

4th U.S. – China Electric Vehicle and Battery Technology Workshop

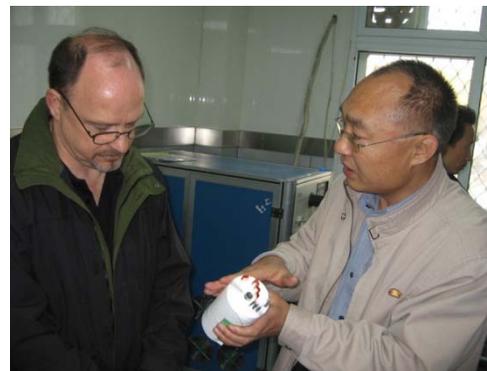
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U.S. Department of Energy

EERE Vehicle Technologies
Program

August 4, 2011

U.S.-China Bilateral R&D Initiative

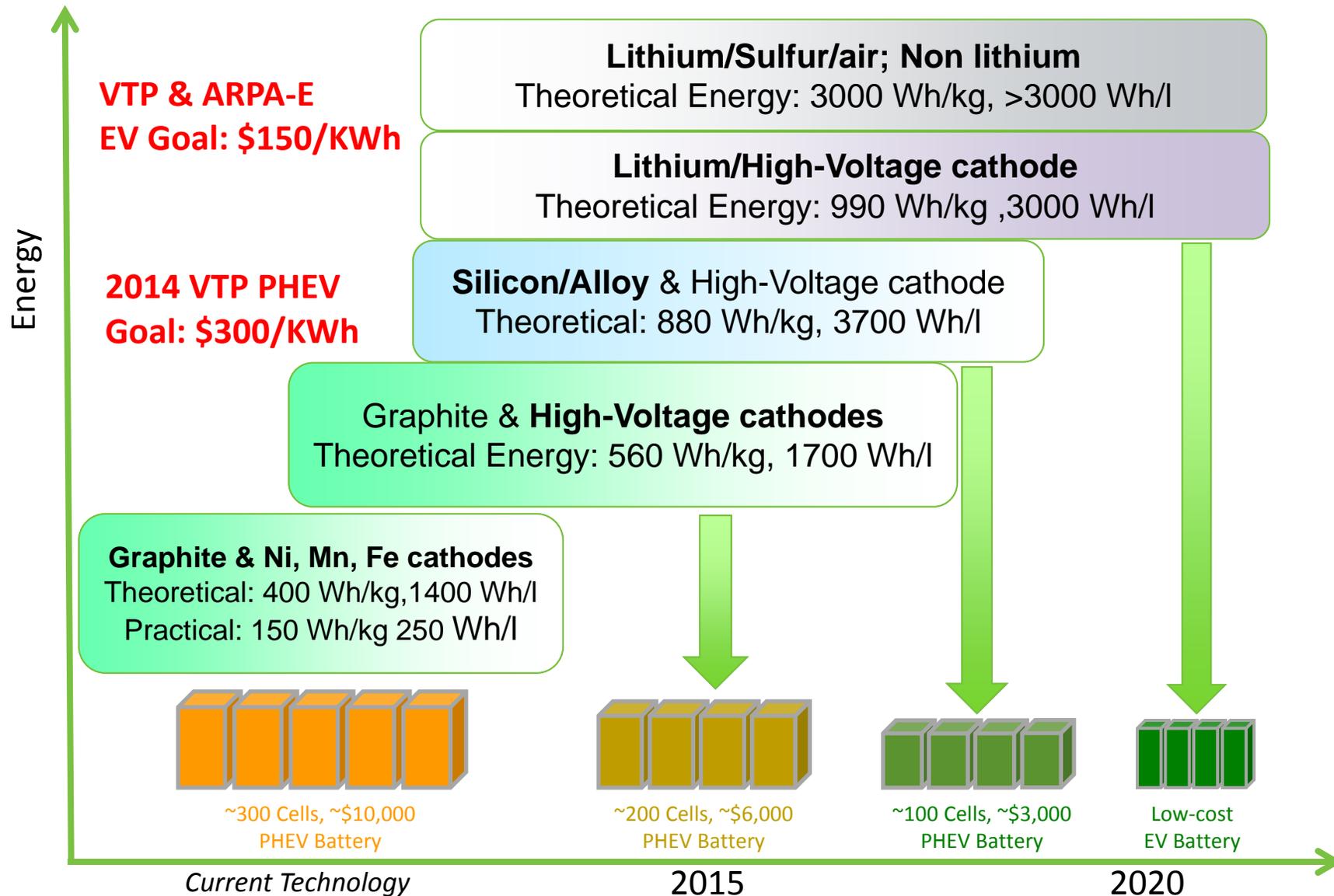
- ❑ 4th U.S. – China Electric Vehicle and Battery Technology Workshop
- ❑ Sponsored by:
 - U.S. Department of Energy
 - China's Ministry of Science and Technology
- ❑ Three focus areas
 - Battery Technology Road-mapping
 - Battery Test Procedures
 - Vehicle Demonstrations and Infrastructure



DOE Vehicle Technologies Battery Research Roadmap for 2015 & Beyond



U.S. DEPARTMENT OF
ENERGY



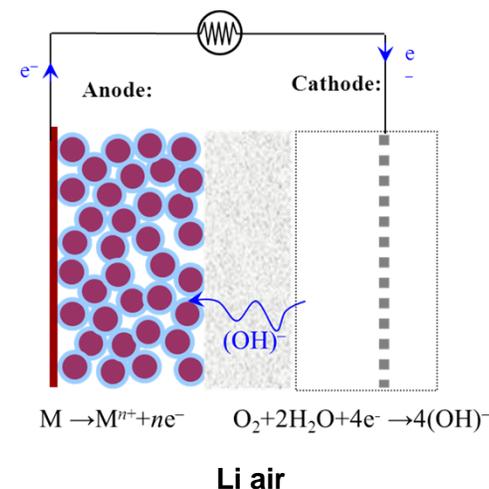
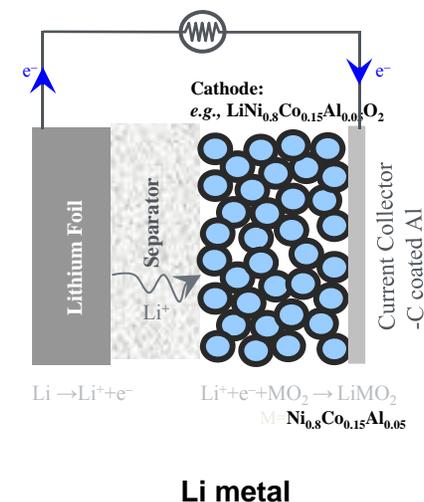
Joint Battery Technology Roadmapping

Lithium metal and lithium air batteries offer revolutionary energy densities and potentially major cost reductions.

Chemistry	Energy (system, Wh/kg)	Power (system, W/kg)	Life (cycles)	Energy Efficiency	Safety
Li metal polymer	150-200	500	~1,000	85%	Concern
Li metal/sulfur	250-400	750	~100	85%	Concern
Li metal/air	400-800	Poor	~10-100	<70%	Concern

Issues

- Lithium metal dendrites lead to cell shorting
- Soluble polysulfides lead to self-discharge and poor cycling (Li/S)
- Li Air batteries have very low efficiency (<70%)
- Poor power



DOE Battery Performance Test Protocols

- ❑ **Battery Performance Targets determined through;**
 - ❑ Establishing electric drive vehicle performance requirements
 - ❑ Battery Performance Modeling and Simulation
 - ❑ Hardware-In-the-Loop Testing

- ❑ **Battery Testing Protocols**
 - ❑ Develop battery performance and cycle life test protocols based on different EDV architectures

- ❑ **Current Test Procedures posted at www.uscar.org**
 - ❑ FreedomCAR Battery Test Manual for Plug-in HEV
 - ❑ FreedomCAR Power Assist Battery Test Manual
 - ❑ Electric Vehicle Battery Test Procedures Manual
 - ❑ FreedomCAR 42 Volt Battery Test Manual
 - ❑ FreedomCAR Ultracapacitor Test Manual
 - ❑ Battery Technology Life Verification Test Manual
 - ❑ Energy Storage Abuse Test Manual for HEV Applications
 - ❑ USABC Abuse Test Procedures Manual (EVs)

Many have been globally adopted: the abuse test manuals are the basis for SAE standards.

Abuse Tolerance Testing

- ❑ **Li-ion Safety Issues**
 - ❑ High energy density
 - ❑ Reactive materials
 - ❑ Flammable electrolytes
- ❑ **Abusive Conditions**
 - ❑ Mechanical (crush, penetration, shock)
 - ❑ Electrical (short circuit, overcharge, over discharge)
 - ❑ Thermal (over temperature from external or internal sources)
- ❑ **SAE Abuse Test Manual J2464**
- ❑ **Typical Abuse Tests Performed**
 - ❑ 1 & 10 mohm short circuit
 - ❑ 1C & 32A Overcharge/Overdischarge
 - ❑ Thermal Ramp @ 100% SOC & 90%SOC
 - ❑ Mechanical crush on both the positive and negative sides @ 100% SOC
 - ❑ Nail penetration @ 100% SOC



Bad!



Good!

U.S. Transportation Electrification Demonstration Projects

Deployment of electric-drive vehicles and charging infrastructure

- Deployment of 13,000 electric-drive vehicles, light-duty through heavy-duty vehicles
- Installation of over 20,000 Level 2 charging sites and 250 (500V DC) Fast Chargers (500 ports)
- Collection of detailed operational data from vehicles and charging infrastructure
 - Driving and charge event data
 - Available via internet
 - Detailed data not available to DOE or through FOIA requests



Joint Demonstrations and Standards Development

U.S. DEPARTMENT OF
ENERGY

Energy Efficiency &
Renewable Energy

Navistar, Inc.

Manufacture and distribute a line of light- to medium-duty battery-electric trucks with initial deployment of 400 vehicles



South Coast Air Quality Management District

Develop a fully integrated, production plug-in hybrid system for Class 2b-5 (GVWR 8501-19,500 lbs) vehicles. Deployment of charging infrastructure in conjunction with demonstration of 378 Class 4-5 vehicles.



Smith Electric Vehicles

Develop and deploy 500 electric medium-duty trucks across a range of commercial and public-sector markets in diverse geographic and climatic areas



Cascade Sierra Solutions

Rebates for idle reduction technologies for Class 8 trucks, and electrification of 50 truck stops along major U.S. interstate corridors.



Recommended Practices for Plug-in Vehicles, Charging Equipment and Grid Connectivity

Activities

- ❑ Expand Advanced Electric Vehicle (AEDV) Codes & Standards to address identified areas of concern such as vehicle charging, smart chargers, and vehicle to grid connectivity.
- ❑ SAE standards committees participation
- ❑ Development and validation of standards



SAE Standards Committees

Safety **J2344** – Electric, HEV & Plug-in Vehicle Safety
J1766 – Crash Integrity Testing
J2578 – FCV Safety

**Connector/
inlet & EVSE** **J1772™** – PEV Conductive Charge Coupler
J2954 – PEV Wireless Charge

**Communi-
cations** **J2836™** – General Information (use cases)
J2847™ – Detailed Information (messages)
J2931 – Protocol (requirements)
J2953 – Interoperability

(Applicable standards; not exhaustive)

Clean Energy Research Center on Clean Vehicle Collaboration (CERC-CVC)

□ Partners

- U.S. Lead Institution: University of Michigan (Base)
- China Lead Institution: Tsinghua, Beijing Inst. of Technology
- Additional Partners:
 - Academic Partners in US and China
 - Government/State Entities
 - Committed Industry Partners in US and China

□ Thrust Areas

- Energy Systems Analysis, Technology Roadmaps and Policies
- Vehicle-Grid Interface
- Vehicle Electrification
- Batteries and Energy Conversion
- Advanced Biofuels and Clean Combustion
- Lightweight Structures

U.S.-China Joint Activities in Electric Vehicle and Battery R&D

Joint standards development, demonstrations, and technical roadmap
Public awareness and engagement

Bilateral Electric Vehicle Initiative & US-China Workshops

- Pre-competitive Battery Research
- Testing Protocols
- EV Testing, Demonstrations, and Infrastructure
- Joint Standards Development
- Public Education

Led by U.S. DOE & China's MOST

Bilateral CERC-CV

- Energy Systems Analysis, Technology Roadmaps and Policies
- Vehicle-Grid Interface
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Cooperative Agreement between U. of Michigan, Tsinghua U, and Beijing Institute of Tech.

Battery R&D, EV infrastructure



www.vehicles.energy.gov