



RDECOM



Energy Storage Requirements & Challenges For Ground Vehicles



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- TARDEC & Energy Storage Team Mission
- Vehicle Requirements for Energy Storage
- Army Ground Vehicle Power & Energy Challenges

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- Provides **full life-cycle engineering** support and is provider-of-first-choice for **all DOD** ground combat and combat support weapons and vehicle systems.
 - Develops and integrates **the right technology solutions** to improve Current Force effectiveness and provide superior capabilities for the Future Force.

**Ground Systems Integrator for the
Department of Defense**

Responsible for Research, Development and Engineering Support to **2,800** Army systems and many of the Army's and DOD's Top Joint Warfighter Development Programs

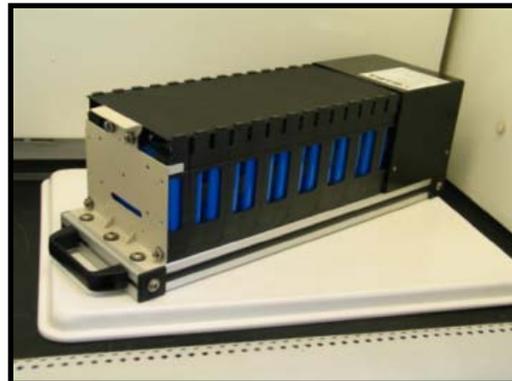
Ground Vehicle Power and Energy Technology

<p>Prime & Non-Primary Power</p>	
<p>Energy Storage</p>	
<p>Thermal Management</p>	
<p>Power Management</p>	

- Pursue energy storage technology research, development, component test and evaluation for CURRENT and FUTURE ground vehicle fleet
- Identify technology barriers and develop technical solutions
- Provide technical support to customers, other teams and government agencies in all energy storage



Battery Technology Evaluation Lab



Module Test & Eval



Cell Test & Eval

There are three distinct requirements for Military Energy Storage:

- ***Starting, Lighting and Ignition***

Batteries provide electric power to start the vehicle power generation (Engines / APUs)

- ***Hybrid Vehicle Boost Acceleration and Regenerative Braking Energy Capture***

In hybrid vehicle powertrains, batteries have the ability to supplement main engine power for burst accelerations.

In addition, batteries can be used to recover wasted energy in vehicle braking

- ***Silent Watch***

Batteries can provide the energy storage capability to power mission equipment with main engine off while the vehicle is stationary

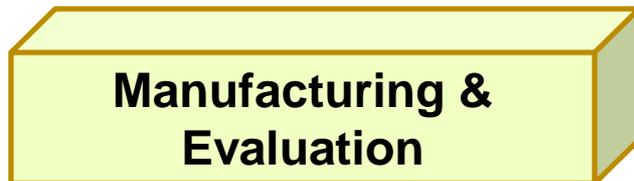
- **Li-Ion**: Future replacement for Lead-Acid in military applications and hybrid electric vehicle boost power
- **Alternative Chemistries**
- **UltraCaps**
 - Starting Assist
 - Hybrid Application
- **Lead-Acid**: Support existing power needs, Starting and Silent Watch utilizing 6T, 2HN & 4HN format batteries.
 - Flooded Cell
 - VRLA
 - Absorbed GlassMat
 - Gel
 - Advanced improvements: increased energy density
 - Qualify additional sources



- Understand aging mechanism
- Safety limits
- Evaluate and/or develop novel materials (cathode, anode, electrolyte) that promise increased power & energy



- Characterize batteries & investigate cell behavior
- Enhanced Battery Management



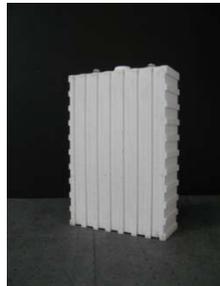
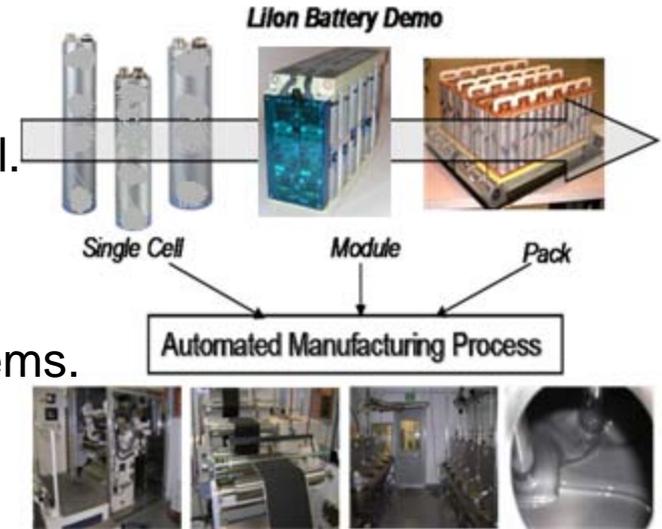
- Perform battery and capacitor evaluation testing (charge, discharge and service life testing) for cell, module, and full battery systems at different temperatures and rate.

Ongoing R&D:

- Focused investigations on novel materials (cathode, anode, electrolyte) for increased power and energy & reduced cost
- Develop advanced diagnostic tools and battery management system.
- Develop and apply advanced models for batteries and components
- Advanced battery design techniques
- Advanced battery manufacturing techniques

Energy Storage

- Power vs. Energy trade-off design optimization.
- Manufacturing process development and cost control.
- Thermal management.
- Cell & system safety & reliability.
- System control & cell and battery management systems.
- Alternative electrochemical improvements.
- Thermal runaway process and its control.



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3D Advanced Battery Technology
Mechanism of Battery Thermal Runaway
Advanced Military Hybrid Technology
Advanced Materials Development
Ballistic Impact Testing
Research Calorimeter/Test Rig
HE-HMMWV Battery Pack
Integrated Platform Battery Test & Evaluation
Large Format Lithium Iron Phosphate Cells
Advanced Li Iron Phosphate Battery system
Li Ion Battery Manufacturability
Prismatic Cell w/liquid cooling
Ultra High Power Batteries
Auxiliary Power Unit

Cell Evaluation
Ultracapacitor Characterization
6T Li
Nickel Zinc Batteries
Ni-Zn Battery Module
Rolled -Ribbon Lithium ion Cells
GS Yuasa Evaluation of LFP Cells & Modules
C4ISR Auxiliary Power Unit (APU) Soldier Tactical
HEV Battery System for FCS
Li-Titanate Evaluation
Cell Evaluation
Battery Aging Phenomenon
Battery SOC/SOH Determination Modeling
ARM 100 Lilon APU
Lion Cell Evaluation
Cell Evaluation



“Power and energy is not only the greatest enabler of the Warfighter, it is also the most significant limitation.”

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