

Zinc Technologies for Grid Scale Energy Storage

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Energy Storage has become a Resounding Success!

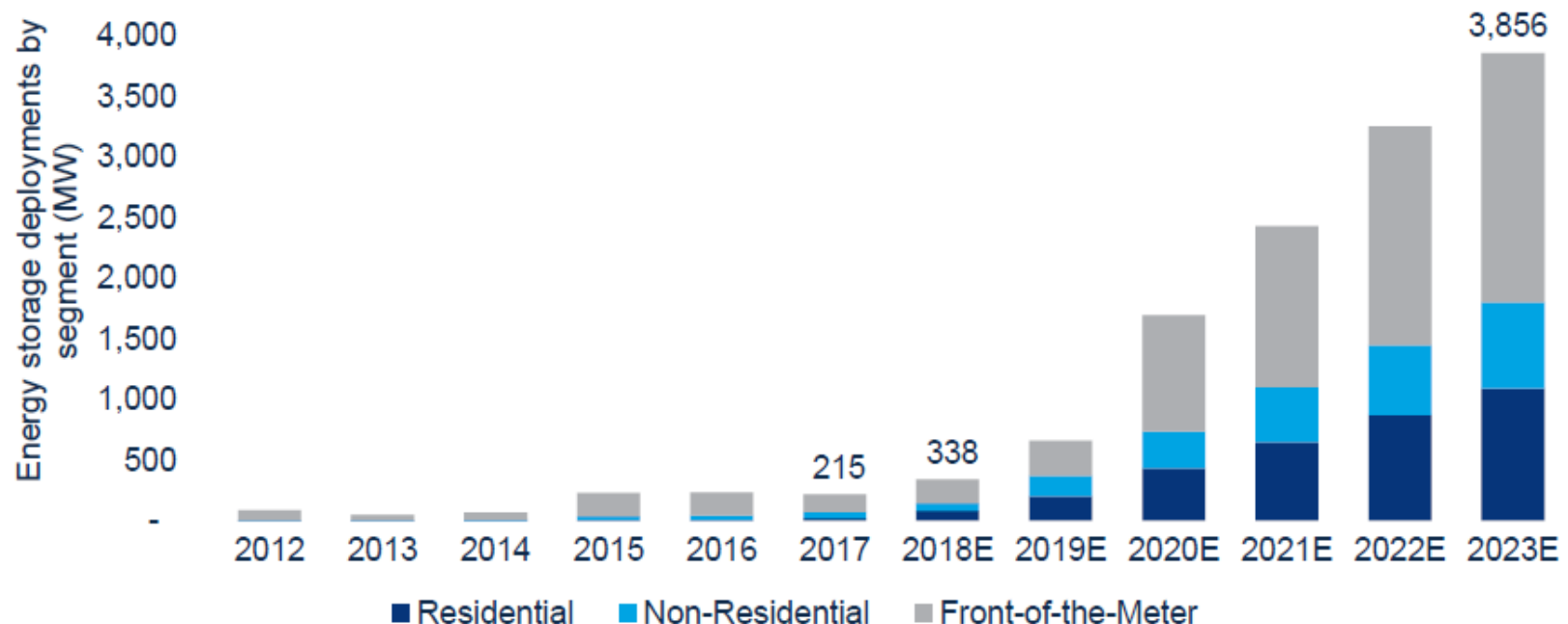
Wood Mac Power & Renewables - U.S. Energy Storage

woodmac.com 

U.S. energy storage annual deployments will reach 3.9 GW by 2023

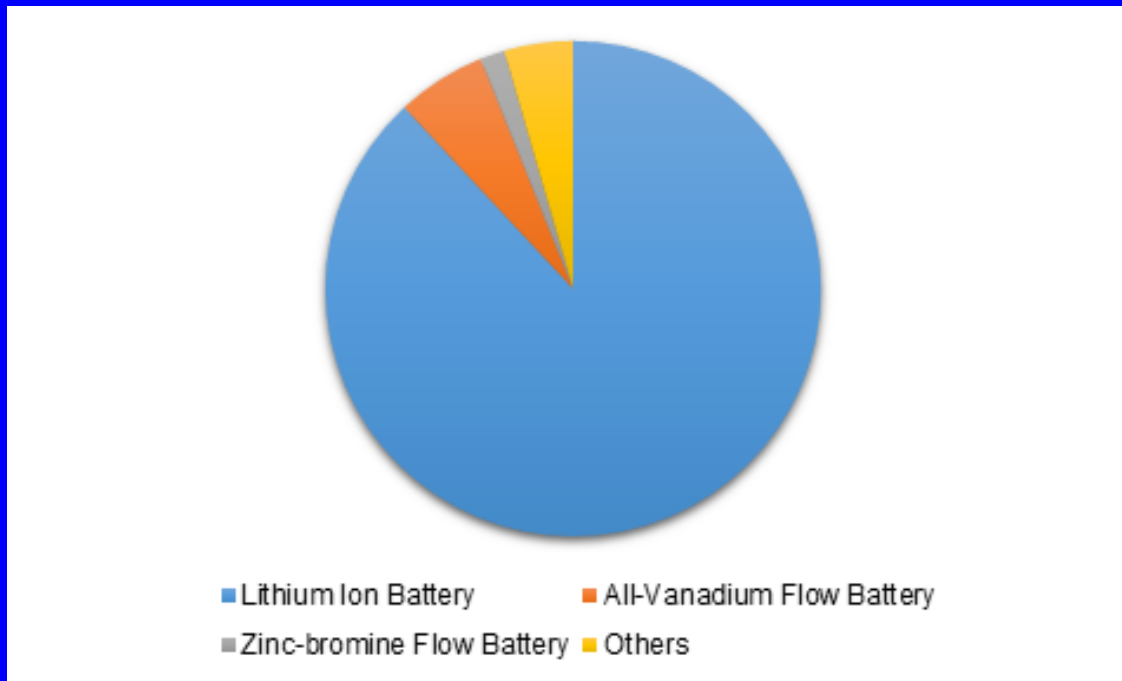
Utility procurements, changing tariffs and grid service opportunities all drive the market forward

U.S. energy storage annual deployment forecast, 2012-2023E (MW)



Source: Wood Mackenzie Power & Renewables

And yet!



Lithium Technologies dominate the Market

Incumbent Lithium Ion Technology:

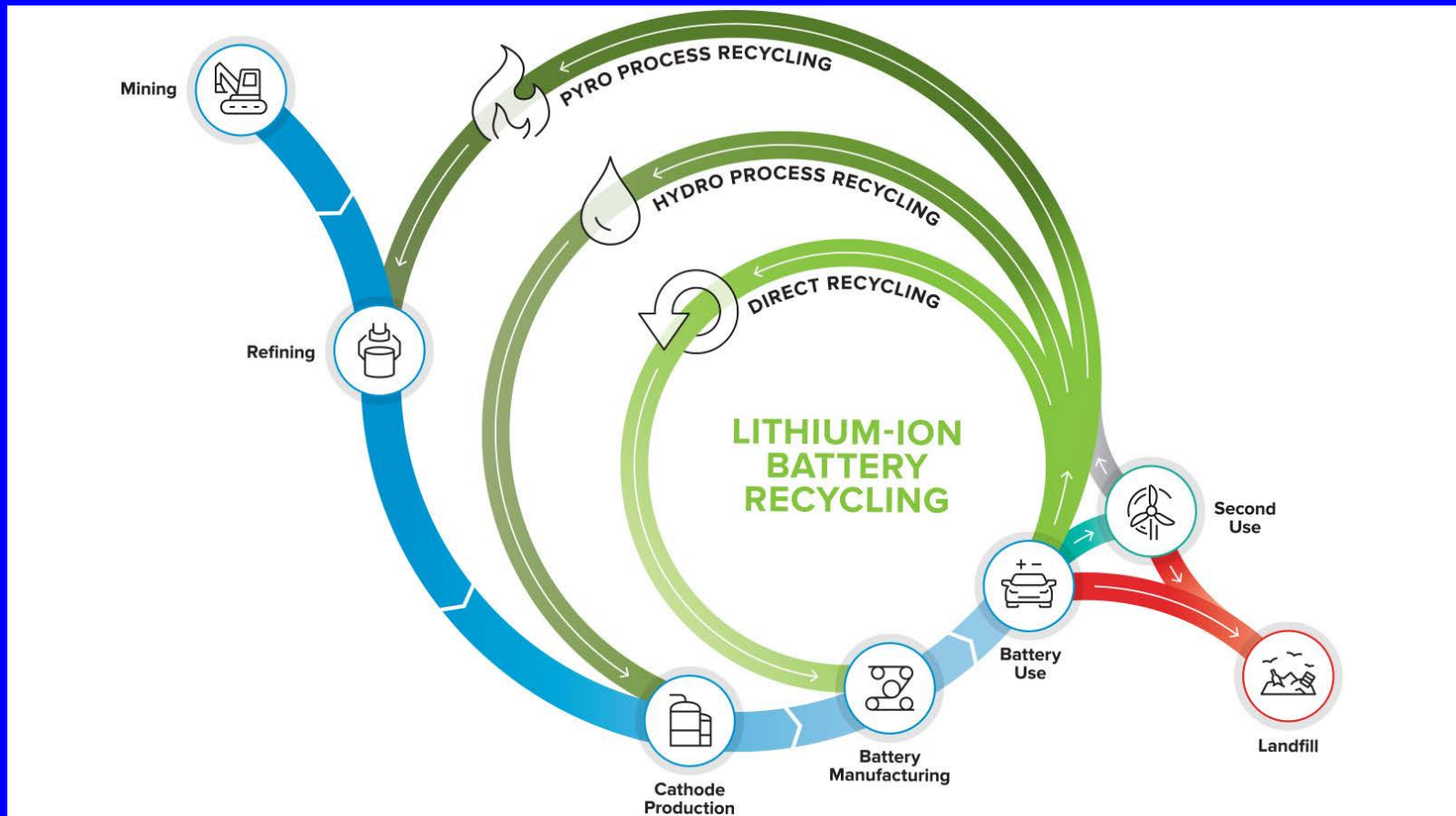
Ecological and Sociological Issues

Safety, Reliability,

Re-Use, Recycling, Disposal



Recycling Lithium Batteries?

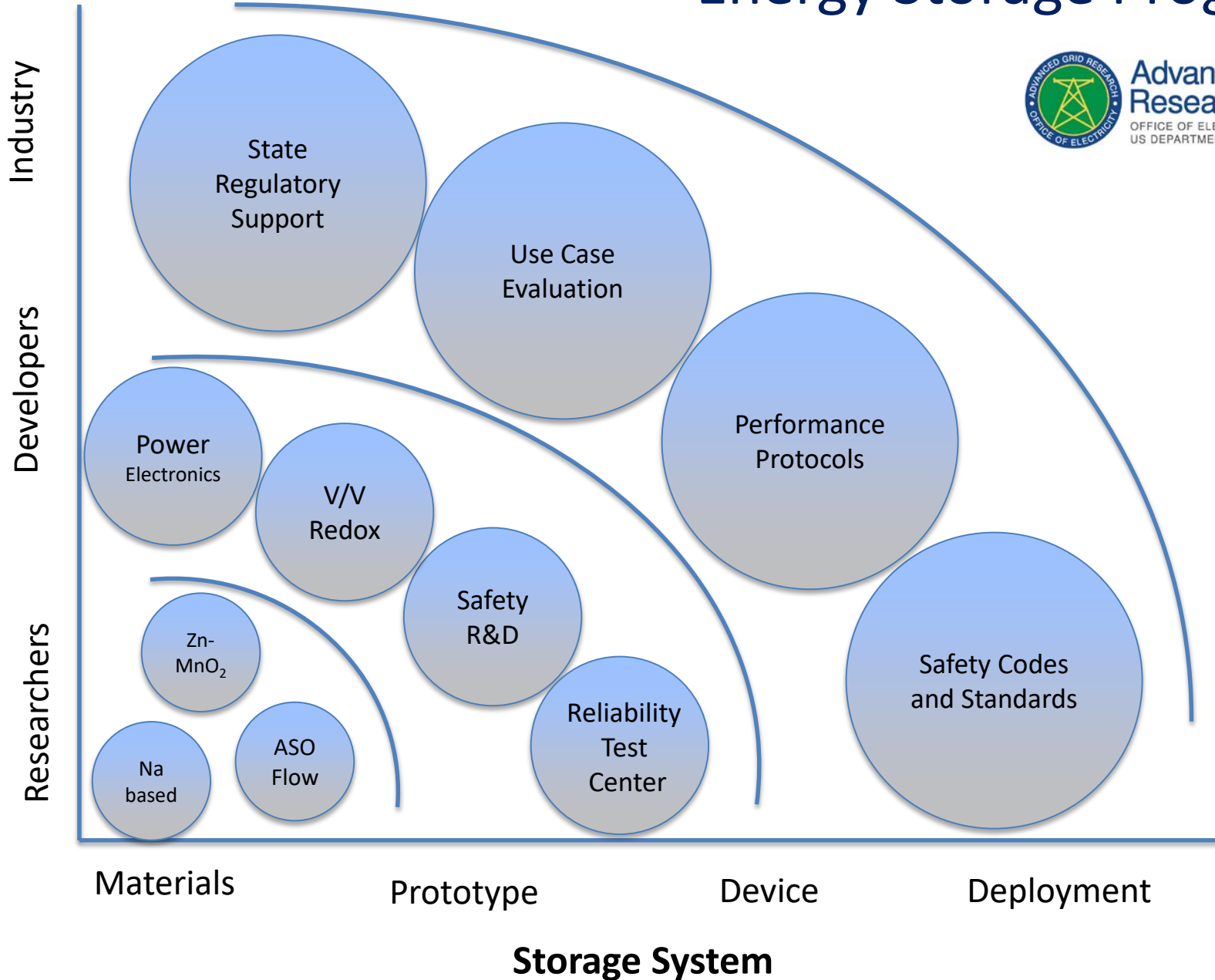


Energy Storage Program



Advanced Grid
Research
OFFICE OF ELECTRICITY
US DEPARTMENT OF ENERGY

Stakeholder Engagement



EPA - American Chemical Society Green Chemistry Award

2017 – V/V Redox

2019 – Zn-MnO₂



Zinc Batteries have:

Low Material Cost

Easily Recycled

No Strategic Vulnerability

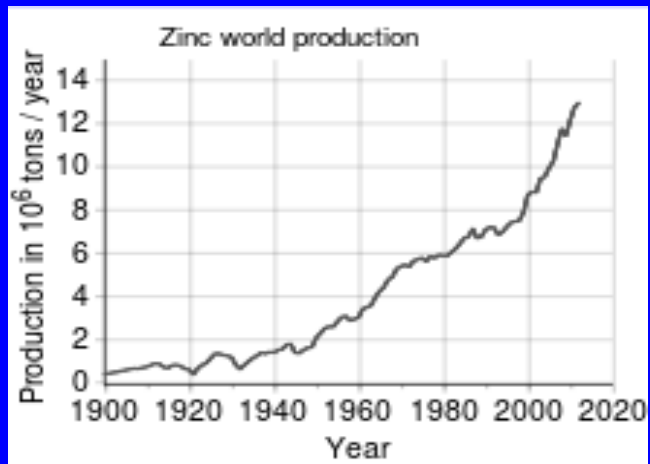
Fire Safe, Low Toxicity

Show Considerable Promise and are
well worth Research Investment!



We want low Cost !

Iron	\$ 529
Zinc	\$ 2,636
Aluminium	\$ 2,104
Lead	\$ 2,284
Copper	\$ 6,320
Nickel	\$14,115
Tin	\$19,770
Vanadium	\$29,000



Country	Tons
China	5,000,000
Australia	1,500,000
Peru	1,300,000
India	820,000
United States	700,000
Mexico	700,000

Zinc Batteries:

Zinc Manganese Oxide

Zinc Bromine

Zinc Air

Nickel Zinc

Zinc Silver

Cost Goals for Focus Technologies

Manufactured at scale

Li-ion Batteries (cells only)	\$100/kWh
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V/V Flow Batteries (stack+PE)	\$300/kWh
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Zinc Manganese Oxide (Zn-MnO ₂) 2 Electron System	\$ 50/kWh
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Low Temperature Na / Na-ion based Batteries	\$ 60/kWh
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Aqueous Soluble Organic (ASO) Redox Flow Batteries (stack+PE)	\$125/kWh
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Advanced Lead Acid	\$ 35/kWh
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