A 12V Start-Stop Li Polymer Battery Pack

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LG Chem Power / LG Chem

June 10, 2015

Project ID: ES249

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LG Chem at a glance

Energy Solution
- Lithium-Ion Batteries for
  - Mobile Phone, Laptop, Power Tool
  - Hybrid & Electric Vehicles
  - ESS

Petrochemicals
- ABS/EP
- NCC/Polyolefin
- PVC/Rubber
- Acrylate

IT & Electronics Materials
- LCD Polarizer
- LCD Glass
- OLED Materials
- Color Filter
**Battery Pack Concepts, Design and Prototype Builds**

**Battery Management Systems**

**Sales and Customer Support**

**$300M+ investment with ARRA funding**

**Groundbreaking: Summer 2010**

**In Production now**

LGCPI

Troy, MI

Sales & Pack R&D

LGCMI

Holland, MI

Cell Manufacturing
Overview

Timeline

- Project Start: Dec 1, 2014
- Project End: Nov 30, 2016
- Percent complete: 25%

Barriers

- Cold-Cranking Power
- Cost

Budget

- Total project funding: $1.82M
- DOE share: $0.91M
- Contractor share: $0.91M
- Funding for FY14: $75k

Partners

- LG Chem, INL, SNL, NREL
- Project lead: LGCP1
Objectives

- Develop a cell suitable for use in the 12V Start-Stop Battery.
- A key goal of the program is to lower the pack cost to close to the $220 target.
- Optimize the cell chemistry to meet the cold-cranking power requirement.
- Design a low-cost, simplified BMS.
- Deliver cells and battery packs to USABC for testing.
# 12V Start-Stop Battery Pack Goals

| **Discharge Pulse, 1s** | **Max current, 0.5s** | **Cold cranking power at -30 °C (three 4.5-s pulses, 10s rests between pulses at lower SOC)** | **Min voltage under cold crank** | **Available energy (750W)** | **Peak Recharge Rate, 10s** | **Sustained Recharge Rate** | **Cycle life, every 10% life RPT with cold crank at min SOC** | **Calendar Life at 30°C, 45°C if under hood** | **Minimum round trip energy efficiency** | **Maximum allowable self-discharge rate** | **Peak Operating Voltage, 10s** | **Sustained Max. Operating Voltage** | **Minimum Operating Voltage under load** | **Operating Temperature Range (available energy to allow 6 kW (1s) pulse)** | **Survival Temperature Range (24 hours)** | **Maximum System Weight** | **Maximum System Volume** | **Maximum System Selling Price (@100k units/year)** |
|-------------------------|----------------------|----------------------------------------------------------------------------------------|-------------------------------|-----------------------------|-----------------------------|-----------------------------|--------------------------------------------------|---------------------------------|-------------------------------|-----------------------------|-----------------------------|-----------------------------|-------------------------------|---------------------------------|-----------------------------|-----------------------------|-----------------------------|
| kW | A | kW (6 kW for 0.5s followed by 4 kW for 4s) | Vdc | Wh | kW | W | Engine starts/miles | % | Wh/day | Vdc | Vdc | Vdc | % | -30 to +52°C | -46 to +66 | kg | L | $ | $180 |
| **Units** | **USABC Not under hood target** | | | | | | | | | | | | | | | | | | | |
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Study cathode/anode materials properties to improve power.

Characterize and improve their performance especially cold-cranking power by optimizing electrode structures, electrolyte compositions, and separator features.

Develop low-cost battery pack designs (mechanical, thermal and electrical) to meet the USABC targets.
Initial work is focused on studying the impact of material attributes such as morphologies on power, high and low temperature behavior.

Composition and processing of electrodes are being optimized that will lead to high low temperature power.

Studying low-cost, efficient packaging and thermal solutions.

Focusing on the development of low-cost BMS.
Higher surface area cathode material results in lower cell resistance. However, they might lead to higher side-reactions especially at elevated temperatures, and hence we are optimizing these parameters.

Electrodes of lower porosities lead to lower cell resistance.

Initial studies on thermal management are being carried out now.

Low-cost BMS is being designed.
Higher surface area cathode material leads to lower cell resistance.
There is a reduction in cathode resistance as evidenced by EIS at low temperatures.
Effect of cathode porosity on cell resistance

The lower the porosity, the lower is the cell resistance.
Pack Studies:

- Designing efficient and low-cost packaging and thermal system.
- Cell frame and Inter-Connect Board design
- Vehicle-mounting
- Thermal strategy
- High and low-current connections
- Designing simplified, low-cost BMS.
Future Work

- Further optimization of cell characteristics to improve cold-cranking power, including:
  - Cathode and anode material properties.
  - Optimization of electrode structures in order to reduce cell resistance.
  - Extensive studies of electrolyte compositions to improve cold-cranking power.
  - Evaluation/optimization of separator properties.

- Optimize pack and BMS designs to lower pack cost.

- 1st Delivery of cells/packs to National Labs.
Development of a High Energy Density Cell and Module for EV Applications

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Overview

Timeline
- Project Start: Feb 11, 2015
- Project End: Feb 28, 2018
- Percent complete: %

Budget
- Total project funding: $3.28 M
- DOE share: $1.64 M
- Contractor share: $1.64 M
- Funding for FY14: 0k

Barriers
- Energy density
- Life
- Cost

Partners
- LG Chem, INL, SNL, NREL
- Project lead: LGCPI
Objectives

- Develop a cell and module suitable for use in the 200-Mile USABC BEV program.

- Two key goals of the program are to meet the USABC cell level targets of 750 Wh/l and $100/kWh.

- The objective will be to employ next-generation high energy density cathodes such as layered-layered compounds and Si anodes.

- Deliver cells and modules to USABC for testing.