



Green Tech Connect Forum

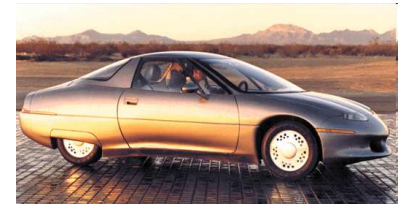
Session 5: Battery and Storage

Kristen Helsel, Director Electric Vehicle Solutions: August 4, 2009

About AeroVironment, Inc.

Company

- NASDAQ: AVAV
- Founded 1971
- Mid Sized - 650 employees



Business segments

- Unmanned Aircraft Systems
- Efficient Energy Systems
 - Propulsion Batteries and Chargers: EV, Lift Trucks, UAV & Marine
 - Micro Grid Energy Systems
 - Architectural Wind & Bi-Directional Power Systems



History

- AV core competency - Alternative energy systems
 - GM Impact, prototype for the EV-1
 - Solar powered aircraft – manned and unmanned
 - Leaders in small unmanned reconnaissance aircraft
 - 7 vehicles in Smithsonian Institute of Technology

“The EV-1 converted me. Fast, more reliable than my gas car and no gas stations. This at a time when oil was \$19 per barrel.”

EV-1 trial participant, 1996-1999



To be successful, EVs must approximate internal combustion engine (ICE) vehicles in performance, price and convenience

Battery Technology Focus – Motive Power

- **Motive Power Battery Systems**

- Passenger Vehicles: 8KWH to 25KWH
- Buses: 125KWH
- Underwater Vehicles: 160KWH
- Industrial Vehicles (Forklifts): 15KWH – 40KWH
- Small Unmanned Aircraft: < 1KWH
- Battery Technology
 - Lead Acid (Sealed and Vented): Forklifts & NEV
 - Nickel Metal Hydride: EV and specialty EV
 - Li-Ion: UAV and EV
 - Hybrid Energy Module: EV (patent pending)



- **Battery Management System**

- For all chemistries and topologies

- **High power battery chargers**

- 3.3 KW to 250 KW
- Bi-Directional



Examples of Battery Designs

■ Allison Heavy-duty Bus Pack

- Lead acid technology
- Parallel air cooled design
- Modular design



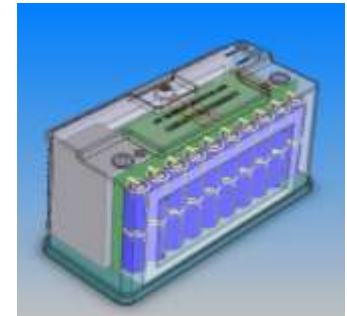
■ PolyStor Lithium Pack

- Liquid cooled design
- Integrated battery management
- Re-usable case design



■ DLCAPTTM Energy Storage System (Patent Pending)

- 900 W/Kg of power and 70 Wh/kg of energy
- >5 year life
- Safe – overcharge or over discharge protection
- Programmable voltage output



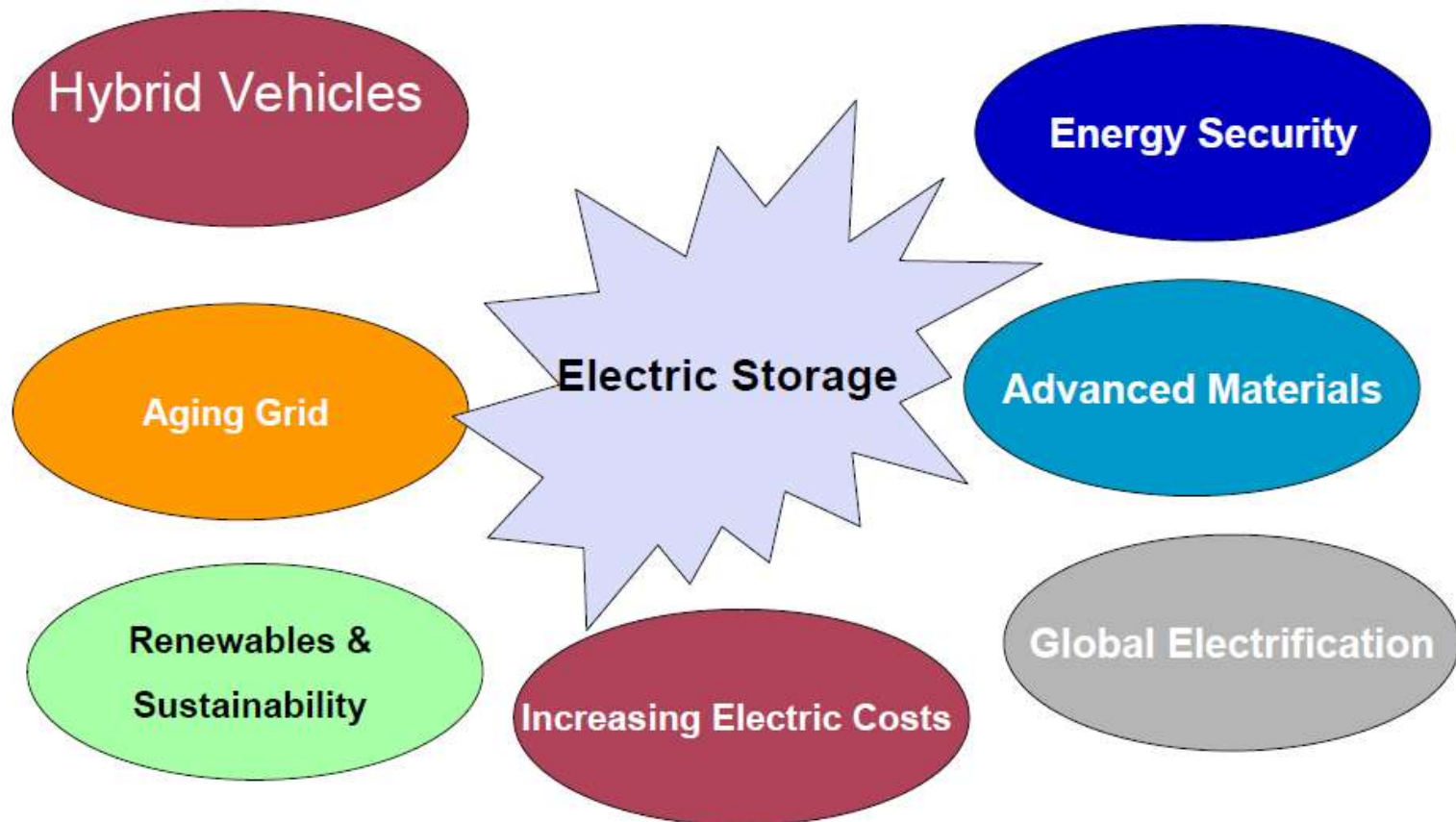
Battery Test and Research Facility

- **Battery test and research facilities**
 - Dedicated battery lab (over \$1M invested)
- **Charge algorithm development**
- **Lifecycle and performance testing**
- **Heat management research and innovation**
- **Advanced Battery Development and Validation**
- **Design Validation for OEM EV batteries**



Electric Storage Demand

A Convergence of Drivers - Creating an Opportunity for Innovation in Electric Storage



Grid Storage - AV Technology

- **HI-Power and other Micro-grid programs**

- Primary military today
- Conceptual Stage



- **DREAM – Hybrid Power Generation**

- Mobile 5 KW Solar Power Generator
- Operational Prototype



- **Bi-Directional Power Systems**

- Chargers and Power Processors
- 30KW – 1MW
- Grid to Battery – Battery to Grid
- Existing Product Line
- Compatible w/ all chemistries



Questions

