Battery Hardware in the Loop

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Sponsored by Lee Slezak

DOE Merit Review
28 February, 2008

U.S. Department of Energy
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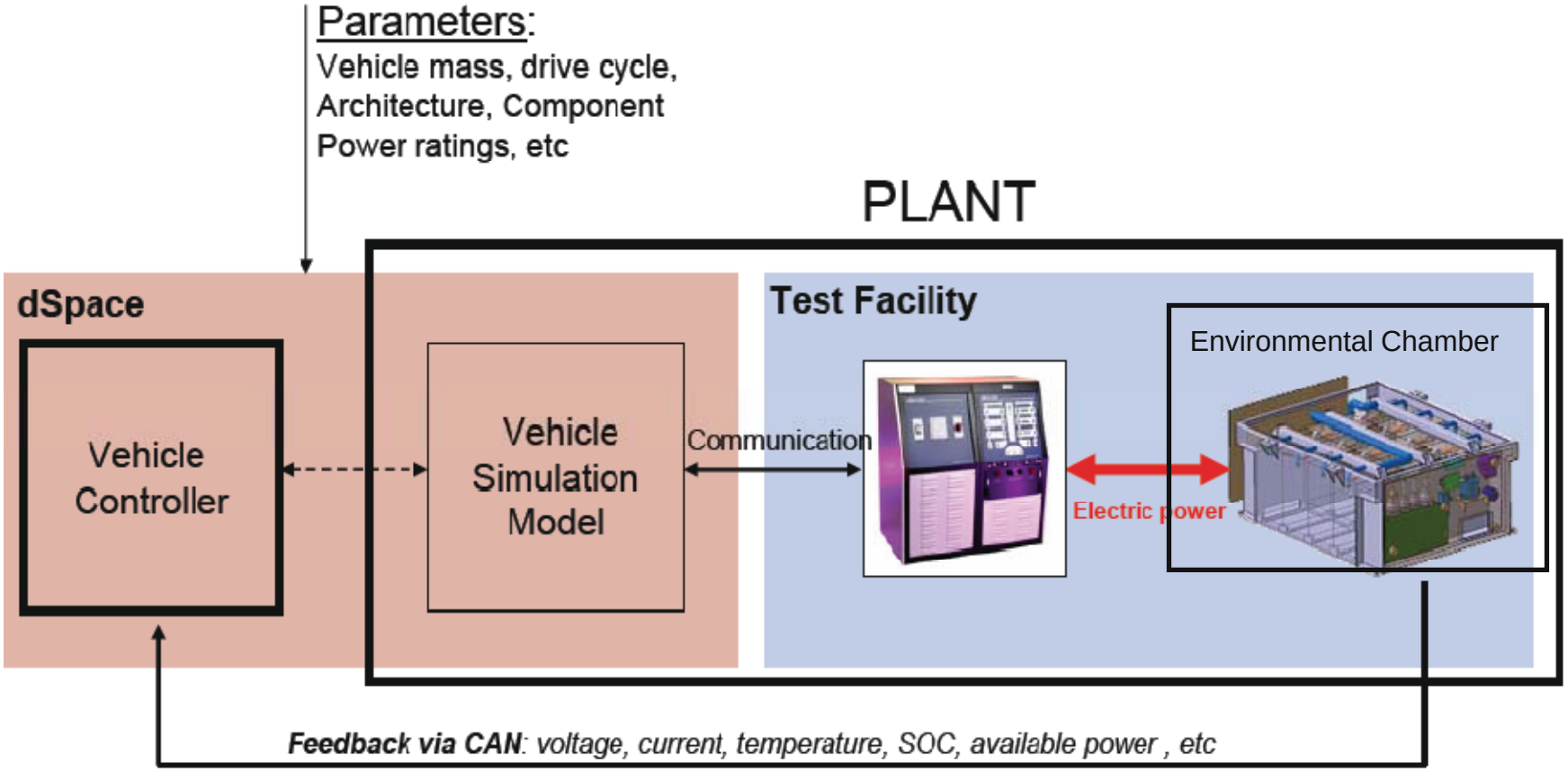
Battery Hardware in the Loop (BHIL) : A real battery (energy storage) in a virtual vehicle

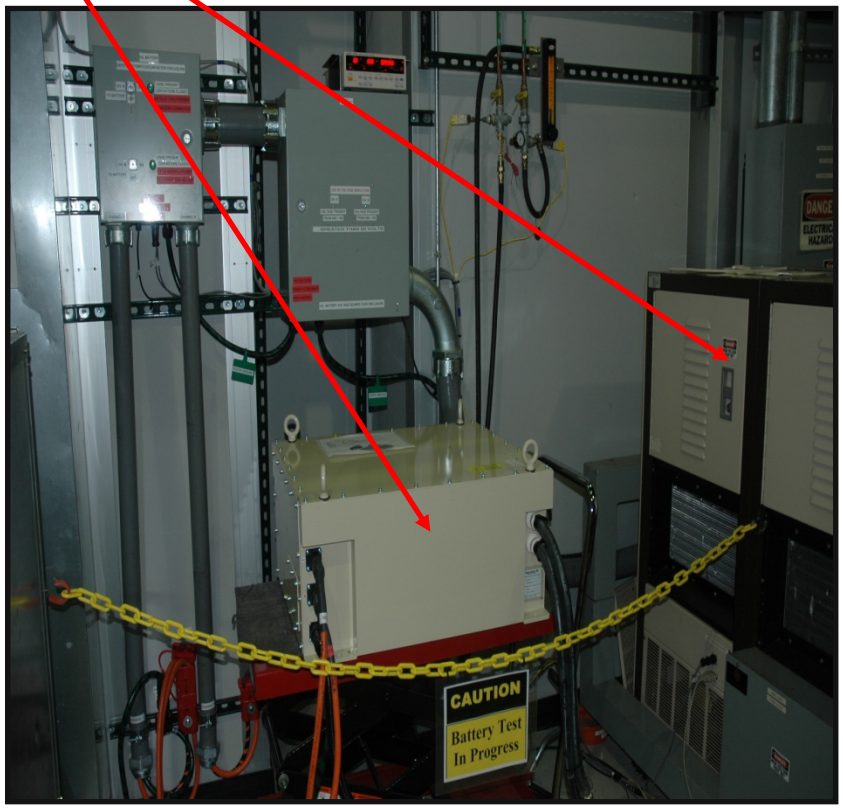


Hardware description

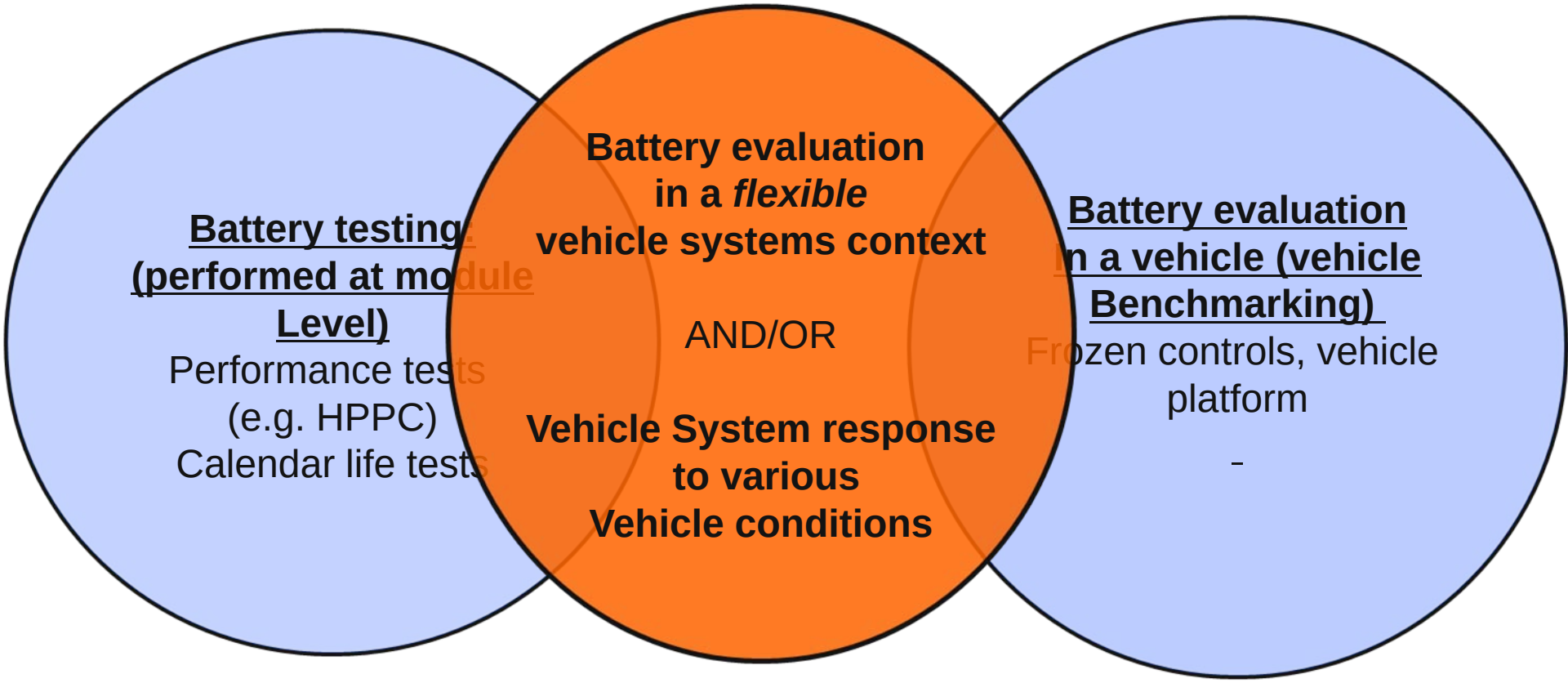
Virtual Vehicle (dSPACE), DAQ (NI – Compact Rio).

ABC-150 HVDC power supply

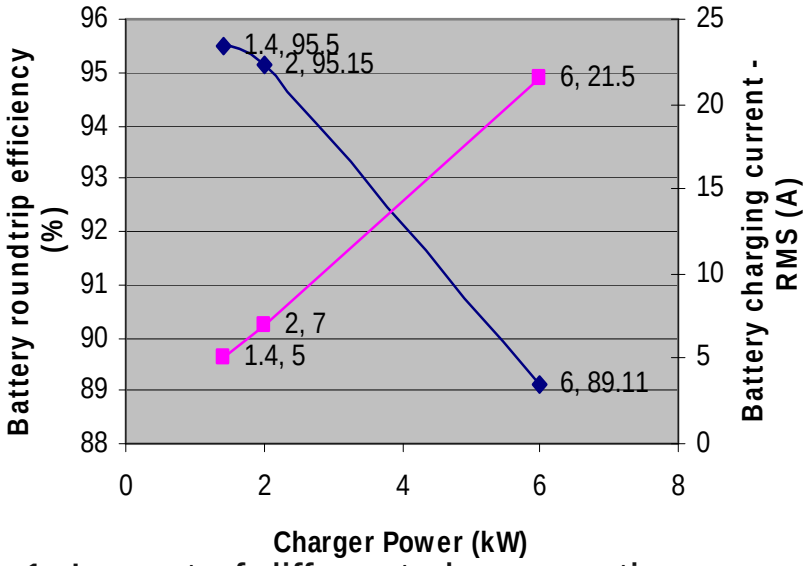
JCS – VL41M (72 cells, 260 V nominal, 41 Ah, liquid cooled)



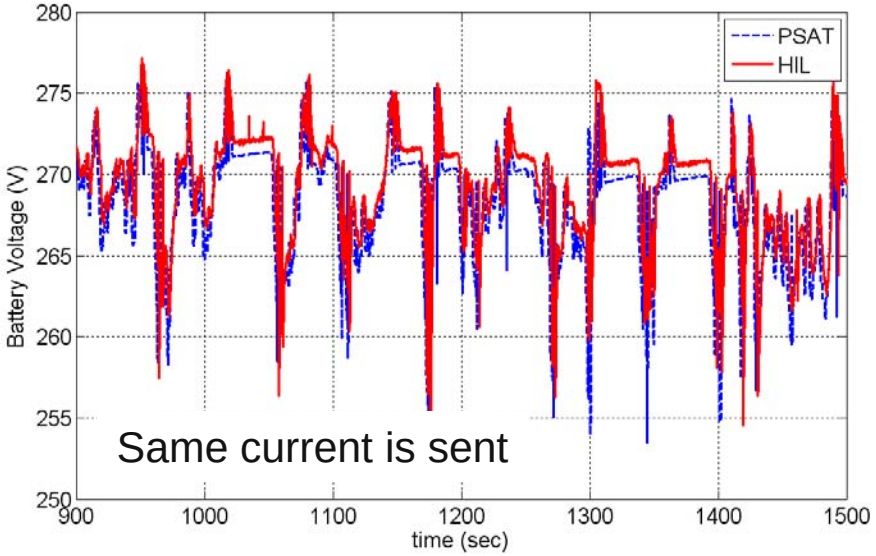
Significance of Battery HIL: component evaluation and systems integration



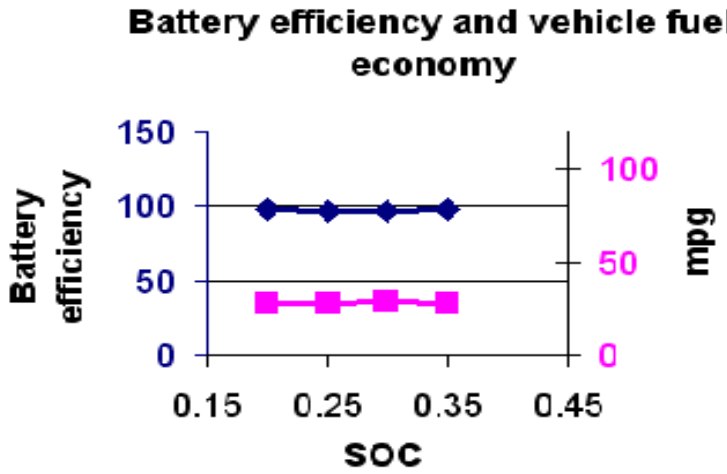
Accomplishments in FY07 – funding $ 400K



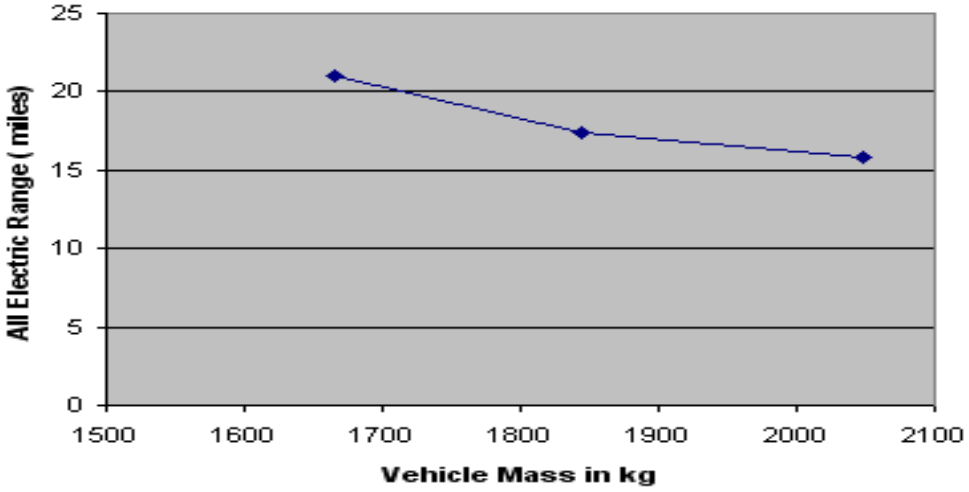
1. Impact of different charger ratings on battery 'roundtrip efficiency'.



2. Validation of ANL developed VL41M model With BHIL



3. Sensitivity of Charge sustaining FE to operation at different SOCs

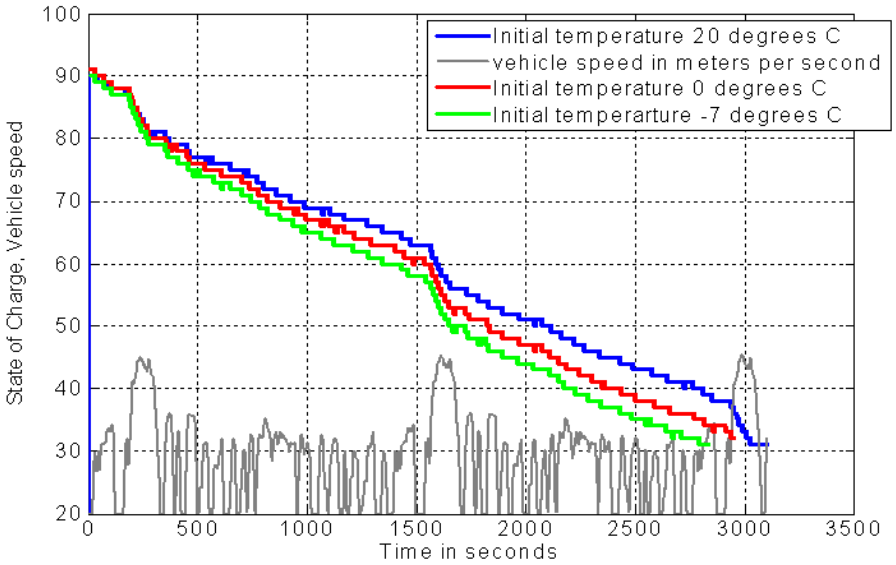


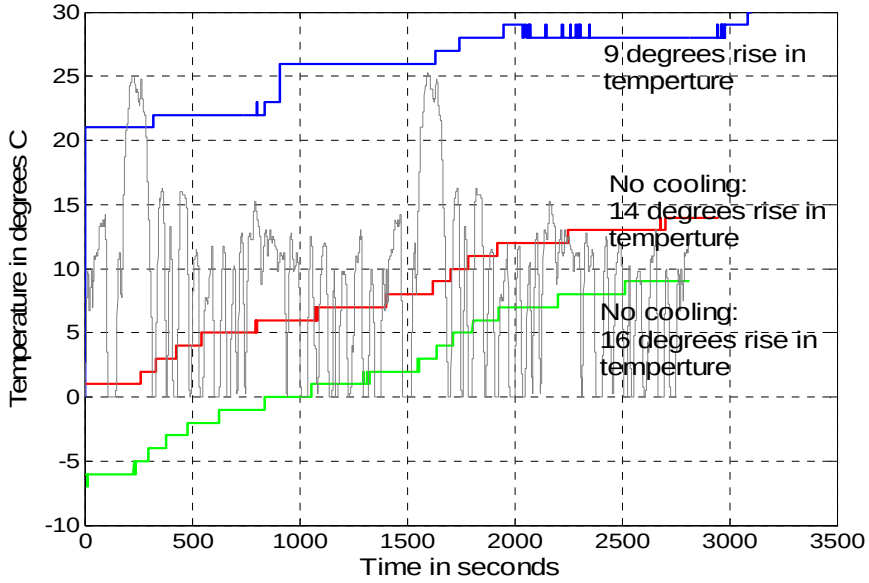
3. All electric range for a midsize, crossover and SUV with the VL41M at 20 $^{\circ}C$

Accomplishments in FY08 – total funding $ 500K- total funding spent - $ 150 K

- Battery HIL (phase 2): Expanded set-up with a state of the art DC power supply and environmental chamber.
- Impact of cold temperature on the EV range using a VL41M.
- WFO with SK Energy – impact of modifications of BMS on vehicle fuel economy and battery.

Initial battery temperature	EV range (miles)	Rise in temperature (degrees C)
20	17.3	9
0	15.7	14
-7	15	16





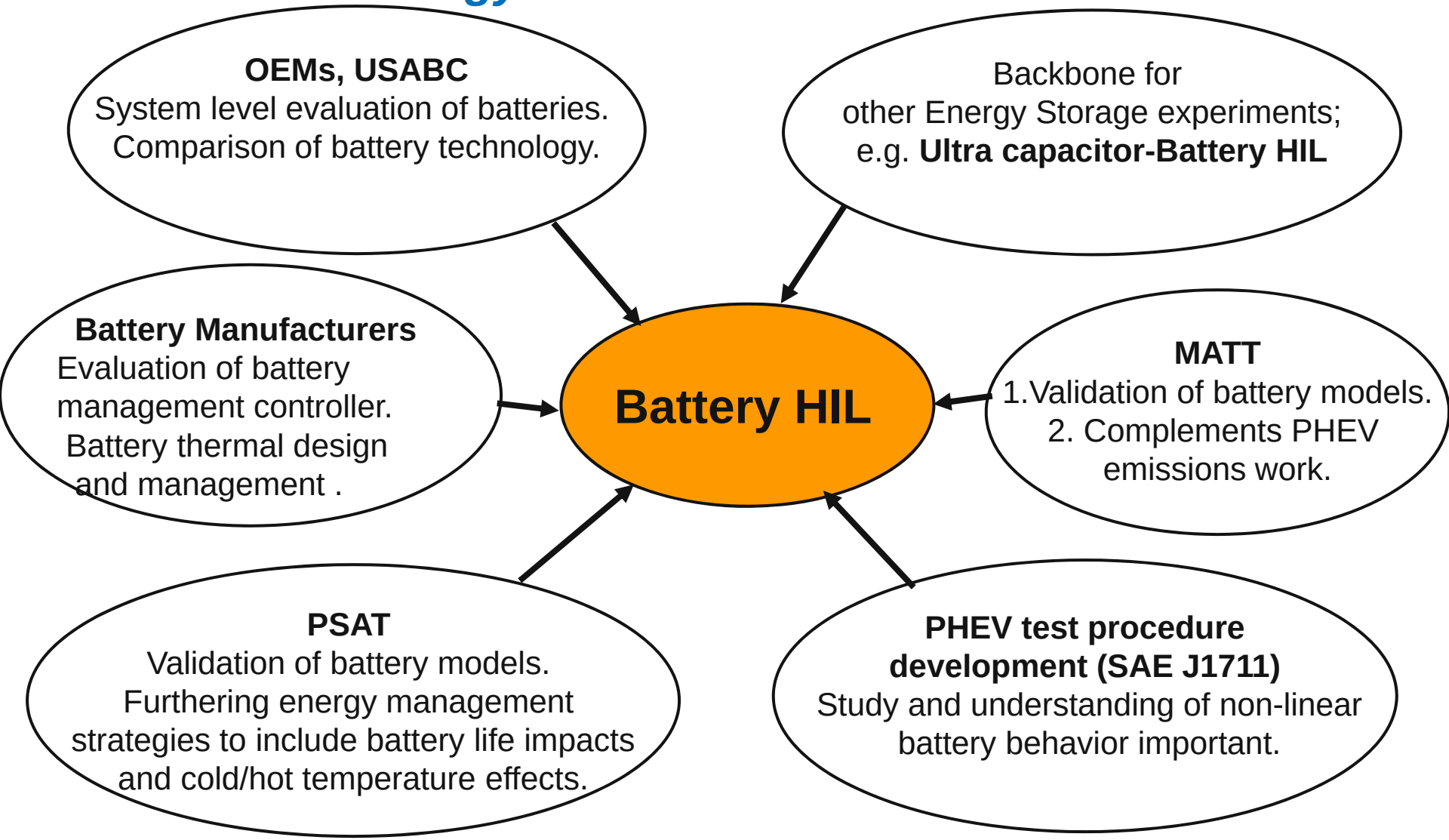
Future Work for FY08 and Beyond

- Impact of different blended mode strategies (rates of SOC depletion) on battery temperature rise (battery life) vis-à-vis improvement in petroleum displacement.

- Evaluation of vehicle controls and battery energy management for extreme cold and hot battery conditions to more fully investigate observations made with ANL on-road data on HEVs and PHEVs over wide extremes of ambient temperatures.

- Battery Evaluation in a systems context:
  - Evaluation of other PHEV batteries in a vehicle system.
  - Create a standard ‘evaluation matrix’ for comparison of batteries as a system, which includes
    - State of charge window
    - Temperature rise
    - Regen versus state of charge, temperature
    - Charging efficiency, time.

What is the Value of Battery HIL and Support to Other Vehicle Technology Activities



To Summarize:

- Advanced energy sources are the enablers of PHEV technology, and yet remain the main technical challenge.
- Battery issues such as sizing/chemistry effects on life, cost and extreme temperature performance are directly linked to battery usage in a vehicle (i.e., battery systems integration is as important as cell development).
- Battery HIL is an ideal tool for
  - Understanding the vehicle system integration issues that exist.
  - Evaluating the impact of cell level development on a system level.

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Publications

- Rousseau, A., Shidore, N., Carlson, R., Freyermuth, V., “Research on PHEV Battery Requirements and Evaluation of Early Prototypes, AABC 2007, Long Beach (May 2007).

- Neeraj Shidore, Lohse-Busch, H., Smith R., Bohn T., Sharer P., “Component and subsystem evaluation in a systems context using Hardware in the Loop” VPPC 2007, Arlington, TX (August 2007).

- Shidore, N., Lohse-Busch, H., Duoba, M., Bohn T., Sharer P., “ PHEV All Electric Range and fuel economy in charge sustaining mode for low SOC operation of the JCS-VL41M using Battery HIL” , EVS-23, Anaheim, CA (December 2007).

- Neeraj Shidore and Ted Bohn, “ Evaluation of the cold temperature performance of the JCS VL41M battery using BHIL”, to be presented at SAE World Congress 2008.