

2011 DOE Vehicle Technologies Program Review:

GM Li-Ion Battery Pack Manufacturing



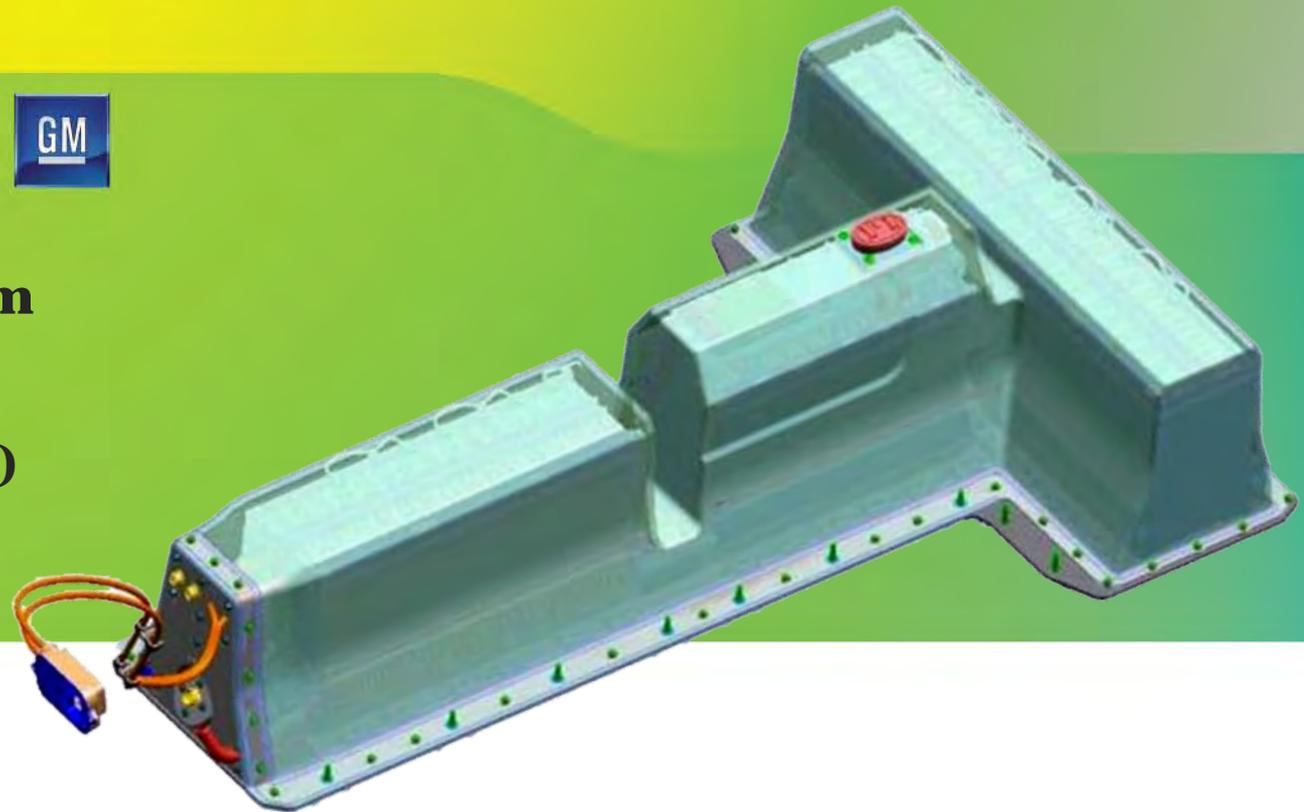
U.S. DEPARTMENT OF
ENERGY



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**General
Motors LLC (GM)**

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OVERVIEW

GM Li-Ion Battery Pack Manufacturing

Timeline

- Start: August 2009
- Finish: September 2013
- Percent Complete: 38%

Budget

Total Project Funding: \$234.8M

- DOE share: \$105.7 M
- GM share: \$129.1 M

Funding received: \$40.1M

- FY10: \$28.7M
- FY11: \$11.4M

Barriers

- Consumer acceptance and new technology implementation
- Product cost

Partners

- University partnerships in continuous improvement activities

RELEVANCE

Project Impact on ARRA Goals

- Aid in the nation's economic recovery by creating U.S. based manufacturing jobs
 - GM will create and retain jobs in manufacturing and engineering
 - GM estimates as many as 100 advanced technology jobs in the Brownstown Battery Assembly plant when ramped to full capacity
 - Jobs will be created and retained at machinery and equipment suppliers and battery component suppliers



RELEVANCE

Project Impact on ARRA Goals

- Accelerate production of Electric Vehicle (EV) drive systems
 - In 2010, GM started production of battery packs for the Chevrolet Volt
 - Additional portfolio entries are underway to respond to market demand and to increase overall volume
 - GM's EV production will substantially reduce petroleum consumption and contribute to our nation's energy independence
- Establish manufacturing capacity for cost-effective, high-volume battery pack production to support introduction of EVs
 - The Chevrolet Volt's battery pack is designed for high-volume production
 - To maximize volume and reduce cost, component sharing with hybrid vehicles is maximized
 - Parallel work on next-generation systems will accelerate cost reduction and increase volume capability

RELEVANCE

Specific Project Goals and Objectives

Overall project goal is to establish and validate production capability for GM Li-Ion Battery Pack Manufacturing with the following specific objectives

- Establish and execute plans to ensure performance to requirements and proper reporting and accountability
- Establish and validate production capability for multiple battery pack manufacturing programs in GM's portfolio plan
- Provide specialized workforce training in new battery pack manufacturing technology
- Provide continuous improvement and innovation cycles to move battery pack technology down the cost curve

FY11 efforts focus on capacity expansion of Chevrolet Volt battery pack manufacturing, continuous improvement and continued planning for subsequent battery pack programs

APPROACH

Proven Methods for Successful Launch

- Utilize proven, industry-standard and GM internal processes for product launch and manufacturing validation
 - Production Part Approval Process (PPAP)
 - GM's Global Vehicle Development Process
 - GM's Global Launch Process
- Provide specialized training via classroom, web-based and on-the-job activities
 - Focus on Health and Safety, Global Manufacturing Systems, Technical Operation and Maintenance, and Production Operations
- Provide continuous improvement and innovation cycles
 - Focused projects using engineering analysis and process testing on critical areas to improve quality, manufacturing flexibility, and cost

Note: Battery pack manufacturing operations are installed in an existing facility, NEPA was submitted with grant application.

APPROACH

DOE Project Milestones

Milestone criteria is per DOE definition and instruction.

2009/2010 Milestones have been successfully completed per established timeline.

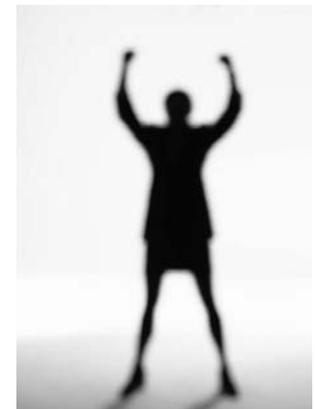
	Q2 FY2011 (Jan-Mar 2011)	Q3 FY2011 (Apr-Jun 2011)	Q4 FY2011 (Jul –Sep 2011)	Q1 FY2012 (Oct-Dec 2011)	Q2 FY2012 (Jan-Mar 2012)
Line 1, Phase 2	100% Equip Ordered	100% Equip Installed	100% Line Installed	100% Line Validated	1 st Production Unit Complete Target Production Rate Achieved Product Delivery for Testing
Line 1, Phase 3	100% Equip Installed	100% Line Installed	1 st Production Unit Complete	Target Production Rate Achieved	
Line 1, Phase 4		100% Equip Ordered	100% Equip Installed 100% Line Installed	100% Line Validated	
Line 2			100% Equip Installed	100% Line Installed	

TECHNICAL ACCOMPLISHMENTS

Volt Battery Pack Program In The Lead

- ✓ Engineering and plant team staffed, Workforce training complete to plan
 - *Cumulative GM jobs retained or created based on ARRA guidelines: 69.6 FTE as of Q1 FY2011*
- ✓ Manufacturing process equipment and tools for initial capacity have been designed, constructed, installed and validated at Brownstown site.
- ✓ All production systems installed and validated for Model Year (MY) 2011 initial capacity
- ✓ Component suppliers have reached full PPAP status
- ✓ Achieved Start of Regular Production for MY2011 Volt battery pack
- ✓ Built 2 battery packs for testing, completed witness testing on MY2011 Volt battery pack
- ✓ Refurbishment processes and equipment procured, installed and validated
- ✓ Equipment, processes and people ready to ramp production to next volume level
- ✓ Planning, procurement and installation is underway for capacity expansion and model year enhancements
- ✓ Preproduction builds underway for model year enhancements

TAKE HOME: Chevrolet Volt Battery Pack Program initial SORP successful, poised to ramp volumes to meet market demand. Implementation directly supports ARRA goals and objectives.



GM BROWNSTOWN BATTERY ASSEMBLY PLANT

2010 - 2011
Highlights



2011 Chevrolet Volt Honors



OnStar MyLink
Volt Mobile App



"TOP PRODUCTS" Award

Popular Mechanics
EDITOR'S CHOICE AWARD



TECHNICAL ACCOMPLISHMENTS

Future Battery Pack Programs Expand Lineup

- ✓ Process planning for future battery pack programs continue
- ✓ Preproduction builds continue, manufacturing learnings in-process
- ✓ Design for Manufacturability concepts incorporated into product design
- ✓ Equipment procurement is in process to meet program timing
- ✓ Preproduction build equipment and processes are installed and operational at Brownstown site

TAKE HOME: Future Battery Pack Programs are on track to GM portfolio plans. Co-location of preproduction builds at Brownstown heightens engagement and provides a solid foundation for ongoing manufacturing validation.

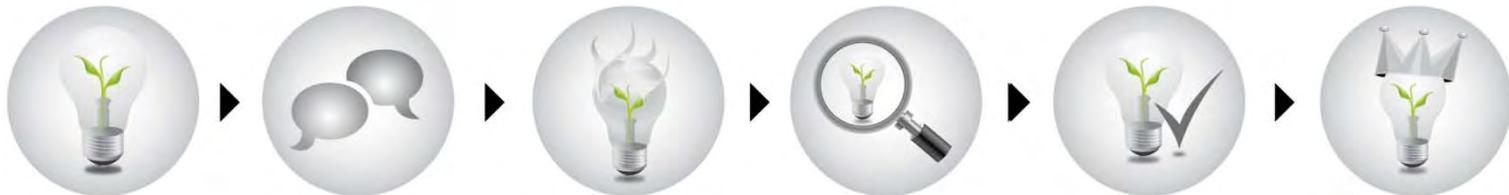


TECHNICAL ACCOMPLISHMENTS

Continuous Improvement Enhances Launch

- ✓ Supporting equipment and facilities are operational.
- ✓ Ongoing Continuous Improvement activities include:
 - Joining Manufacturing and Quality Processes
 - Battery Design For Assembly
 - Battery Assembly Process Variation Reduction
 - Assembly Tooling Durability
 - Battery Charging & Diagnostic Testing
 - Assembly Process Improvement
- ✓ Continuous improvement deliverables are being implemented in production process upon plant review and acceptance.

TAKE HOME: Implementation of Continuous Improvement projects are solving real challenges in real time.



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COLLABORATIONS/PARTNERSHIPS

Leverage key resources outside GM

- University collaborations are intended to support Continuous Improvement and Innovation Cycle activities.
- Universities bring unique qualities.
 - Fresh technical insight
 - Unconstrained solutions
 - Cross-industry experience
- Work with universities has begun. Project focus areas are in Joining Manufacturing and Quality Processes. Collaborations include:
 - New York Institute of Technology
 - University of Illinois
 - University of Michigan
 - University of Texas
 - University of Wisconsin
 - Wayne State University



FUTURE WORK

Increase capacity and prepare for the future

■ 2011

- Complete transition of preproduction build activities to Brownstown
- Continue preproduction builds for Volt EREV model year enhancements and future battery pack programs
- Provide increased Chevrolet Volt battery pack capacity as needed for market demand
 - Continue plant staffing and workforce training
 - Continue the equipment/line installation and manufacturing validation for the Chevrolet Volt battery pack future phases.
- Implement continuous improvement results into production process
- Continue planning and equipment installation for future battery pack programs

■ 2012

- Continue expansion of Chevrolet Volt battery pack capacity as needed for market demand, increase plant staffing as required
- Implement continuous improvement results into production process
- Validate and achieve SORP for Volt EREV model year enhancements and additional battery pack programs
- Product “delivery” for witness testing

SUMMARY

GM Li-Ion Battery Pack Manufacturing

- **Relevance:** GM's Li-Ion Battery Pack Manufacturing project creates and retains jobs, establishes a US-based battery pack manufacturing capability, improves our energy independence, and drives significant advancement of electric vehicle battery pack technologies.
- **Approach:** A proven and disciplined approach is being utilized to accomplish the project goals.
- **Technical Accomplishments:** Significant progress is demonstrated by the production of Chevrolet Volt battery packs. Future battery pack program efforts are on track. Continuous Improvement activities are directly impacting quality, cost and throughput performance.
- **Collaborations:** University-based knowledge is strategically targeted to near-term production challenges.

*General Motors is committed to the success of
Electric Vehicles and Advanced Propulsion Technologies*