Li-Ion Battery Cell Manufacturing

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LG Chem Michigan Inc.
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Project ID # ARRAVT001

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Program Overview

**Timeline**
- Start date: 09/01/2009
- End date: 05/31/2013
- Percent Complete: 20%

**Budget**
- Total Project Funding:
  - DOE Share: $151,387,000
  - LGCMI Share: $151,403,339
- Funding Received in FY10: $14.9M
- Funding for FY11 Project Funding: $9.2M

**Barrier**
- Environmental Permits
- Construction/Building Permits
- Investment Cost Increase

**Partners**
- DOE/NELT
- LG Chem Ltd.
- Architect & Engineering Firm
- Design Builder
- State of Michigan
- City of Holland, MI
Company: LG Corp. and LG Chem.

### LG Corp.’s Business Area

<table>
<thead>
<tr>
<th>Chemicals</th>
<th>Electronics</th>
<th>Comm. &amp; Services</th>
</tr>
</thead>
<tbody>
<tr>
<td>• LG Chem</td>
<td>• LG Electronics</td>
<td>• LG U+</td>
</tr>
<tr>
<td>• LG Hausys</td>
<td>• LG Display</td>
<td>• LG CNS</td>
</tr>
<tr>
<td>• LG</td>
<td>• LG Innotek</td>
<td>• LG Solar</td>
</tr>
<tr>
<td>Household &amp; Health Care</td>
<td></td>
<td>Energy</td>
</tr>
<tr>
<td>• LG Life Sciences</td>
<td></td>
<td>• HS Ad</td>
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<tr>
<td>• LG MMA</td>
<td>• Hiplaza</td>
<td>• LG</td>
</tr>
<tr>
<td></td>
<td>• Siltron</td>
<td>International</td>
</tr>
<tr>
<td></td>
<td>• Lusem</td>
<td>• LG Sports</td>
</tr>
</tbody>
</table>

- Established in 1947.
- LG Chem: Mother company of LG Corp.
- 52 Subsidiaries in LG Corp.

### Key achievements

<table>
<thead>
<tr>
<th>Number of employees in LG Corp.</th>
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</thead>
<tbody>
<tr>
<td>177K</td>
</tr>
<tr>
<td>186K</td>
</tr>
<tr>
<td>200K</td>
</tr>
</tbody>
</table>

### Revenue

- 2008: $82B (LG Corp.), $11.5B (LG Chem)
- 2009: $113B (LG Corp.), $12.4B (LG Chem)
- 2010: $128B (LG Corp.), $15.3B (LG Chem)

[Assumption: Fixed Exch. Rate: KRW1,100/USD]

**LG Chem**
- The largest vertically integrated chemical company in Korea.
- Engaged in research and development, manufacturing and marketing of petrochemicals, information and electronic materials.
- Produces ABS, PVC, synthetic rubbers, specialty polymers and other petrochemical products; lithium-ion rechargeable batteries for portable electric application, advanced rechargeable batteries for automotive application, LCD polarizer, PDP filters, and other information and electronic materials.

**LG Chem Michigan Inc. (“LGCMI”)**
- A wholly-owned North American subsidiary of LG Chem.
- Established in October, 2000. (Formerly known as Compact Power, Inc.)
- Manufactures lithium ion battery cells for automotive application at the $303 million production facility in Holland, Michigan.

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Company: LG Chem’s Vision & Core Values

**Vision**
To be a global leader -
Growing with customers by providing innovative materials and solutions

**Core Values**
- Customer Value Creation
- Execution
- Mutual Respect
Objective: Li-Ion Battery Cell Manufacturing Facility

- To design, construct, start-up and test a production facility for Li-Ion Polymer Batteries in Holland, Michigan.

- After starting assembly operations in 2012, an expansion of production capability will continue through 2013 with the addition of a high volume electrode manufacturing line and more assembly lines.

- When it reaches full-scale operation in 2013, more than 390 direct employees (Operators, Engineers, Management & Administration staff) will be working at the facility.
## Milestones

<table>
<thead>
<tr>
<th>Date</th>
<th>Milestones</th>
</tr>
</thead>
<tbody>
<tr>
<td>02/2010</td>
<td>DOE Grant Award</td>
</tr>
<tr>
<td>03/2010</td>
<td>Completion of General Contractor Selection</td>
</tr>
<tr>
<td>03/2010</td>
<td>Completion of DCAA Audit</td>
</tr>
<tr>
<td>06/2010</td>
<td>Completion of EVMS Set-Up</td>
</tr>
<tr>
<td>06/2010</td>
<td>Groundbreaking followed by Official Groundbreaking Ceremony</td>
</tr>
<tr>
<td>12/2010</td>
<td>Completion of Steel Erection</td>
</tr>
<tr>
<td>02/2011</td>
<td>Completion of Enclosure</td>
</tr>
</tbody>
</table>

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To achieve the program objective, LGCMII’s project will be performed in 3 phases.


- Establish and maintain plans to ensure program performance to requirements, and ensure proper reporting and accountability to meet Award requirements.


- Construct buildings to create a domestic U.S. based advanced lithium-ion battery cell manufacturing capability.

Phase 3: Equipment Installations and Validation of Production Processes (07/2011 – 03/2012)

- Assure integration with other interfacing processes and systems to minimize production disruptions.
Approach: Utilization of Technological Advantage

LG Chem’s Li-Ion battery technology, utilizing laminated packaging with mixed cathode chemistry and Safety Reinforced Separator (SRS™), offers a number of advantages including the following:

- **Unique design (Stacking of Plates & Folding)**
  - High rate capability (easy electric current collection)
  - More suitable for scaling-up (handling of long electrodes not required)
  - Maintains dimensional stability during cycling
  - Proven technology in mass production through manufacturing of cells for consumer applications

- **Robust laminated packaging design**
  - Simple, more reliable and less expensive manufacturing
  - Simpler to change cell footprint

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Approach: Technical Advantage

• Unique Design (Stacking of Plates & Folding)

Lead film (insulation tape)
Positive terminal

Negative terminal

Stack and Folded cell

Bi-cell

SRS™

Laminated film

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**Approach: Technical Advantage**

SRS\(^\text{TM}\) provides superior abuse-tolerance

1. By preventing internal short circuit
2. By improved thermal and mechanical strength

- Has ~6x the puncture strength of conventional separator

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**Technical (Separator)**

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<table>
<thead>
<tr>
<th>Components</th>
<th>Materials</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cathode</td>
<td>Mn-Spinel based</td>
</tr>
<tr>
<td>Anode</td>
<td>Graphite or Amorphous-carbon</td>
</tr>
<tr>
<td>Separator</td>
<td>$\text{SRS}^{\text{TM}}$</td>
</tr>
<tr>
<td>Electrolyte</td>
<td>LiPF$_6$ in Organic solvents (Gel type)</td>
</tr>
<tr>
<td>Packaging</td>
<td>Laminated</td>
</tr>
</tbody>
</table>
Accomplishments & Progress

- Completion of Conceptual Design (03/2010)
- Project Announcement in the City of Holland (03/2010)
- Completion of Design Builder Bidding/Selection Process (03/2010)
- Completion of Land Acquisition (05/2010)
- Groundbreaking (06/2010)
- Construction & Environmental Permits/Approval (06/2010)
- Completion of Detailed Due Diligence (9/2010)
- Completion of Design Development (10/2010)
- Completion of Steel Erection (12/2010)
- Completion of Enclosure (02/2011)
Accomplishments & Progress

- The DOE Grant Nomination (10/2009)
- Environmental Assessment Report for the NEPA Compliance (12/2009)
- Completion of the DOE Grant Negotiation (02/2010)
- The DOE Grant Award Announcement (02/2010)
- Project Kick-off Meeting (03/2010)
- DOE Merit Review Presentation (06/2010)
- Completion of Definitization (07/2010)
- Completion of EVMS Set-Up (06/2010)
Accomplishments & Progress

- Project Announcement in the City of Holland (03/2010)
- Beginning of the Office Staff Hiring (04/2010)
- Relocation of the Management Office to Holland, MI (06/2010)
- On-Site Project Office Set-Up (06/2010)
- Groundbreaking (06/2010) and the Groundbreaking Ceremony (07/2010)
- Beginning of the Hiring Process of Engineers (06/2010)
- Official Corporate Name Change from Compact Power, Inc. to LG Chem Michigan Inc. (09/2010)
- LGCMII’s First Job Fair (04/2011)
Accomplishments & Progress

LG Chem's Project Management & Planning, Construction, Equipment Installation & Validation are on schedule as of February 28, 2011.

<table>
<thead>
<tr>
<th></th>
<th>2009</th>
<th>2010</th>
<th>2011</th>
<th>2012</th>
<th>2013</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>3Q</td>
<td>4Q</td>
<td>1Q</td>
<td>2Q</td>
<td>3Q</td>
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<tr>
<td>Project Management &amp; Planning</td>
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<tr>
<td>Construction</td>
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<td>Equipment Installation &amp; Validation</td>
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<td>9</td>
</tr>
</tbody>
</table>

**Note:** Project progress rates for (i) Project Management & Planning, (ii) Construction, and (iii) Equipment Installation & Validation are calculated based on the EVMS report standard.
Collaborations/Partnerships

Level of collaboration and support from the public and private sectors have been enormously great.

- **DOE/NETL**
  - Clear guidelines for the DOE billing and reporting requirements
  - Quick responses to specific inquiries

- **State of Michigan**
  - Financial incentives (=tax credit) to LG Chem Michigan Inc.
  - Coordination with state agencies (e.g., environmental permits)

- **City of Holland**
  - Support and assistance in various areas (e.g., road expansion, site preparation)
  - Renaissance zone designation in coordination with the state of Michigan

- **Private Sector Partnership**
  - Timely co-operation and excellent support in the various stages of the project

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Future work

To successfully complete the project, LGCMI’s future work shall include:

- Completion of Main Utility Set-Up.
- Completion of Building Construction (i.e., building shell, interior & fit-up).
- Installation of Manufacturing Equipment.
- Validation of Separator, Assembly and Electrode Equipment.
- Test Running of the Entire Manufacturing Process.
- Production of battery Cells for Validation.
- Completion of Plant Operator Hiring.
- Extensive Training of the Plant Staff and Operators (i.e., safety, efficient manufacturing, production operations, maintenance, information security).
Summary

- LG Chem/LGCMII has not encountered any significant issues that can become hindrances to its project progress. The project has been on track since its launch.

- LGCMII has been receiving tremendous support from federal, state and municipal authorities.

- LG Chem has a successful track record of developing and manufacturing Li-Ion polymer batteries for electric and hybrid vehicles. LG Chem is confident that it can successfully accomplish the project by utilizing its technological advantage.

- LG Chem’s proven track record is evidenced by 9 major customers in the world (as of March 2011).

- The successful completion of this project will create more than 390 direct jobs. In addition, it will reduce U.S. foreign oil dependence.