



## Panel VII: State & Federal Programs to Support the Battery Industry

*“U.S. Army’s Ground Vehicle  
Programs & Goals”*



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# Overview



**§ Energy Storage Goals & Mission**

**§ Program Collaboration & DOD Customers**

**§ DOD Applications & Approach**

**§ Power & Energy Requirements**

**§ Energy Storage R&D Challenges**

**§ Army Ground Vehicle Energy Storage R&D Programs**

§ Roadmap

§ Functional Breakdown

§ Highlighted R&D Programs & Projects

**§ Summary**



# Energy Storage Goals and Mission



## Energy Storage Goals

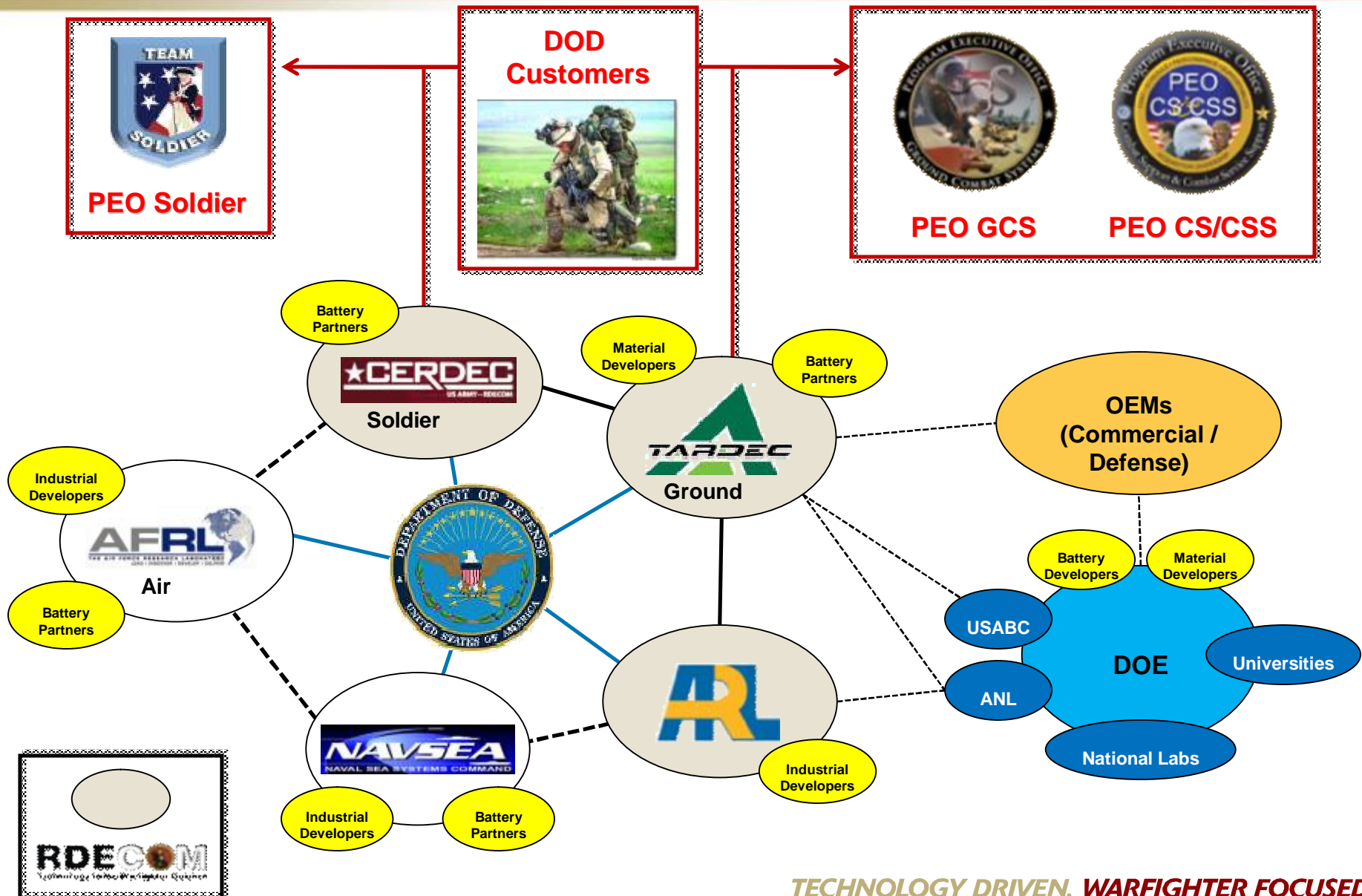
- Develop **safe and cost** effective energy storage systems
- Reduce **battery weight & volume burden** (Increase Energy & Power Density)
- Reduce logistics and fuel burdens
- Extend **calendar and cycle life**
- Enhance performance and increase operating time (silent watch, etc)

## Energy Storage Mission

- **Develop** and **mature** advanced ES technologies for transfer to vehicle platforms
- Test & evaluate ES technologies for prequalification and to assess their TRL
- Identify **technology barriers** and develop technical solutions
- Provide technical support to customers, other teams and government agencies for all ES requirements
- Provide **cradle-to-grave** support for all Army ES systems



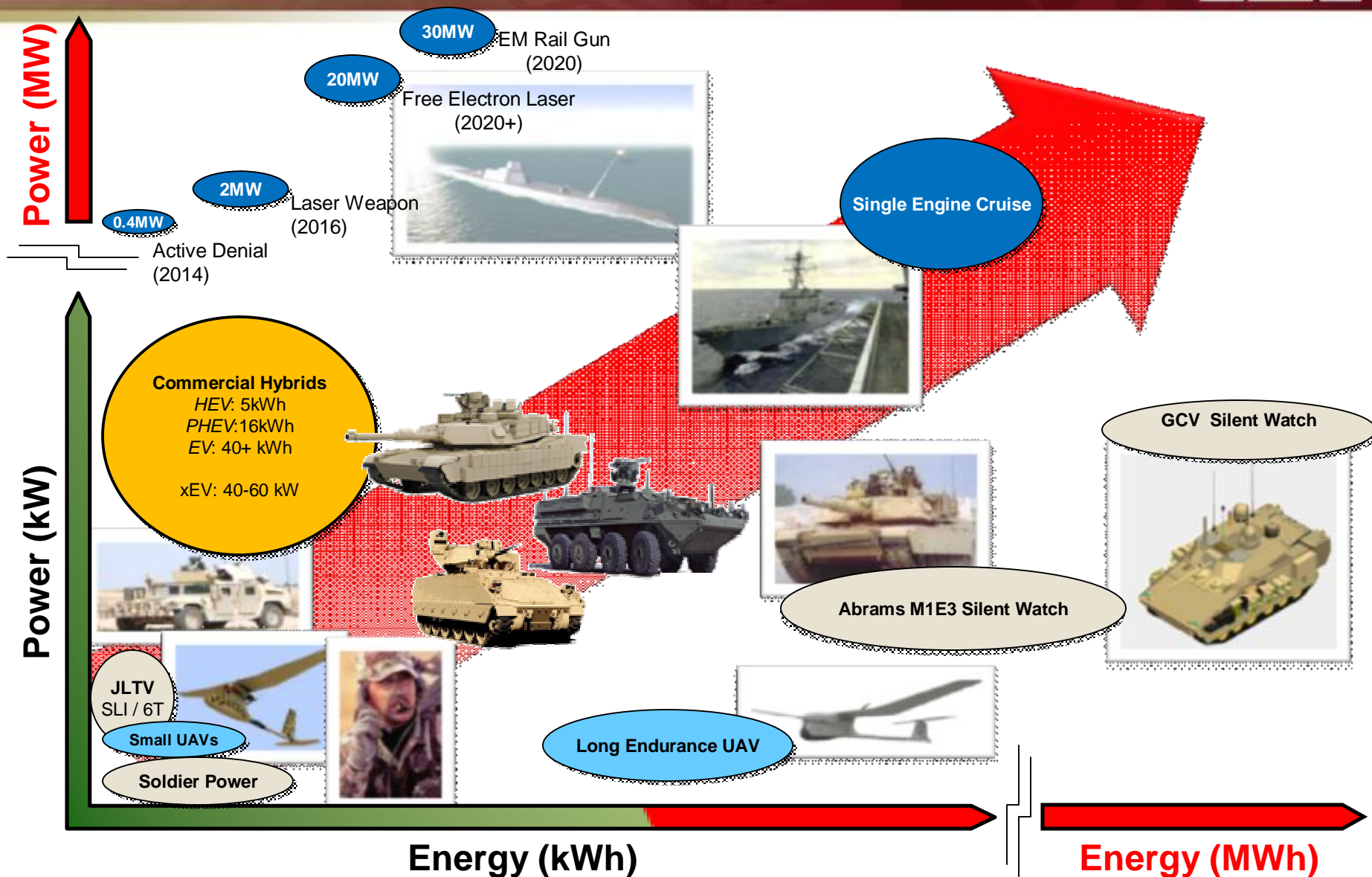
# Program Collaboration & DOD Customers



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## • Air Force: (mass restrictions)

- Major Applications:
  - Ø Aircraft Emergency Power
  - Ø Small Unmanned Aerial Vehicle (UAV)
  - Ø Long Endurance UAV / Persistent Munitions
- Approach
  - Ø High Energy component
  - Ø High Power component
  - Ø Power Management



## • Navy: (volume restrictions)

- Major Applications:
  - Ø Unmanned Underwater Vehicles (UUV)
  - Ø Shallow Water Combat Submersible (SWCS)
  - Ø Submarine Small Distributed Power Systems
  - Ø Surface Ship Fuel Economy
  - Ø Surface Ship Pulsed and High Power
- Approach
  - Ø Modular, scalable approach to support multiple applications



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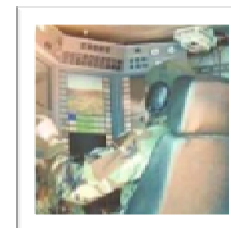
## • Army Applications/Drivers:

### CERDEC - Soldier

- Major Applications
  - ø Soldier Power – *(Soldiers carry as much as 30lbs of batteries to support Mission Essential Equipment)*
  - ø Advanced C4ISR Systems
- Approach
  - ø Standard Form Factor (BB2590)
  - ø Fuel-Cell/Battery Hybrid Power Sources



Communications



### TARDEC - Ground

- Major Applications
  - ø Robotics
  - ø Survivability
  - ø Weapons Systems
  - ø Electromagnetic Armor (EM Armor)
  - ø Silent Watch
  - ø Starting, Lighting and Ignition (SLI)
  - ø Hybrid Vehicle Acceleration and Regenerative Breaking
- Approach
  - ø Standard Form Factor (6T)
  - ø Ultra-capacitor/Battery Hybrid Power Sources



Hit Avoidance



Targeting Systems

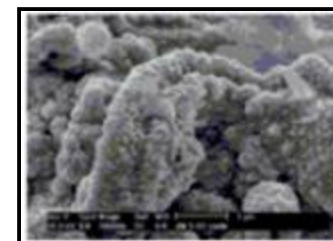
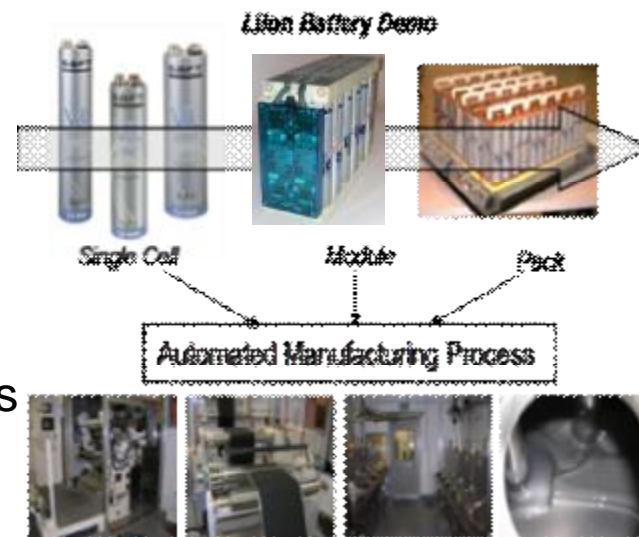


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## Energy Storage Challenges:

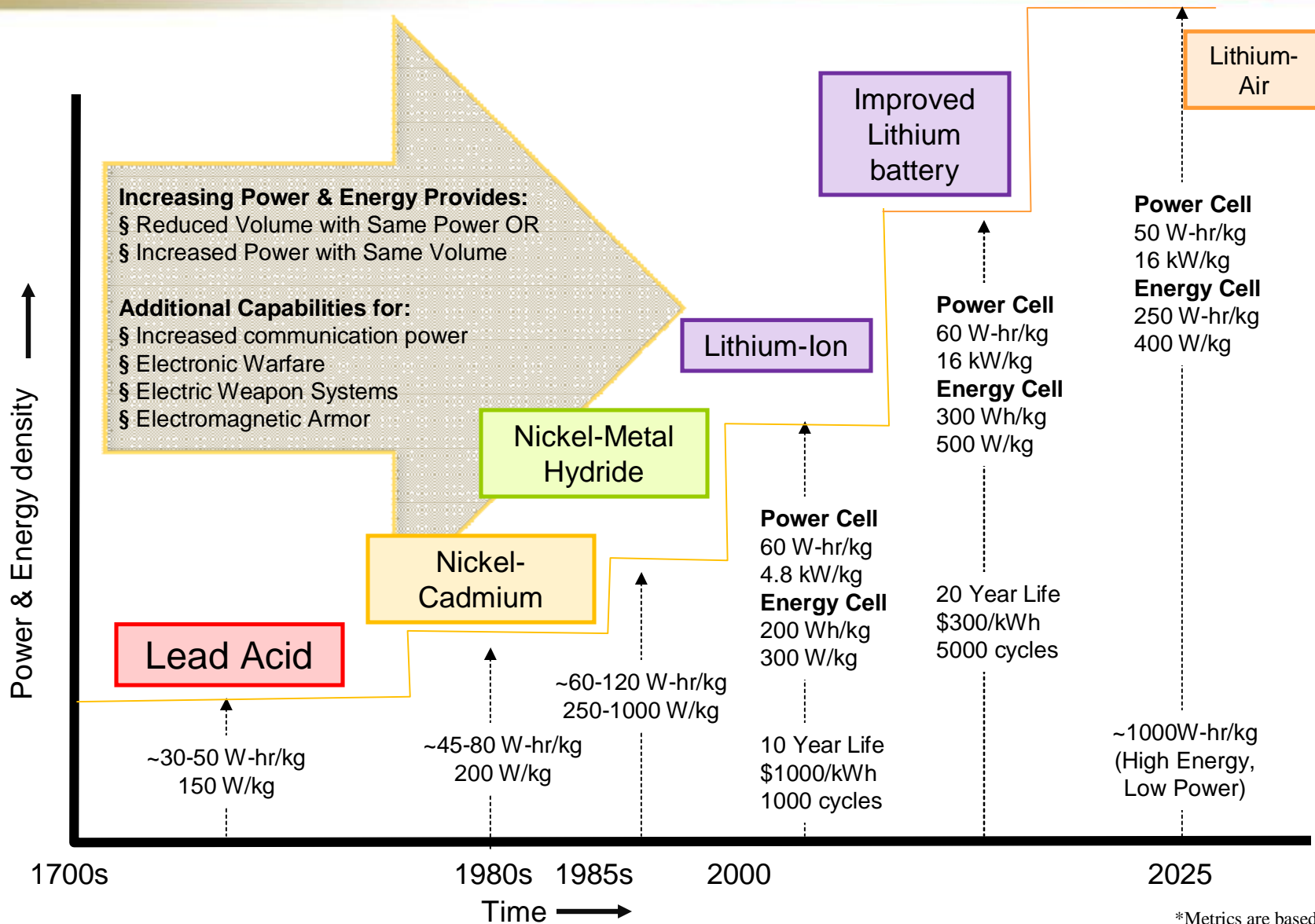
- Cell & system safety & reliability
- Higher energy / higher power designs & chemistries
- Power vs. energy trade-off design optimization
- Manufacturing process development and cost control
- Thermal management
- System control and cell & battery management systems
- Alternative electrochemical improvements
- Thermal runaway process and its control
- Standardization of cells, modules and packs (logistics)



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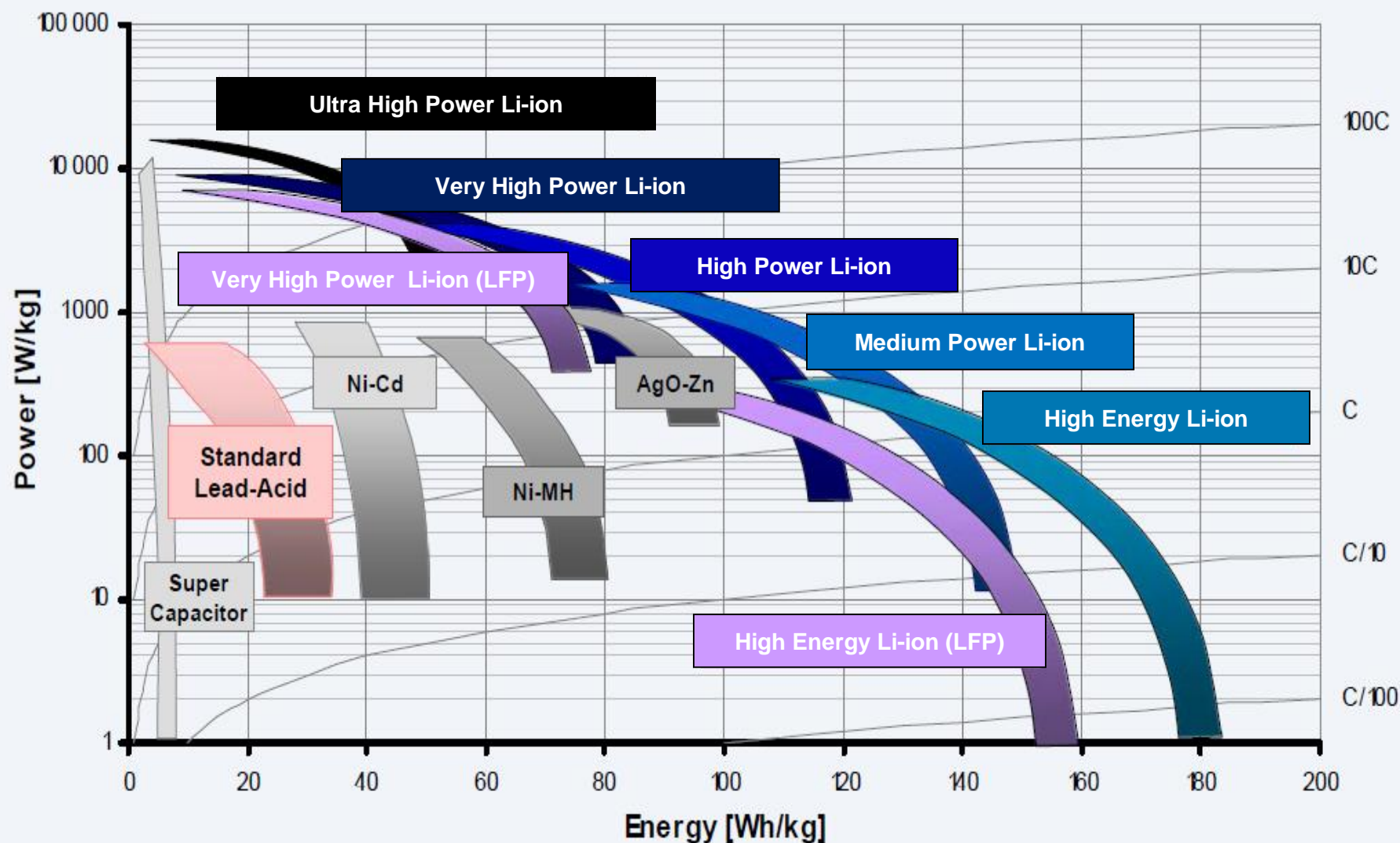
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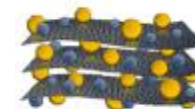
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### Energy Storage Functional Breakdown



#### Basic Research

- Lithium plating phenomenon in Li-ion batteries
- **Study on the mechanism of thermal runaway in VRLA Batteries and Methods of Suppression**
- Study of electrode/current collector interface & safe separator for Li-ion batteries
- Development of high energy density anode materials for improved Li-ion batteries
- Alternative electrolyte for use in lithium-ion batteries (higher voltage, improved performance)

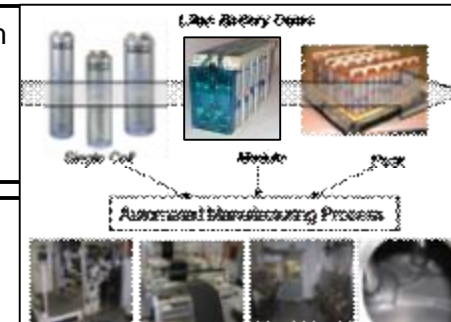
#### Applied / Applications Research

- Electromagnetic Armor Power Maturation
- Nickel-Zinc 6T Battery Development
- **Development of 6T battery for SLI and silent watch using lithium-iron phosphate**
- Absorbed Glass Matt lead acid battery for 24V military 4HN battery



#### Manufacturing

- High Power, High Energy Density Li-Ion Battery Manufacturing Program
- **Lithium-Ion Battery Pack Manufacturing**
- Advanced battery material scale-up facility



#### Battery Management / Safety

- **In-House BMS evaluation for PM HBCT & new laboratory**
- Universal BMS using novel algorithms for battery health
- Ballistic and abuse tolerance studies on cells, module and packs
- Development of advanced diagnostic tools for cycled cells

#### Alternative Systems

- Hybrid Power Module
- Lithium-Titanate Hybrid Vehicle Pack Integration
- **Characterization of ultra-capacitors for SLI and high power applications**





## Summary



- § Army has a diversified energy storage portfolio supporting a wide-range of customers**
- § Army has and is actively seeking collaboration with other Government Agencies, and Commercial & Military OEM's**
- § Army has projects supporting several different functional areas in Energy Storage including: basic research, applied research & applications, manufacturing, battery management & safety, and alternative systems**
- § Army labs currently perform a wide variety of testing activities and has an established program for technology maturation and technology readiness level verification**
- § Army is actively involved in the development of battery standards and standard vehicle battery products**





Its all about the War Fighter!



Thank you



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