

Non-aqueous Flow Batteries for Grid Scale Energy Storage

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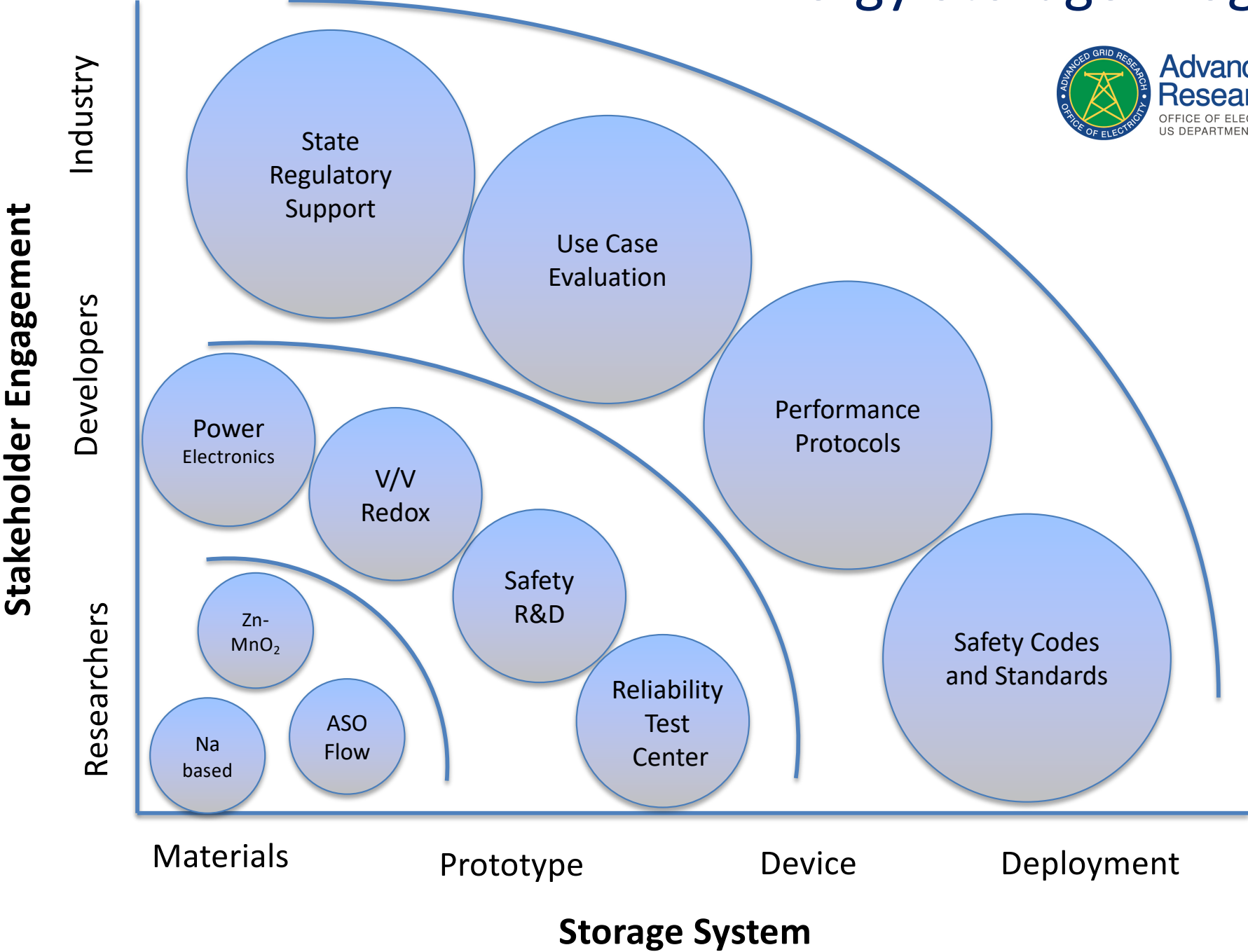
DOE Office of Electricity, Priorities:

- Puerto Rico and U.S. Virgin Islands Restoration and Resiliency Efforts
- North American Energy Systems Resiliency Model
- **Mega-Watt Scale Grid Storage**
- Revolutionize Sensing Technology Utilization
- Operational Strategy for Cyber and Physical Threats

Energy Storage Program

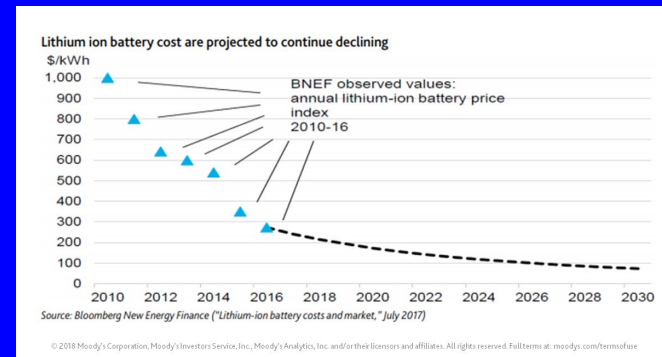


**Advanced Grid
Research**
OFFICE OF ELECTRICITY
US DEPARTMENT OF ENERGY



Li-ion Batteries?

Low cost, market ready

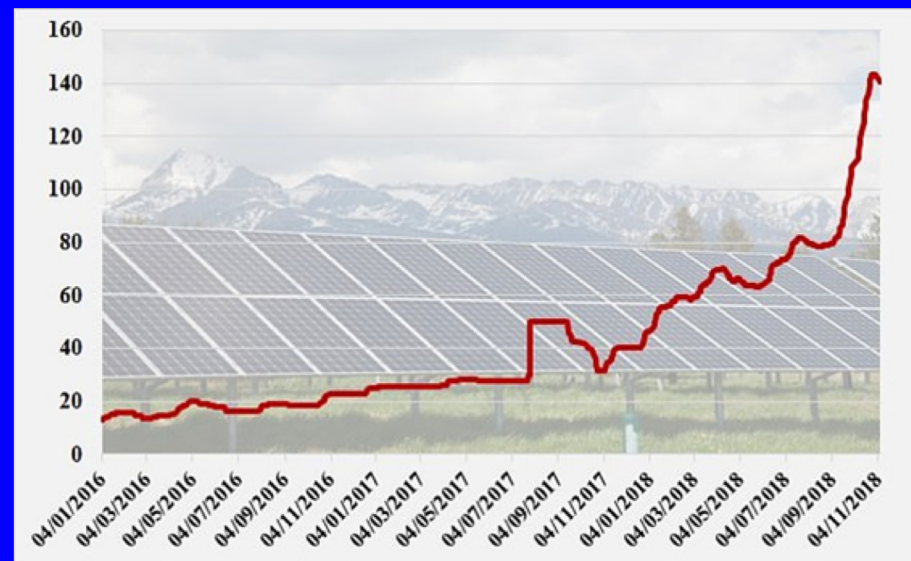
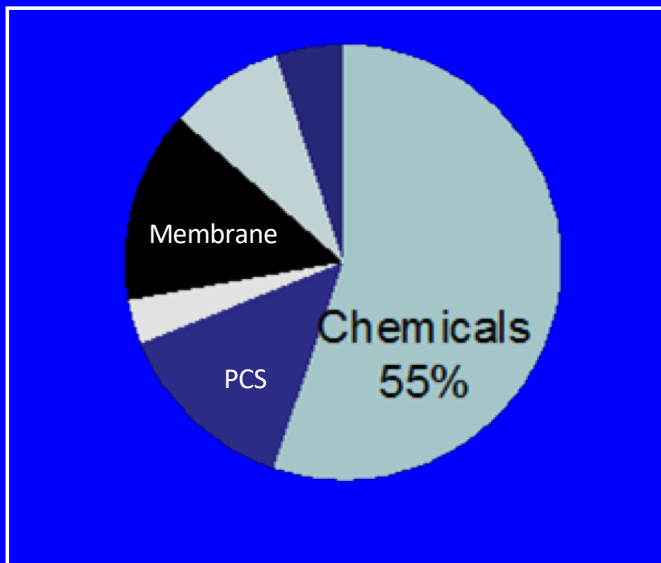


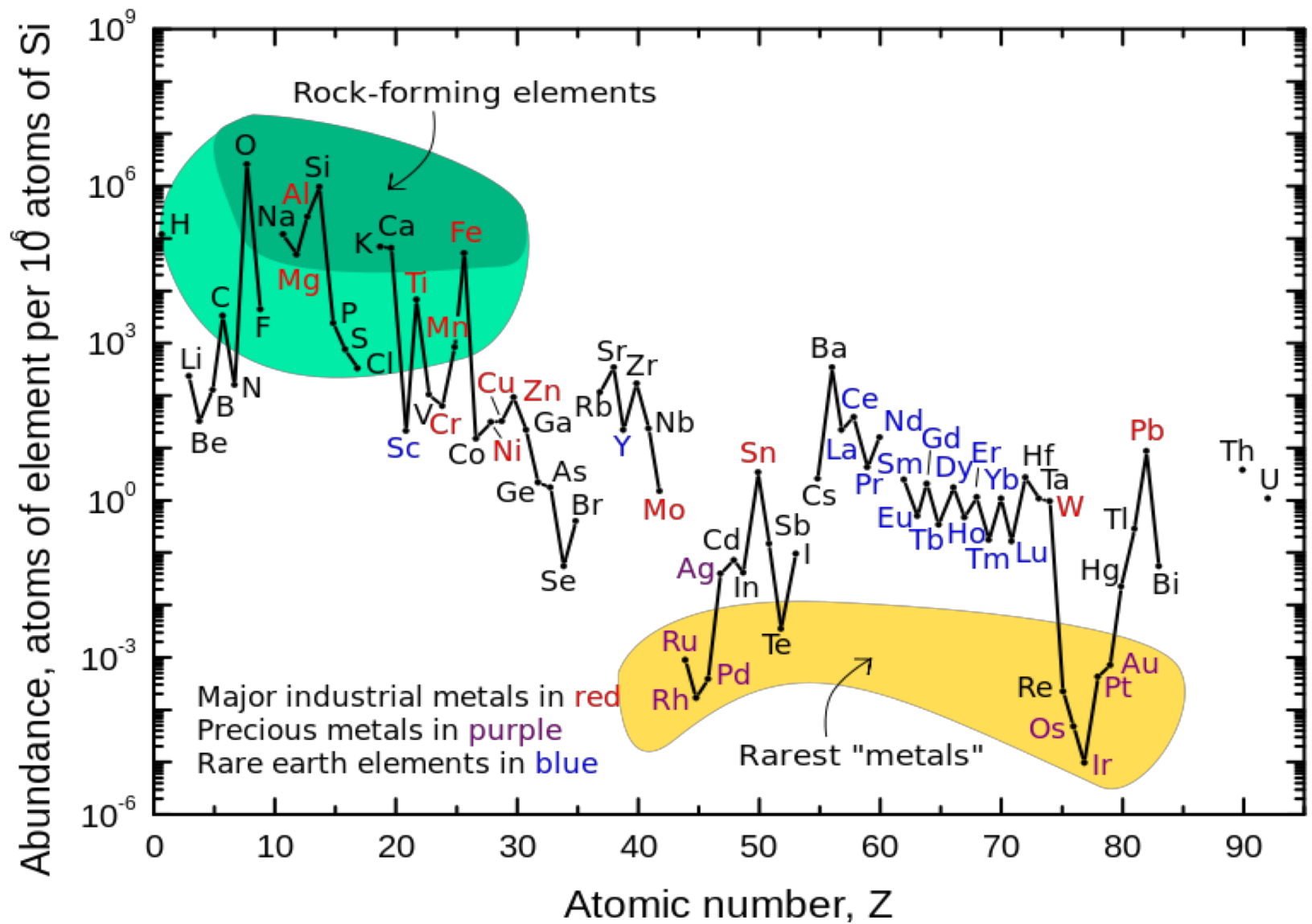
- Cycle life <<20years
- Safety Issues
- Social & Ecological Issues
- No Recycling!
- No U.S. Manufacture



Mixed Acid V/V Redox Flow Battery

Enhanced Temperature Range, Good Energy Density,
Cost Estimate \$300/kWh, 20 year Cycle Life
Recycleable, Commercially Available





We want low Cost !

Cost Goals for Focus Technologies

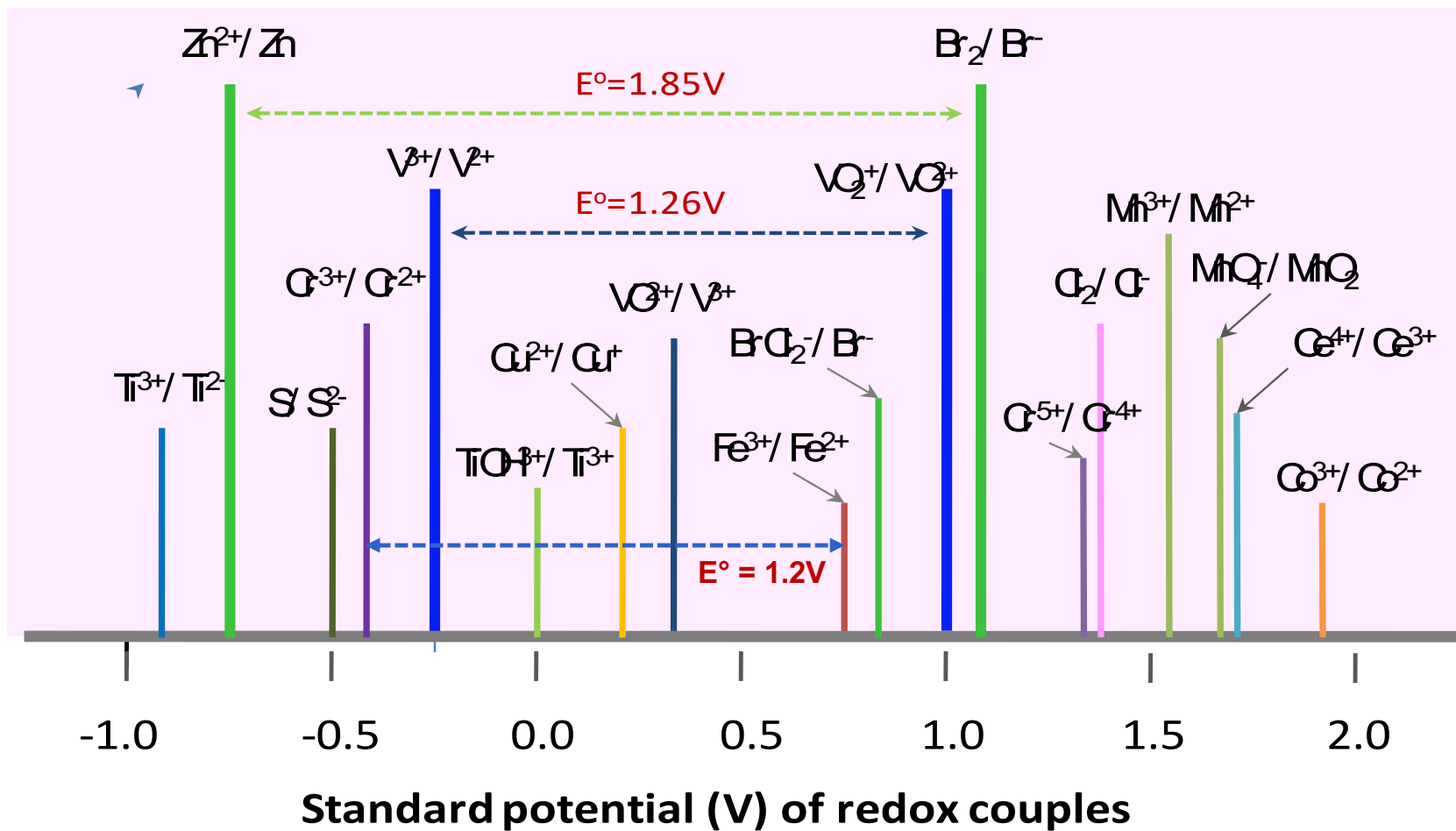
Manufactured at scale

Aqueous Soluble Organic (ASO)
Redox Flow Batteries (Stack+PE) \$125/kWh

Zinc Manganese Oxide (Zn-MnO₂)
2 Electron System \$ 50/kWh

Low Temperature Na-NaI
based Batteries \$ 60/kWh

Advanced Lead Acid \$ 35/kWh



We want high Potential !

Non-aqueous Redox Flow Batteries

Flow Batteries decouple Energy and Power
Suitable for Long Duration Batteries.

High Cell Voltage, and high energy density (~4.5V)

Larger Temperature Window

→ Increased Viscosities and Decreased Conductivities

Metal based: Ru, Fe, Mn, Cr, Ni, Co, V

All-organic Technologies

Hybrid Aqueous / Non-aqueous Systems

Non-aqueous Redox Flow Batteries
show Considerable Promise and are
well worth Research Investment!



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