - Anti-idle
    - 48V

	TOTAL UNITS	ANNUAL UNITS
Heavy duty trucks	3,500,000	218,268
Semi-truck trailers	4,900,000	234,700
Medium duty trucks	5,600,000	1,678,514
Light duty trucks	17,600,000	2,056,800
School buses	480,000	40,000
Commercial buses	805,000	na
	27,285,000	4,228,282

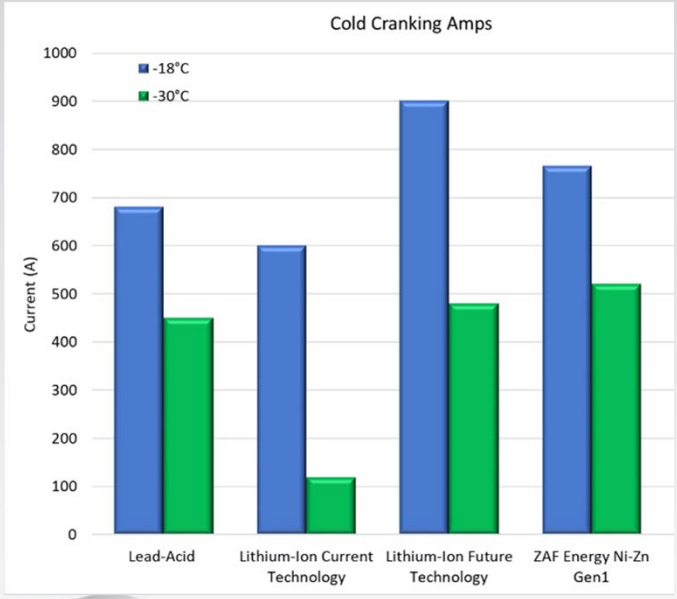
Select Target Markets – Marine

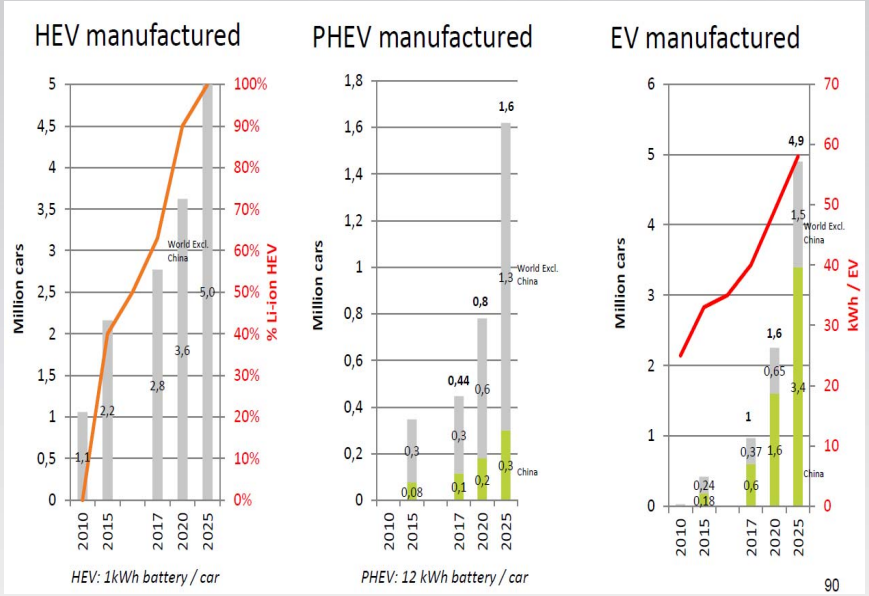
- Marine - $2.2B[3]
  - Market Growth from $2.2 billion in 2015 to $4.5 billion by 2022
  - Aging Vessels: vessels require either replacement or retrofits
    - Constant use – electrification reduces downtime and maintenance
  - Pollution Controls Tightening
    - Emission Control Areas (ECA's) for N. American and European coasts
    - Ports imposing emission taxes and usage restrictions
  - By 2020, diesel particulates will not be allowed in European ports
    - Towed into port by electric tug or convert to fully electric/hybrid ship



Select Target Markets - Automotive

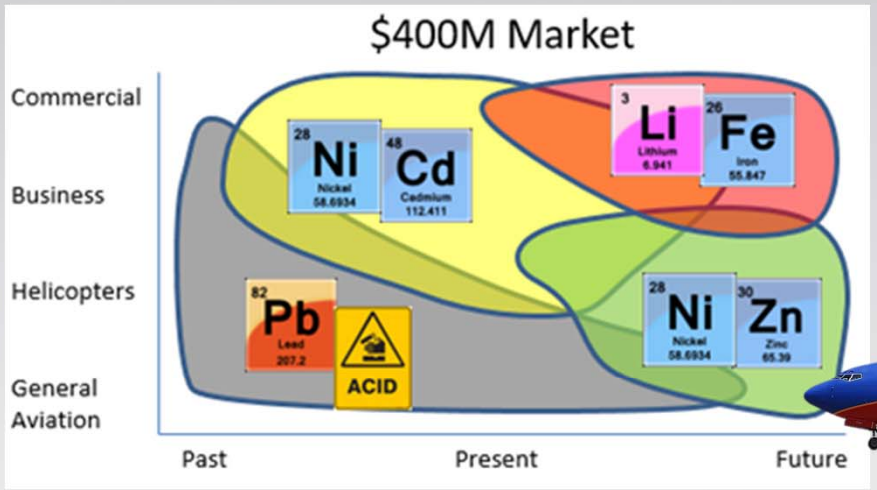
- Stop Start and Hybrid Electric Vehicles - $10B[3]
- Fastest growing segment of the automotive market





Select Target Markets – A & D $2.4M

- Aerospace and Defense - $400M and $2B[8]

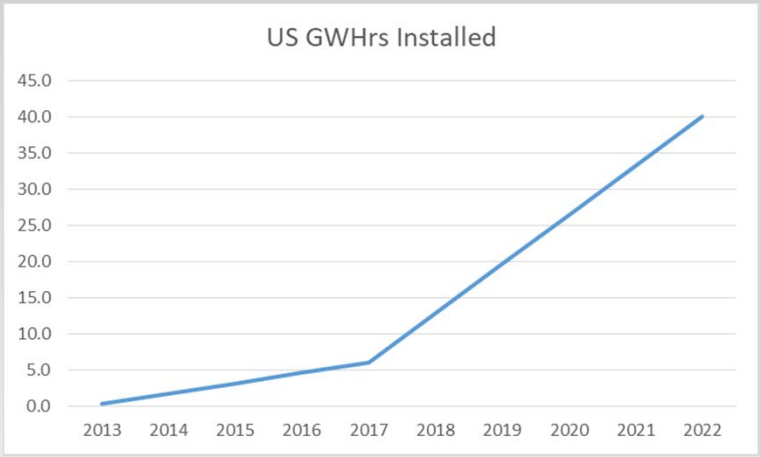


Not Necessairly a Target Market – Silver Zinc

- DoD ~ $40M[9]
- Market size for hearing aids, cameras, and laptops – Unknown.
- Paved the way for reversible Zinc

Select Target Market – Grid Storage

- Grid Storage $600B over 10 Years[11]



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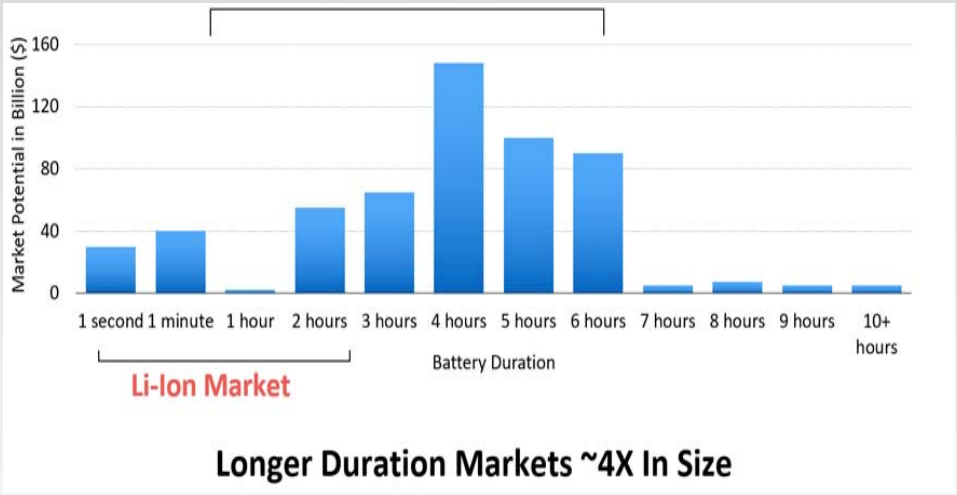
Zinc Flow Battery Market



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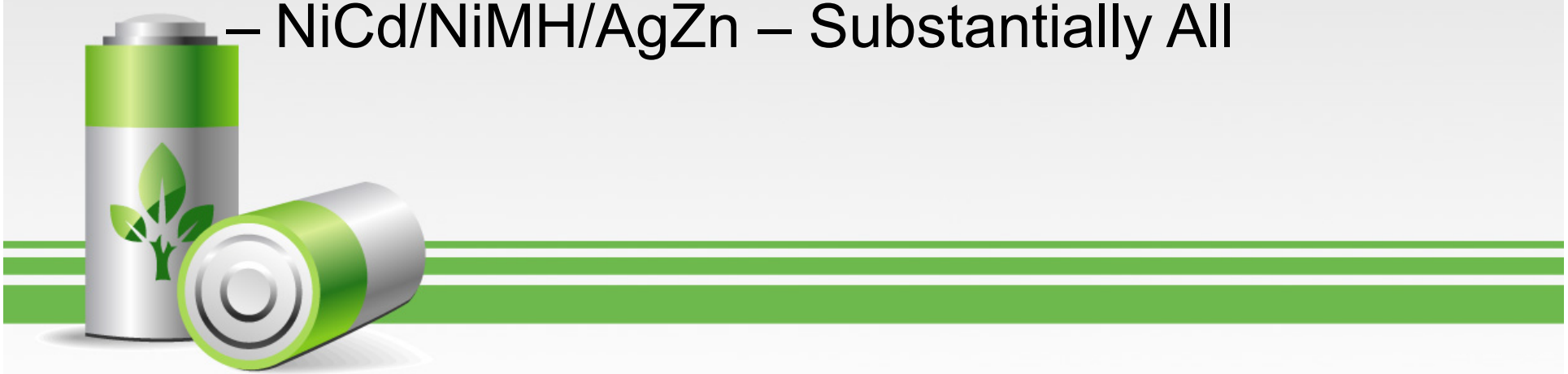
Conclusion

- The Battery Market is Quite Large
  - $80B – $120B (???)
  - Growing Fast
- Zinc Addressable
  - All of the Lead Acid (half of the dollar volume)
  - Signicant Portion of Li–ion Market
  - NiCd/NiMH/AgZn – Substantially All



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