



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

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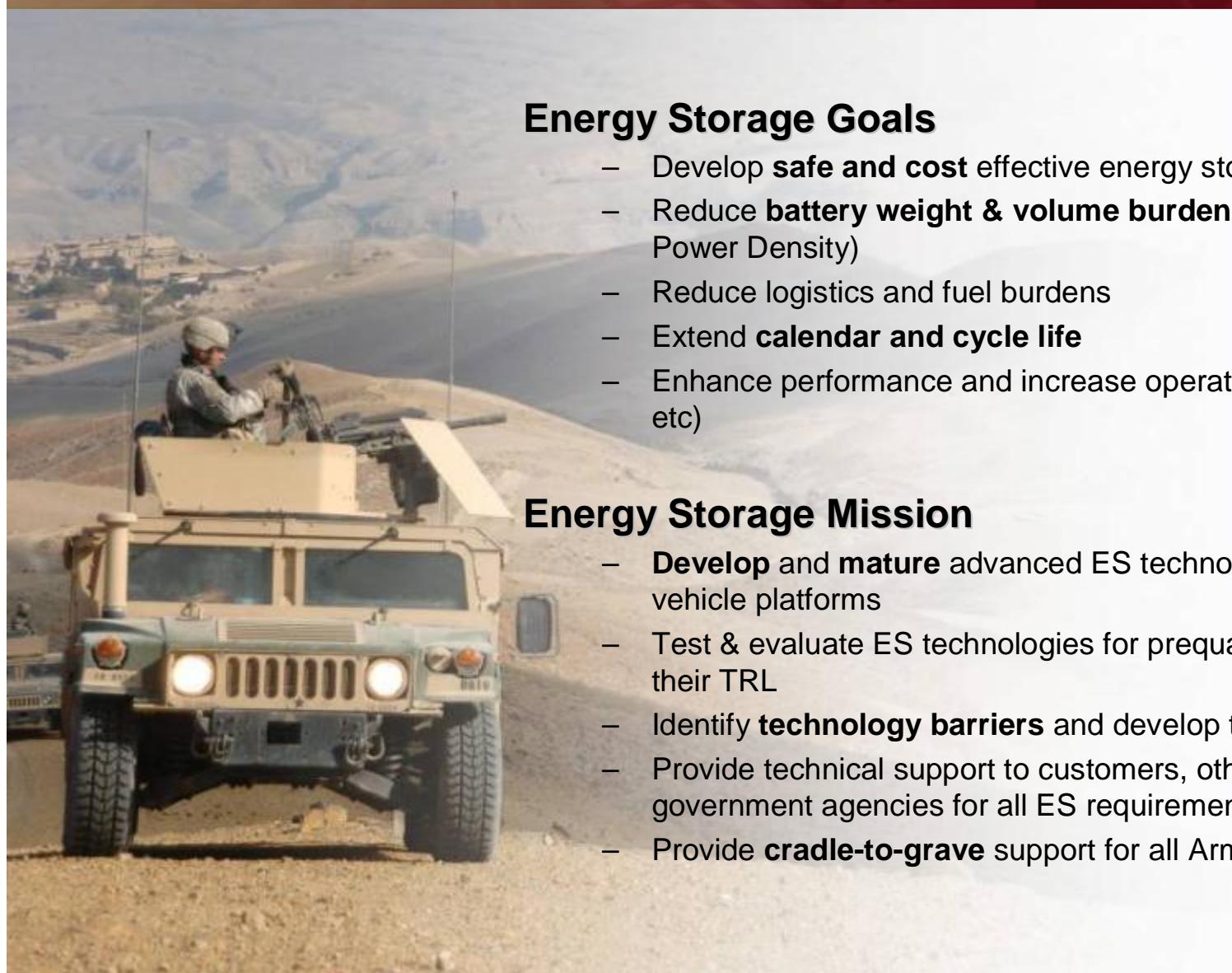
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Energy Storage Goals

- 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)

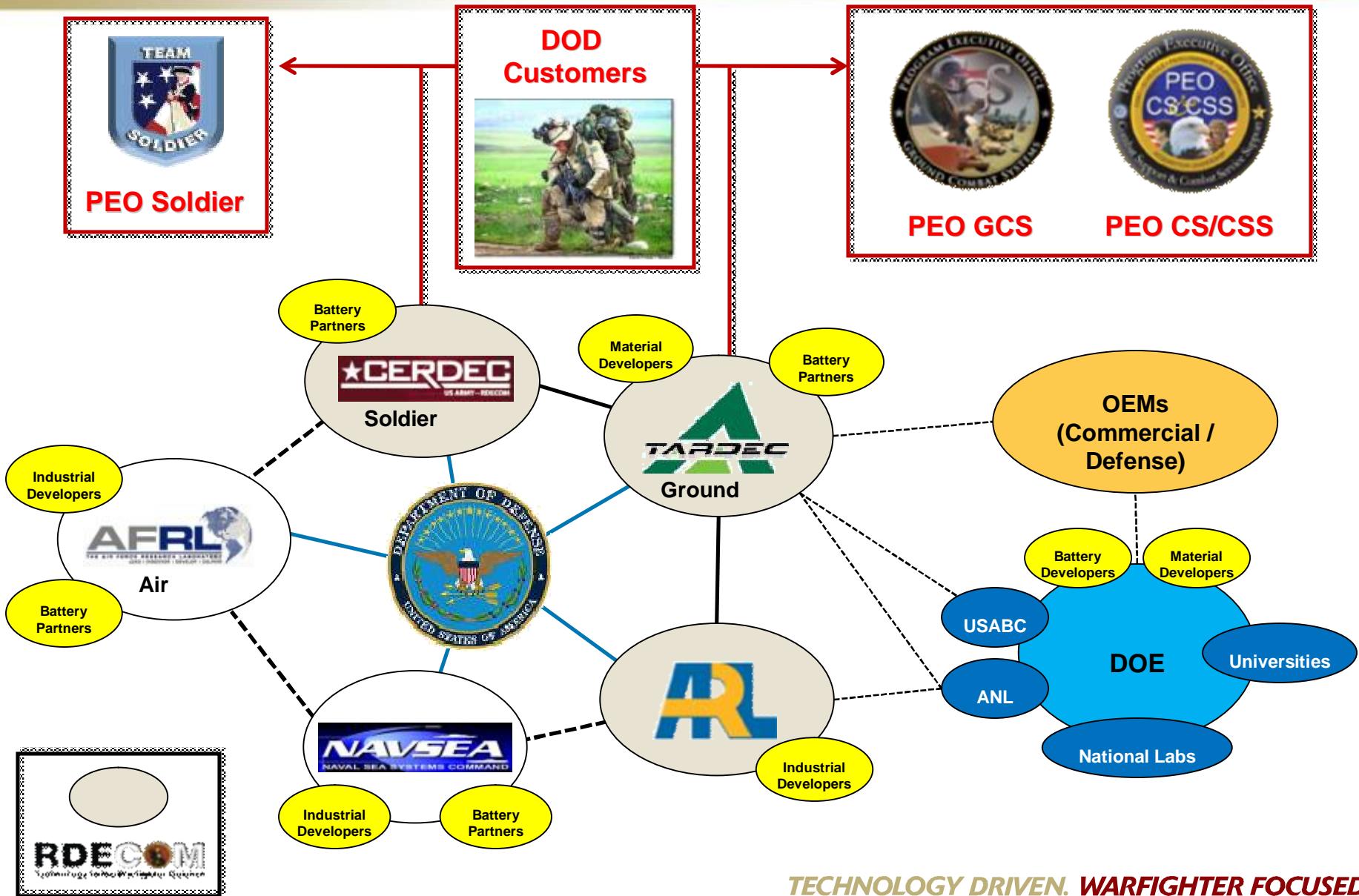
Energy Storage Mission

- **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



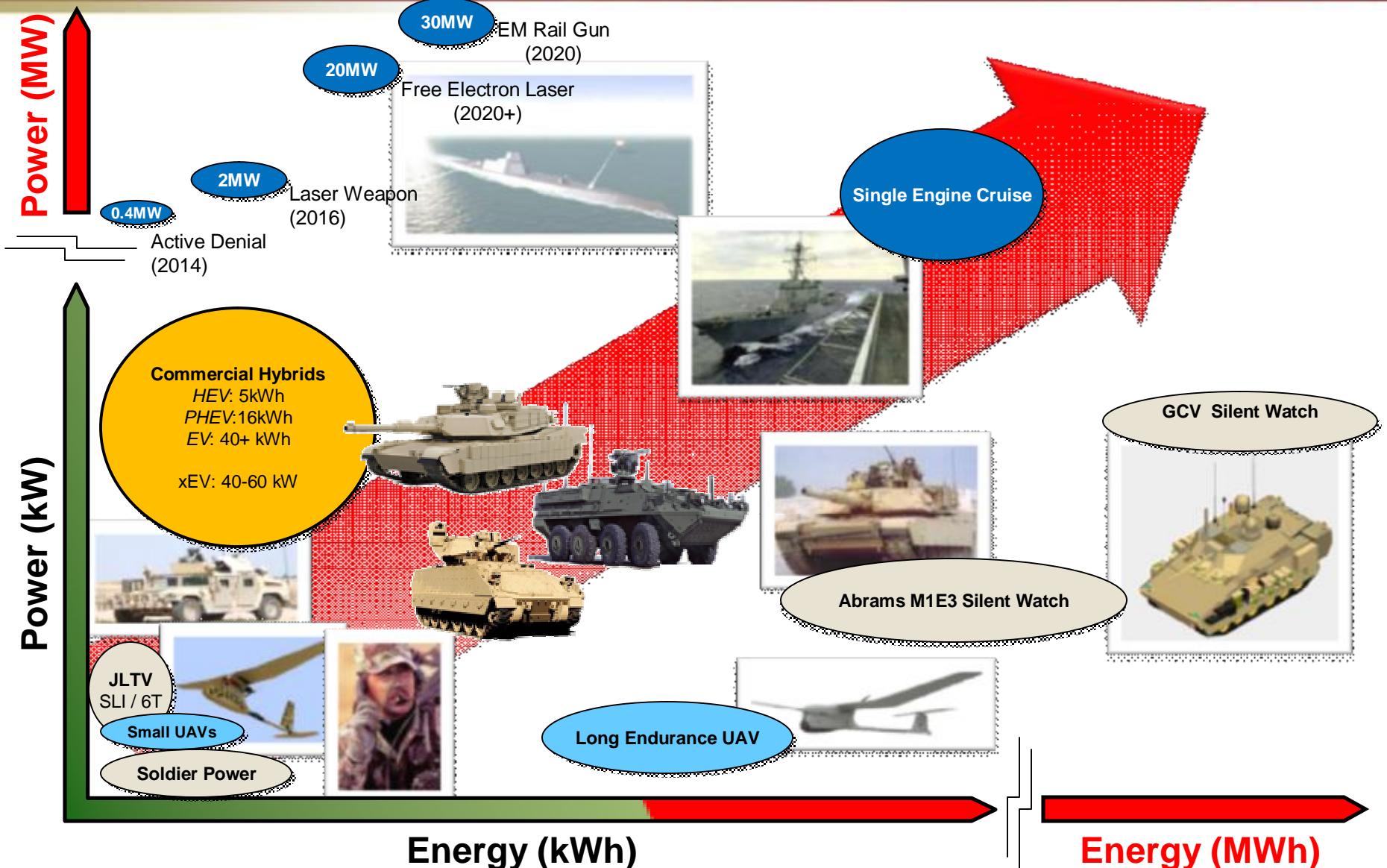
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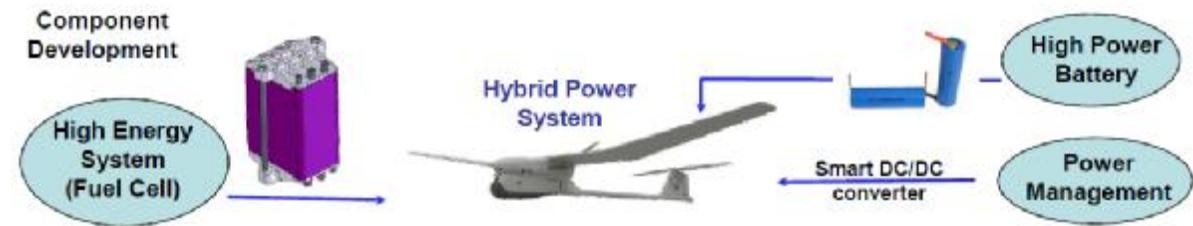


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- **Air Force: (mass restrictions)**

- 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

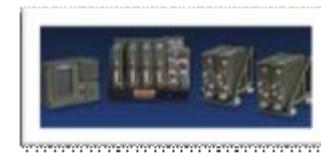


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- Army Applications/Drivers:

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



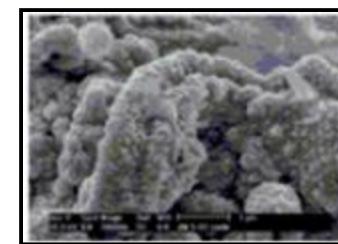
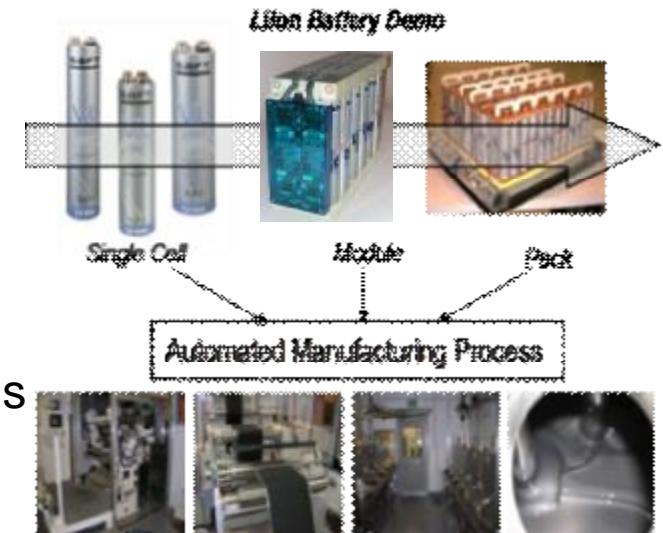
Targeting Systems



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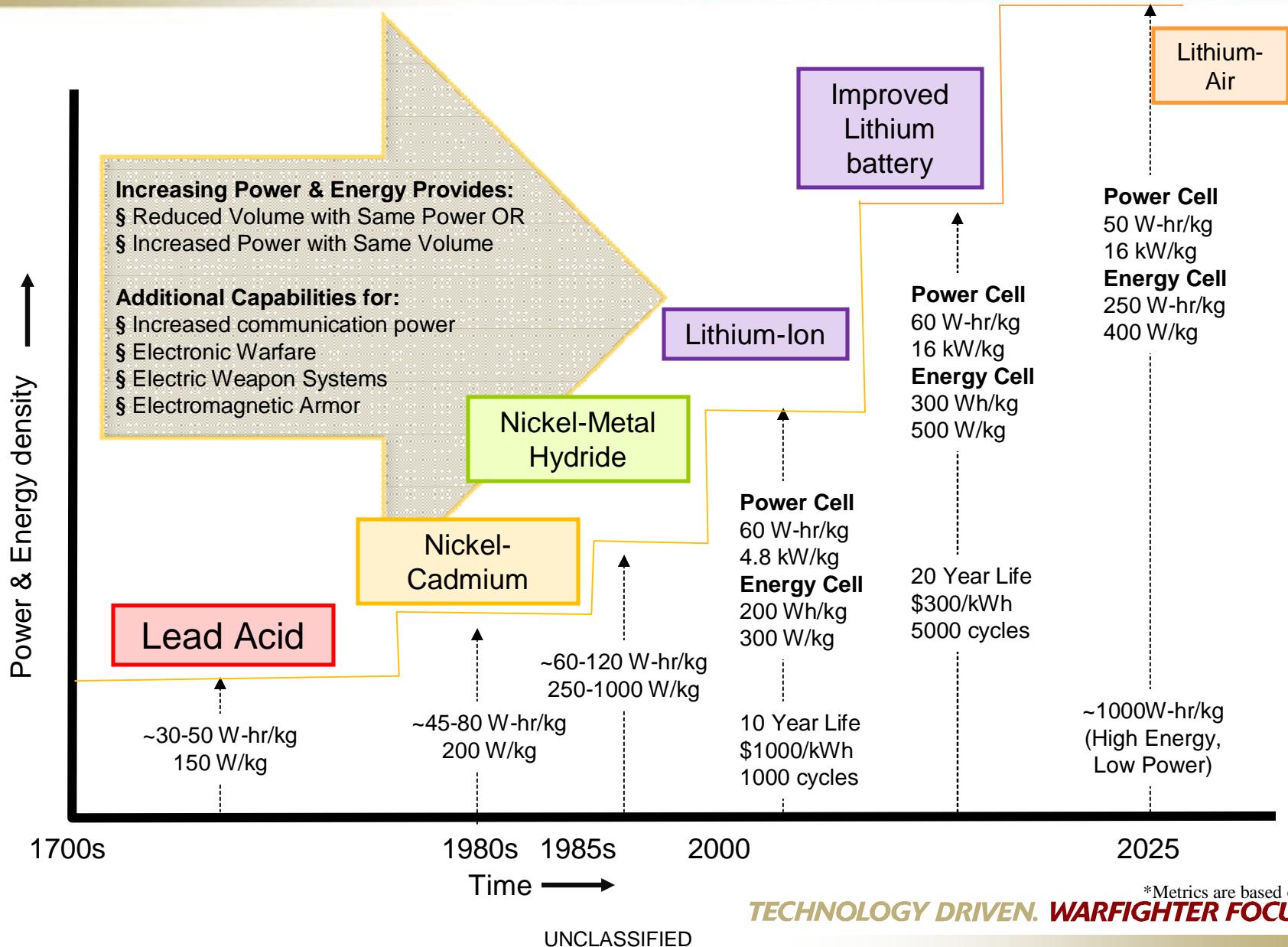
Energy Storage Challenges:

- 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)



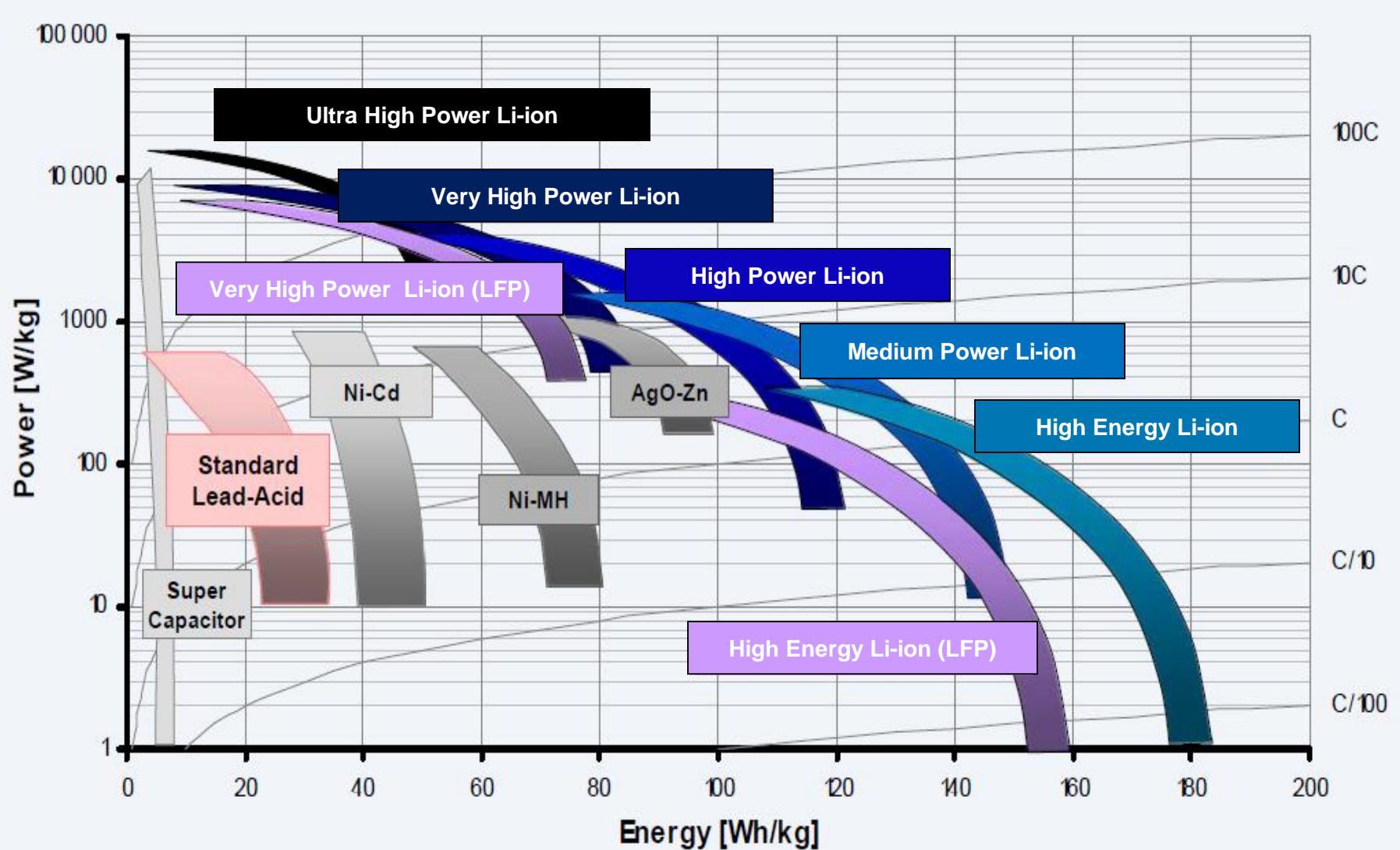
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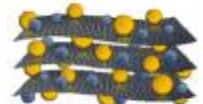


*Metrics are based on cell data
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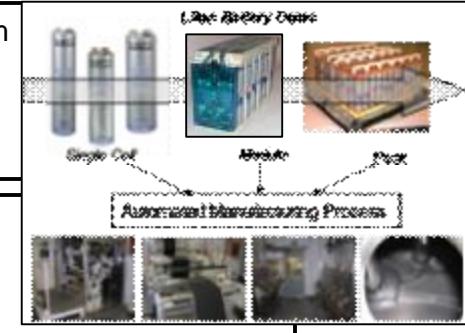
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Energy Storage Functional Breakdown



Basic Research	<ul style="list-style-type: none"> • 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	<ul style="list-style-type: none"> • 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	<ul style="list-style-type: none"> • High Power, High Energy Density Li-Ion Battery Manufacturing Program • Lithium-Ion Battery Pack Manufacturing • Advanced battery material scale-up facility
Battery Management / Safety	<ul style="list-style-type: none"> • 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	<ul style="list-style-type: none"> • Hybrid Power Module • Lithium-Titanate Hybrid Vehicle Pack Integration • Characterization of ultra-capacitors for SLI and high power applications



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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

Thank you



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