Energy Efficiency &
Renewable Energy

Energy Storage R&D for Vehicles

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Advanced Research Projects Agency-Energy (ARPA-E)
Robust Affordable Next Generation Energy Storage Systems (RANGE)
Kickoff Meeting

January 29, 2014

The *EV Everywhere* Grand Challenge

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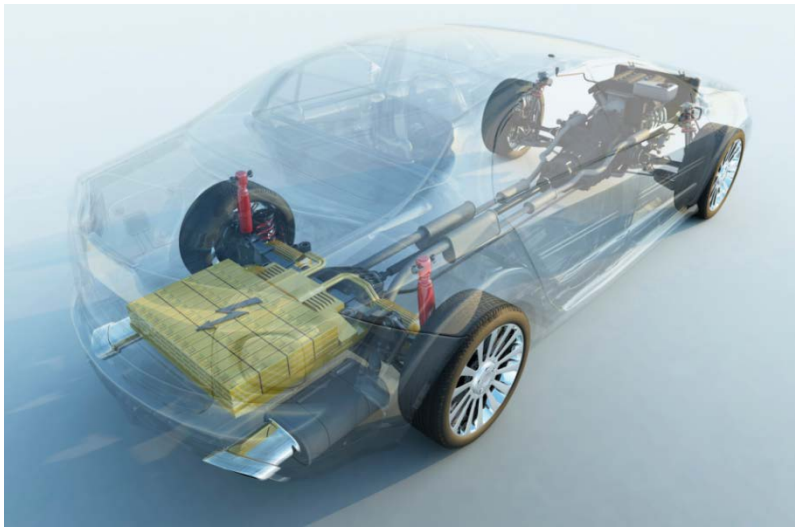
Enable the U.S. to be the first in the world to produce plug-in electric vehicles that are as affordable as today's gasoline-powered vehicles within the next 10 years.

- **Technology Push (R&D):** targets focus on reducing PEV costs
  - Advanced batteries
  - Electric drive systems
  - Lighter weight structures
  - Advanced climate control
- **Charging Infrastructure (Enablers):** Critical issues include codes and standards, siting, grid integration, permitting, and signage.
- **Market Pull (Consumer Acceptance):** Consumer education and exposure to PEVs, innovative PEV ownership incentives, and leadership by example among public and private fleets.



2022 Battery Technology

$125/kWh
250 Wh/kg
400 Wh/l
2,000 W/kg

Energy Storage R&D: Program Structure

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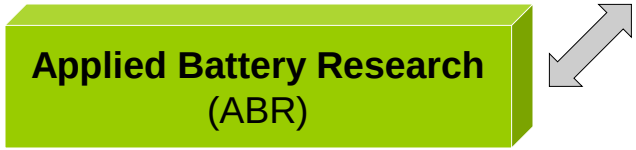
- Develop full prototype battery systems with industry



- Assist developers of lithium-ion technologies for PHEV applications overcome key barriers to large-scale usage

- Address the fundamental science of chemical and mechanical instabilities in current battery technologies and develop the next generation of battery technologies

Points of Contact

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Research effort closely coordinated with DOE Office of Electricity, ARPA-E, Office of Basic Energy Sciences, and the NSF

Charter

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❑ CHARTER

- Advance development of batteries and other electrochemical energy storage devices to enable a large market penetration of electric drive vehicles

❑ TARGET APPLICATIONS

- 12V Start/Stop
- Power-Assist Hybrid Electric Vehicles (HEVs)
- Plug-in Hybrid Electric Vehicles (PHEVs)
- Battery Electric Vehicles (EVs)

❑ DRIVERS

- Energy security
- Greenhouse gas reduction
- CAFE Standard 54.5 MPG for all light duty vehicles, effective 2025

Vehicle Technologies Office: Battery R&D Activities

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FY 2013 Energy Storage R&D Budget (~$88M)

Advanced Battery Materials Research

- ✓ Capacity Improvement
- ✓ Failure Mitigation

Anodes
(600 mAh/g)

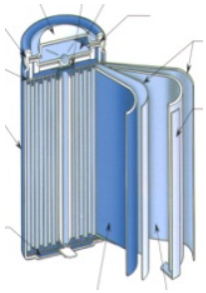
Cathodes
(300+ mAh/g)

Electrolytes
(5 volt)

Beyond Lithium-ion

Cell Design & Electrochemistry Optimization

- ✓ Power & Capacity Increase
- ✓ Life Improvement



Cell Targets
350 Wh/kg
750 Wh/l
1,000 "C/3" cycles

Advanced Battery Development

- ✓ Performance Optimization
- ✓ Cost Reduction

$125/kWh
250 Wh/kg
400 Wh/l
2,000 W/kg

10-100 mAh cells

0.5 - 1.0 Ah cells

5 - 40^{+} Ah cells

Funding Opportunity Announcement

Energy Efficiency & Renewable Energy

DE-FOA-0000991

- Released: 01/24/2014
- URL: http://eere-exchange.energy.gov

Due Dates

- Concept Paper
  - February 19, 2014
- Full Application
  - April 1, 2014

Awards Expected

- 4 to 8 awards (up to 3 years)
  - Size: $0.5M - $1.25M

Areas of Interest

- Methods/additives to protect a **lithium metal electrode**.
- Improved Li-ion **conductors** for solid-state and/or liquid cells.
- Optimum Li_2S **solubility** and suitable electrolytes.
- Electrolytes to prevent **dendrite** formation
- Tools to investigate speciation and reaction kinetics in **sulfur electrode**
- Ionic/electronic conduction in **solid-state cathodes**.
- Poor reversibility and large voltage hysteresis of the **air electrode**.

THANK YOU!

For more information, contact:

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