II. AMERICAN RECOVERY & REINVESTMENT ACT(ARRA) OF 2009

Integrated Battery Materials Production, Cell Manufacturing, and Battery Assembly Facilities

Battery Cell and Pack Assembly Facilities

Battery Materials Production Facilities

Battery Recycling Facilities

II. AMERICAN RECOVERY & REINVESTMENT ACT (ARRA) OF 2009

The American Recovery and Reinvestment Act of 2009 (ARRA) (Public Law 111-5) is an economic stimulus package enacted by the 111th United States Congress in February 2009. This Act of Congress is based largely on proposals made by President Obama early during his Administration and is intended to provide a stimulus to the U.S. economy in the wake of an economic downturn. The measures are nominally worth $787 billion and include federal tax cuts, expansion of unemployment benefits and other provisions, including domestic spending in education, health care, and infrastructure, including that in the energy sector.

As part of ARRA implementation, on August 5, 2009 President Obama announced $2.4 Billion in manufacturing grants to accelerate the manufacturing and deployment of the next generation of U.S. batteries and electric vehicles – by funding 48 new advanced battery and electric drive components manufacturing and electric drive vehicle deployment projects – including PHEV and EV demonstration and education projects – in over 20 states. The grantees were selected through a competitive process conducted by DOE and are intended to accelerate the development of U.S. manufacturing capacity for batteries and electric drive components as well as the deployment of electric drive vehicles to help establish American leadership in developing the next generation of advanced vehicles. The new awards included $1.5 billion in grants to U.S. based manufacturers to produce batteries and their components and to expand battery recycling capacity, distributed over all parts of the country. As shown in Figure II - 1, these grants cover a range of manufacturing areas including those associated with material supply, cell components, cell fabrication, pack assembly, and recycling. The recipients and amounts for the individual grants are listed in Table II - 1.

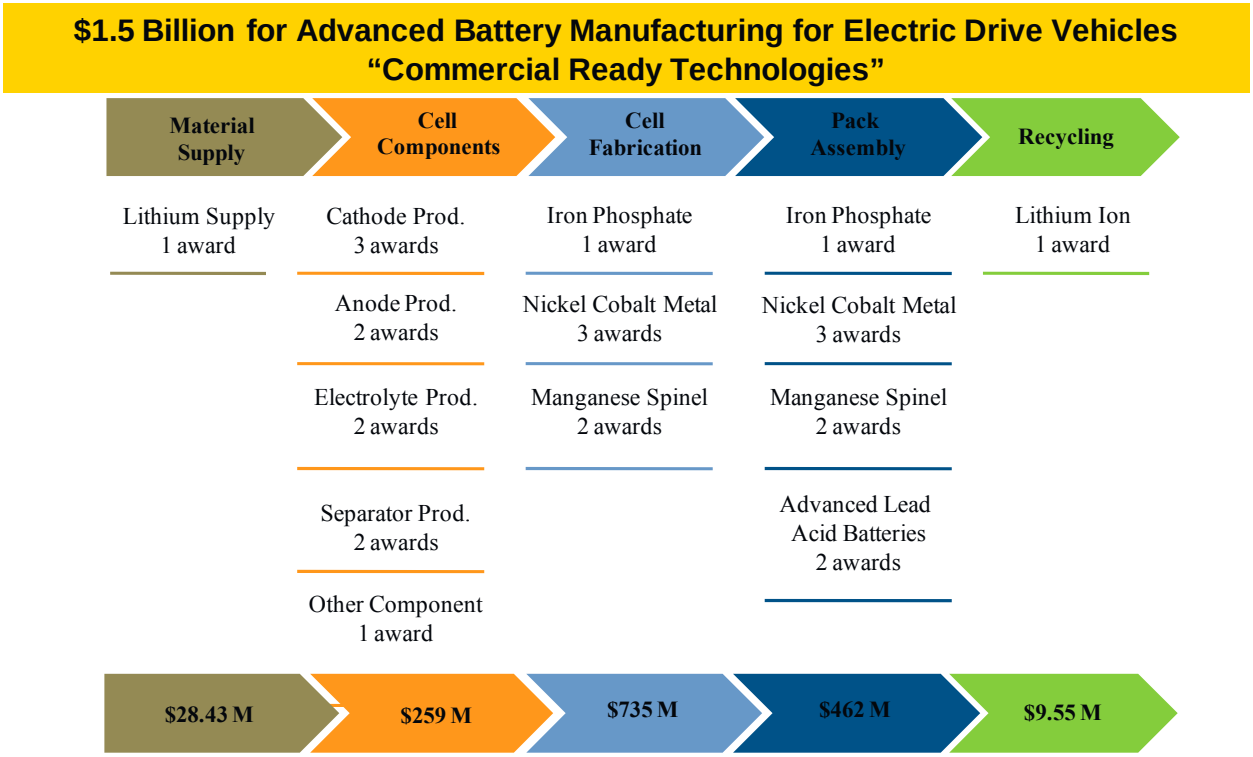

Figure II - 1: American Recovery and Reinvestment Act (ARRA) 2009 grants distribution for battery and electric drive manufacturing.

The rest of this section presents a brief summary of the individual ARRA grants.

Table II - 1: Recovery Act Awards for Electric Drive Vehicle Battery and Component Manufacturing Initiative.

Applicant	DOE Award (Dollars in Millions)	Project Locations	Technology
Cell, Battery, and Materials Manufacturing Facilities			
Johnson Controls, Inc.	$299.2	Holland, MI Lebanon, OR (Entek)	Production of nickel-cobalt-metal battery cells and packs, as well as production of battery separators (by partner Entek) for hybrid and electric vehicles.
A123 Systems, Inc.	$249.1	Romulus, MI Brownstown, MI	Manufacturing of nano-iron phosphate cathode powder and electrode coatings; fabrication of battery cells and modules; and assembly of complete battery pack systems for hybrid and electric vehicles.
KD ABG MI, LLC (Dow Kokam)	$161	Midland, MI	Production of manganese oxide cathode / graphite lithium-ion batteries for hybrid and electric vehicles.
Compact Power, Inc. (on behalf of LG Chem, Ltd.)	$151.4	St. Clair, MI Pontiac, MI Holland, MI	Production of lithium-ion polymer battery cells for the GM Volt using a manganese-based cathode material and a proprietary separator.
EnerDel, Inc.	$118.5	Indianapolis, IN	Production of lithium-ion cells and packs for hybrid and electric vehicles. Primary lithium chemistries include: manganese spinel cathode and lithium titanate anode for high power applications, as well as manganese spinel cathode and amorphous carbon for high energy applications.
General Motors Corporation	$105.9	Brownstown, MI	Production of high-volume battery packs for the GM Volt. Cells will be from LG Chem, Ltd. and other cell providers to be named.
Saft America, Inc.	$95.5	Jacksonville, FL	Production of lithium-ion cells, modules, and battery packs for industrial and agricultural vehicles and defense application markets. Primary lithium chemistries include nickel-cobalt-metal and iron phosphate.
Exide Technologies with Axion Power International	$34.3	Bristol, TN Columbus, GA	Production of advanced lead-acid batteries, using lead-carbon electrodes for micro and mild hybrid applications.
East Penn Manufacturing Co.	$32.5	Lyon Station, PA	Production of the UltraBattery (lead-acid battery with a carbon supercapacitor combination) for micro and mild hybrid applications.
Advanced Battery Supplier Manufacturing Facilities			
Celgard, LLC, a subsidiary of Polypore	$49.2	Charlotte, NC Aiken, SC	Production of polymer separator material for lithium-ion batteries.
Toda America, Inc.	$35	Goose Creek, SC	Production of nickel-cobalt-metal cathode material for lithium-ion batteries.
Chemetall Foote Corp.	$28.4	Silver Peak, NV Kings Mtn., NC	Production of battery-grade lithium carbonate and lithium hydroxide.
Honeywell International Inc.	$27.3	Buffalo, NY Metropolis, IL	Production of electrolyte salt (lithium hexafluorophosphate ($LiPF_6$)) for lithium-ion batteries.
BASF Catalysts, LLC	$24.6	Elyria, OH	Production of nickel-cobalt-metal cathode material for lithium-ion batteries.
EnerG2, Inc.	$21	Albany, OR	Production of high energy density nano-carbon for ultracapacitors.
Novolyte Technologies, Inc.	$20.6	Zachary, LA	Production of electrolytes for lithium-ion batteries.
FutureFuel Chemical Company	$12.6	Batesville, AR	Production of high-temperature graphitized precursor anode material for lithium-ion batteries.
Pyrotek, Inc.	$11.3	Sanborn, NY	Production of carbon powder anode material for lithium-ion batteries.
H&T Waterbury DBA Bouffard Metal Goods	$5	Waterbury, CT	Manufacturing of precision aluminum casings for cylindrical cells.
Advanced Lithium-Ion Battery Recycling Facilities			
TOXCO Incorporated	$9.5	Lancaster, OH	Hydrothermal recycling of lithium-ion batteries.

II.A Integrated Battery Materials Production, Cell Manufacturing, and Battery Assembly Facilities

II.A.1 ARRA-supported Production Facility Project (Johnson Controls, Inc.)

Christopher Johnson (NETL Project Manager)
Grant Recipient: Johnson Controls, Inc.

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Start Date: July 2009
Projected End Date: October 2014

Introduction

Johnson Controls is a leading supplier of hybrid and electric battery systems that make vehicles more energy efficient. In 2009, Johnson Controls received a $299.2 million matching grant – the largest grant awarded – from the United States Department of Energy under the American Recovery and Reinvestment Act (ARRA) to build domestic manufacturing capacity for advanced batteries for electric drive vehicles. The grant will help to build a U.S. advanced battery industry that allows for long-term growth, new jobs, and global leadership in the development and manufacture of today's hybrids and electric vehicles.

- Description of facilities: This project involves the construction or expansion of four facilities related to the Li-ion battery industry: Two Li-ion battery plants, a comprehensive technology center, and the expansion of a Li-ion separator facility
- Total Value of award: $299,177,757
- Percent of funds expended: 33% of the funds have been expended as of Sept. 30, 2011

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Progress and Current Status

Facility 1 – Meadowbrook Lithium-Ion Battery Plant

Johnson Controls Power Solutions new Meadowbrook facility in Holland, Michigan is the first in the United States to produce complete lithium-ion battery cells and systems for hybrid and electric vehicles, producing battery systems for U.S. based automakers, such as Ford's Transit Connect.

This project has led to the accomplishments towards the following Johnson Controls' goals:

- Investing in America
  - We are making an investment in the U.S. to build an advanced energy industry
  - Developing and bringing advanced products to market
  - Sourcing most equipment and materials in the U.S. to retain and create jobs in the domestic supply chain
- Investing in people
  - We are hiring engineers, technicians, and an experienced manufacturing workforce in the U.S.
- Delivering successes
  - Vehicles that use our batteries, like the Ford Transit Connect Electric, are reaching the public with great interest and success
  - We are building a domestic supply base, as well as anchoring foreign suppliers in the U.S.
  - Our plant has already begun domestic production of complete advanced battery systems this year, full ramp-up next year

Accomplishing Johnson Controls' goals of manufacturing excellence:

- Installing state-of-the-art equipment to deliver:
  - Automotive quality product
  - High volume capability
  - Significantly reduced cost
  - Minimized environmental impact
  - Processing efficiency
- Reducing costs
  - Domestic production will allow us to reduce shipping and duty costs from our European plant

- Domestic sourcing
- Design optimization
- Manufacturing process optimization
- Johnson Controls operational excellence, Best Business Practices, and continuous improvement

Accomplishing Johnson Controls' goals – sustainability:

- Certified U.S. Green Building Council LEED® gold factory
  - Our plant performs more efficiently with less impact on the environment
- Cooling for free
  - Our plant's cooling towers relieve significant pressure from our facility's chiller plant
  - As a result, the plant will have more consistent operating costs throughout the year
- Recovering heat
  - Heat from the battery formation process is captured and used in other areas of battery manufacturing
- Reclaiming what would have been wasted
  - We have designed our processes to reclaim materials used in manufacturing to save time, cost and energy

Facility statistics:

- Construction complete (99%)
- Equipment Installed (67%)
- Production has started
- Jobs: There are currently 95 permanent employees, with 320 expected at full capacity
- Jobs: 1000 temporary/construction workers were employed at this site during the construction phase

Facility 2 – Battery Technology Center / Battery Test Facility

Johnson Controls Power Solutions' newly renovated, state-of-the-art Battery Technology Center and Battery Test Facility is located at its Power Solutions headquarters in Glendale, Wisconsin. A specific portion of this facility was matched by a DOE grant to support the testing capabilities for component qualification, validation and launch of battery systems in support of customers' production programs including domestic supplier qualifications. The facility is the largest energy storage technical center in North America. More than 46,000 square feet of existing labs and office space was redesigned in the Battery Technology Center (BTC) to enhance labs used to support mass battery production for our customers.

The newly renovated facility features the most high-tech equipment available, including a CT Scanner, X-ray Diffractometer and Dry Room. The renovation marks the first time the facility has been majorly overhauled since 1983.

The Battery Test Facility, which was built in 2007, was also re-designed. Its size increased by 50 percent to 9,000 square feet and state-of-the-art equipment was installed for testing of advanced batteries in extreme conditions such as heat, cold and vibrations.

The ARRA grant and Johnson Controls' matching investment have so far created 60 jobs at the company's Power Solutions headquarters in Glendale.

Facility statistics:

- Construction complete (100%)
- Equipment Installed (100%)
- Production has started
- Jobs: 60 permanent fulltime positions have resulted from this project
- Jobs: 500 temporary/construction workers were employed at this site during the construction phase

Facility 3 – ENTEK Separator Expansion

Under this project, Entek is expanding their production capabilities of Li-ion separator production.

Engineering scope has been developed, but no construction has started on the new production line

All major equipment has been installed on existing production line, with some smaller upgrades remaining.

Long lead time equipment has been ordered for the new production line.

Facility statistics:

- Construction complete (0% on the new line)
- Equipment Installed (80%)
- Production has started
- Jobs: One additional employee has been hired, with 26 expected at completion
- Jobs: An estimated 30 temporary/construction workers will be employed to complete the construction phase at this facility

Facility 4 – Lithium-Ion Plant 2

Johnson Controls is in the planning phase to build and bring on-line a second Li-ion battery plant as a part of this program.

Facility statistics:

- Construction complete (0%)
- Equipment Installed (0%)
- Production has not started

- Jobs: 300 permanent fulltime employees will be employed when this facility is complete
- Jobs: An estimated 1000 temporary and construction workers will be employed to complete this facility

Pictorial Overview

Figure II - 2: Michigan Li-ion battery plant during construction – 1000 construction workers were employed in the construction of our Michigan plant.

Figure II - 3: Construction included the upfit of an existing building for Li-ion battery production, including the construction of new outbuildings to house equipment and materials.

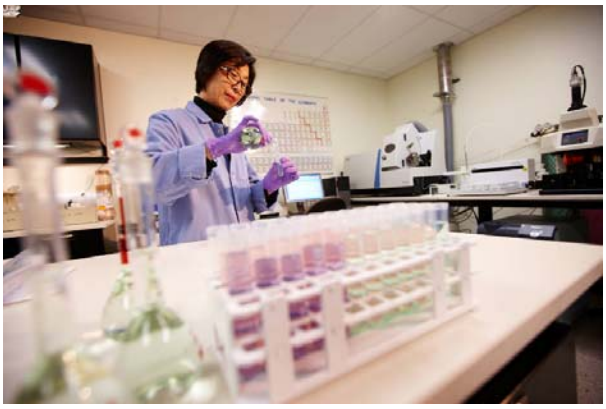

Figure II - 4: This project helped fund the material characterization and test facilities that are critical to support advanced energy production programs.

Figure II - 5: Johnson Controls' facilities include the equipment necessary to perform all relevant battery and cell tests, including cycle testing in controlled temperature environments.

Figure II - 6: Pilot scale equipment installed in controlled environments support the mass production programs.

Figure II - 7: Equipment – Pack assembly was up and running within 10 months of receiving the award from the Department of Energy.

Figure II - 8: Complete battery packs and systems are assembled domestically prior to being sent to the customer.

Figure II - 9: The Ford Transit Connect Electric features a 28 kWh Li-ion pack that was built in our Michigan plant.

Planned Work for FY 2012

In the remainder of the project:

- Our Holland, Michigan plant will be ramping production of advanced Li-ion cells
- We will be assembling complete battery packs with domestically produced cells
- Build and start production in a second Li-ion battery plant
- Meet hiring projections to support our plants and customer programs
- Continue to win production contracts to produce xEVs
- Continue to develop our technology roadmap to maintain Johnson Controls leadership position

Customers and Other Information

The following announced production contracts have been announced by Johnson Controls:

- Daimler S Class HEV
- BMW 7 Series Active Hybrid
- Azure Balance HEV
- Azure E450 Balance HEV
- Azure F550 Super Duty PHEV
- Transit Connect Electric
- BAIC EV
- Range Rover L405 HEV
- Geely EK-2 EV

II.A.2 Vertically Integrated Mass Production of Automotive Class Lithium-ion Batteries (A123Systems)

Ralph Nine (NETL Project Manager)
Grant Recipient: A123 Systems

Jesus M. Alvarez, Program Manager
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Watertown, MA 02472
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E-mail: jalvarez@krdon.com

Start Date: Decmber 3, 2009
Projected End Date: December 30, 2014

Introduction

- Description of facilities: this program will construct three (3) facilities: 1) Livonia- Cell Assembly/Module Pack; 2) Romulus 1- Coating, 3) Romulus 2- Cell Assembly/Module Pack
- Total Value of award: ($249M)
- Percent of funds expended: at the close of FY 2011 the funds provided by the DOE will amount to $124,926,918 which represents approximately 50% of the funds.

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Progress and Current Status

Facility 1 – Livonia (Cell Assembly/Module Pack)

- Construction complete (100%)
- Equipment Installed (100%)
- Production Started (100%)
- Jobs: permanent (487 full time employees)

Facility 2 – Romulus 1 (Coating)

- Construction complete (100%)
- Equipment Installed (100%)
- Production Started (100%)
- Jobs: permanent (115 full time employees)

Facility 3 – Romulus 2 (Cell Assembly/Module Pack)

- Facility construction has not commenced

Figure II - 10: Livonia Cell Assembly Line.

Planned Work for FY 2012

The general philosophy of manufacturing expansion is to cost-effectively meet the rapidly escalating customer volume needs while managing operational risk. This approach began with transferring our existing low-risk, mature process technologies from Asia, improve the processes and level of automation, and systematically increase throughput and lower costs over time. The first portion of the build-out involves the rapid deployment, using a "Copy Improve" approach wherein the initial Livonia cell and module/pack factory capacity will be installed with the same processes and equipment currently used in A123's Asian factories, while increasing the level of automation for material movement and process control to increase output and boost productivity.

The second portion of the build-out uses near identical equipment as what is used in the Livonia production factory, but with increased throughput at specific operations that are at low risk. This will be the "Factory of the Future" approach for high volume manufacturing (HVM) will further reduce cost and headcount through additional automation, data collection and improved manufacturing execution platforms. This approach will be used as A123 brings up the coating operations at the Romulus campus.

II.A.3 ARRA-supported Production Facility Project (Exide Technologies)

NETL Manager Name: Bruce W. Mixer, P.E.
Grant Recipient: Exide Technologies

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Milton, GA 30004
Phone: (678) 566-9211; Fax: (678) 566-9566
E-mail: larry.atkins@exide.com

Start Date: December 21, 2009
Projected End Date: December 22, 2012

Introduction

- Exide Technologies is expanding its manufacturing capacity for producing advanced batteries in existing U.S.-based battery plants. The project plan is to implement a combined increase in yearly production capacity of 1.5 million additional units at two of Exide's current manufacturing locations in Columbus, Georgia and Bristol, Tennessee.
- These advanced battery technologies are targeted to have an accelerated near-term impact (in high volume) for micro-hybrid vehicles, idle reduction commercial vehicles, and other strategic market segments.
- Total Value of award: $34,294,772
- Percent of funds expended: 73.67% as of 09/30/2011

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Progress and Current Status

This manufacturing expansion project involves two of Exide's global technologies: a Flat Plate Absorbed Glass Mat (AGM) design and a Spiral Wound AGM design, both of which will be manufactured with advanced carbon technology as required by customer specific advanced vehicle applications.

During the FY11 period of performance both of the project sites were in the Procurement and Implementation phase of the Project Management Plan. Significant progress has been made and will be summarized for each location in more detail below.

Facility 1 – AGM Flat Plate, Columbus, Georgia

- Construction complete (%) N/A - No facility construction funded by ARRA grant project.
- Equipment Installed (96%)
- Production Started (0%)
- Jobs: permanent (current = 35; at project completion, assuming full production = 200)

The Columbus project made significant progress over this reporting period – both in implementing the production operation systems, as well as in attracting interest from major OEM customers for the upcoming new product introductions. This reporting period began early in the Procurement and Implementation phase of the project during major procurement activities and proceeded through equipment installation, commissioning, and process validation. Near the end of FY11 all the major production operations were fully implemented and ready for production trials. During September 2011 the project shifted to production trials and the product validation phase which will lead to production start-up activities in FY12 and allow the successful and timely completion of the project.

The Columbus Expansion Team has continued to meet weekly via conference calls. Bi-weekly meetings were also implemented as necessary over the period to discuss the status of key equipment and major operations. A summary of the FY11 accomplishments by major expansion area follows in the paragraphs below.

Figure II - 11: New State-of-the-Art AGM Battery Assembly Operation in Columbus, Georgia Exide Battery Plant.

- Battery Assembly Expansion: A full new battery assembly operation was installed and implemented over the past reporting period. This includes a new cell group building machine and associated separator equipment, as well as, a new battery component assembly line and inline acid filling operation. This full line was procured as discrete equipment items, as well as sub-component operations and implemented incrementally throughout the period. At the end of FY11 the line was beginning production validation of

the new advanced AGM product types for new and existing OEM and OES customers – scheduled now through November 2011.

Figure II - 12: New World-Class Continuous Plate Manufacturing Operation in Columbus, Georgia Exide Battery Plant.

- Plate Manufacturing Expansion: Another department expansion has taken place in FY11 regarding the plate manufacturing operation. As well as several upgrades to existing lines, a full new automated continuous plate production line was installed and commissioned. With some equipment arriving as early as December 2010, and the remainder early in 2011, the line was commissioned in March 2011. Process validation followed and now the new line has been cleared for the ongoing product validation runs.

Figure II - 13: Optimized Lead Plate Curing Operation in Columbus, Georgia Exide Battery Plant.

- Plate Curing Expansion: The plate curing department expansion was also required for this project. A total increase of 36 new optimized curing ovens is being implemented. The first phase of this expansion began in January 2011 and was commissioned in June 2011. The second phase will be completed in early FY12.

Figure II - 14: Significant Additional Production Capacity in Battery Formation Department – Columbus, Georgia Exide Battery Plant.

- Formation Expansion: Another important area in the project plan requiring significant new operational equipment was the battery formation department. New charging rectification equipment began arriving in December 2010 and was in place by April 2011. Also, 61 new upgraded formation tables and all associated conveyors and infrastructure were incrementally installed and implemented, with commissioning completed in May 2011. The new expanded formation capacity is now ready to serve the product validation runs that are now underway.

Figure II - 15: Product Validation Trial Production has begun on the New Advanced AGM Battery Assembly Expansion Line – Columbus, Georgia Exide Battery Plant.

- Battery Production Status: The new expanded production capacity for advanced AGM battery production at the Exide Columbus, Georgia battery plant has now moved into the product validation phase of the Project Management Plan. A concentrated effort is now extending into FY12 to satisfy the growing (confidential) list of existing and prospective OEM customers for the upcoming new

advanced AGM battery products. The focus is to serve the new and developing US market demand for more robust batteries that will enable the introduction of competitively priced advanced-fuel saving vehicles. The start of actual production on the new expanded capacity operations is planned to begin by about January 2012.

Facility 2 – AGM Spiral Wound, Bristol, Tennessee

- Construction complete (%) N/A - No facility construction funded by ARRA grant project.
- Equipment Installed (83%)
- Production Started (0%)
- Jobs: permanent (current = 5; at project completion, assuming full production = 120)
- The Bristol project began FY11 in an existing empty building space and has made significant and steady progress over this reporting period. All of this period falls within the Procurement and Implementation phase which has included all the procurement activities, followed by equipment installation and debugging activities. Near the end of FY11 most of the major production equipment was installed and beginning debug and commissioning.
- Coordination of the Bristol project continued through weekly Implementation Team conference calls. In addition, the pace of personnel traveling to Bristol to assist in project implementation and equipment start-up has significantly increased. A summary of some of the FY11 accomplishments by production area follows below.

Figure II - 16: Emptied Building Site was readied for the New Advanced AGM Spiral Wound Battery Production Equipment.

- Existing Plant Site was Prepared: An available area in the existing Bristol, Tennessee Exide Battery Plant was cleared and readied early during the FY11 period. The plan was described as a "*Plant within a Plant*" concept with all manufacturing equipment for the new spiral wound AGM operation together in one area – not added to other existing battery departments.

Figure II - 17: New High Purity Lead Oxide Manufacturing Operation in the new AGM area in the Bristol, Tennessee Exide Battery Plant.

- Lead Oxide Manufacturing: A new dedicated lead oxide manufacturing operation was procured and all the equipment components were installed in the new AGM area in the Bristol project site. The equipment was delivered in June 2011 and completed commissioning in August 2011. At the end of FY11 the operation was beginning start-up and debug.

Figure II - 18: State of the Art Grid Manufacturing Operation in the new AGM Battery Operation in Bristol, Tennessee Exide Plant.

- Continuous Grid Operation: Two dedicated continuous grid production lines have been installed in the spiral wound AGM area of the Bristol plant. All of the equipment components for this operation are on site and equipment shakedown and validation has begun.

Figure II - 19: Automated Spiral Wound Plate Manufacturing Line in New Advanced AGM Battery Area in Bristol, Tennessee Exide Plant.

- Plate Manufacturing Operation: The highly automated continuous plate manufacturing component equipment was installed in the Bristol project site during this reporting period. Equipment validation is planned to begin in early FY12.

Figure II - 20: Overall View of new AGM Battery Production area in Bristol, Tennessee Exide Battery Plant.

- Spiral Wound AGM Battery Area - Summation: The FY11 reporting period covered a very busy time for the Bristol ARRA grant project site. Beginning early in 2011 with an empty space and progressing to the fully integrated and dedicated advanced battery manufacturing operation shown in the broad view photo above. Several of the contiguous operations are ready for final equipment validation runs in early FY12.

Planned Work for FY 2012

The focus of work moving into FY12 will involve considerable product qualification activity in the Columbus, Georgia project site for the first few months. After production begins near the end of the first fiscal quarter, the ramp up in production will proceed as additional customer requirements build incrementally throughout the rest of FY12. The project will extend into the first quarter of FY13 as originally planned.

The Bristol, Tennessee project site is following a similar pattern, however is several month later in the scheduled implementation plan due to slower customer response. Product validation is planned for the winter period of 2012 with first production by September 2012.

Other Information

Exide Technologies does not publicly discuss specific customers or other business sensitive information. As mentioned earlier we have been working with a number of OEM vehicle manufacturers to be ready to satisfy their advanced battery requirements for the upcoming new generation of fuel saving vehicles.

For the FY11 reporting period no actual production of new products has begun in the ARRA co-funded battery production sites and no public announcements have been made during this reporting period.

II.A.4 ARRA-supported Production Facility Project (East Penn Manufacturing Co., Inc.)

John G. Tabacchi (NETL Project Manager)
Grant Recipient: East Penn Manufacturing Co., Inc.

Robert P. Flicker (Program Manager)
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Start Date: December 2009
Projected End Date: November 2012

Introduction

Description of facilities: The objective of this project is the expansion of production capacities to manufacture high volumes of Advanced VRLA (Valve Regulated Lead-Acid) batteries and the UltraBattery, both proven commercially viable technologies. East Penn will use a recently constructed manufacturing plant that will be populated and fully developed with specialized battery manufacturing equipment.

- Total Value of award: $32,500,007
- Percent of funds expended: 73% of funds have been expended as of September 30, 2011 end of fiscal year 2011.

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Progress and Current Status

The non-ARRA funded and recently constructed 739,000 square foot manufacturing plant will be equipped with electrode formation, current collector and cell assembly equipment (suitable for both Advanced VRLA batteries and the UltraBattery), battery assembly equipment, and equipment for electrolyte filling, finishing, conditioning, and testing. Also, component production (containers and covers) and distribution facilities will be expanded to support the additional production capacities. No building construction is part of this project.

Facility 1 – Automotive Battery Plant A4 Equipment

At the present time 72% of the battery manufacturing equipment is installed. Production is currently at 45% of planned capacity.

Currently 146 direct permanent job positions have been created at this location with a total of 190 direct permanent job positions anticipated at project completion. At the present time 74 construction/contractor job positions have been retained. This is the maximum amount of retained jobs anticipated for this project. (Reference photos 1,2,3,4)

Facility 2 – Injection Molding Plants IM1/IM2 Equipment

At the present time 92% of the Injection Molding equipment is installed. Production is currently at 99% of planned capacity. Currently 59 direct permanent job positions have been created at this location with a total of 65 direct permanent job positions anticipated at project completion. At the present time 0 construction/contractor job positions have been retained. (Reference photos 5,6,7)

Facility 3 – Distribution Center Equipment

At the present time 0% of the equipment is installed. Production is currently at 0% of planned capacity. Currently no direct permanent job positions have been created at this location with a total of 5 direct permanent job positions anticipated at project completion. At the present time 0 construction/contractor job positions have been retained.

Planned Work for FY 2012

Anticipated work for this time period will include the installation, start-up and validation of:

- Southeast Baghouse #2
- Current Collector Fabrication Equipment – Final Phase
- Electrode Formation Ventilation – Final Phase
- Battery Valve Assembly and Testing – Final Phase
- Injection Molding Machines – Final Phase
- Cast On Strap/Injection Molding Tooling

Pictorial Overview

Figure II - 21: Facility 1 – Automotive Battery Plant A4 Equipment.

Figure II - 22: Facility 2 – Injection Molding Plants IM1/IM2 Equipment.

Figure II - 23: UltraBattery Test Vehicle (on site at East Penn Mfg).

These equipment functions are key components of this project that need to be completed to achieve project objectives. Our final planned annual production rate is 2,800,000 batteries. These batteries will be VRLA (Valve Regulated Lead-Acid) and the Ultra Battery, both proven commercially viable technologies. At the present time and at the end of FY 2012 (September) our current annual production rate is 1,250,000 batteries. Between the end of FY 2012 (September) and the end of program (November 2012) the last key equipment element will be made functional and validated which will allow East Penn to meet final planned production rate and project objectives. Based on current projections at the end of FY 2012 (September) direct job creation totals should be at 250 which exceeds our initial direct job creation totals for the entire project.

Other Information

Public Relations and Media

- **Reading Eagle Newspaper** – Release from last 3 years such as:
  - *"Battery plant in Berks gets $32 million in stimulus"* Thursday, August 6, 2009
  - "*East Penn wins Energy Dept. funding"* Wednesday, November 25, 2009
  - *"East Penn wins funds for Advanced BatteryResearch"* Wednesday, December 23, 2009
  - *"East Penn powering battery industry growth [Transportation officials says investment and recovery money will create up to 200 jobs]"* Saturday, July 17, 2010
- Channel 69 Television News – Grant project coverage
- **WEEU AM Radio** – Grant project coverage
- **Batteries International magazine** – Grant project and Advanced Battery Technological coverage
- **BEST magazine** – Advanced Battery Technological coverage
- **ALABC Newsletter article** – Involvement with organizations like the ALABC (Advanced Lead Acid Battery Consortium) and CSIRO (Commonwealth Scientific and Industrial Research Organization) and their venues for promotion add a higher level of project exposure among the scientific community.

Trade Shows: Multiple venues featuring signs and supporting content that highlights advanced battery projects supported by government funding

- Industry shows
- Customer events

Internal

- Repeated features in **company internal newsletter** distributed to over 6,000 employees
- **Open house displays** such as "UltraBattery Car" that features an implementation of advanced battery technology, supported by the DOE, for HEV use

Other

- **UltraBattery and Advanced VRLA battery brochures** educating and promoting technology and its benefits in applications that conserve fuel, reduce carbon emission, and create clean, renewable energy.
- **UltraBattery Car flyer** promoting UltraBattery use in HEV to reduce carbon emissions and conserve fuel
- **UltraBattery Test Vehicle** (on site at East Penn Mfg.) (See Photo #8)

II.B Battery Cell and Pack Assembly Facilities

II.B.1 ARRA-supported Production Facility Project (Dow Kokam MI, LLC)

Ralph Nine (NETL Project Manager)
Grant Recipient: Dow Kokam MI, LLC

John Pham
2125 Ridgewood Drive
Midland, MI 48642
Phone: 989-698-3304;
E-mail: jpham@dowkokam.com

Start Date: May 30, 2010
Projected End Date: January 31, 2013

Introduction

Dow Kokam, MI will construct a 400,000 square foot (SF) highly automated large-format battery manufacturing facility in Midland, Michigan.

This facility, Midland Battery Park, will use a proprietary and patented technology that will produce affordable advanced Lithium-ion batteries Superior Lithium Polymer Batteries (SLPB) for the electric vehicle (EV) and hybrid electric vehicle (HEV) markets.

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Progress and Current Status

This annual period began with completing the erection of the tilt up walls and ended with the building-exterior completed and the building-interior & systems nearing completion.

The clean room has been completed and the major equipment system purveyors: Kokam Co., Route JD Inc., and Noritake Co. Limited have completed design, design reviews, manufacture, and factory performance tests, and are proceeding to package and ship.

67% of the project budget has been expended or $212.9 million, primarily for process equipment engineering, technology licensing, progress payments on manufacturing equipment, completed construction of the building exterior, and construction of the building interior that is approaching completion.

Facility 1 – Midland Battery Park

- Construction complete (98%)
- Equipment Installed (61%)
- Production Started (0%)

Pictorial Overview

Figure II - 24: Midland, Michigan Manufacturing Facility – Dow Kokam, LLC.

Figure II - 25: Midland, Michigan Manufacturing Facility – Dow Kokam, LLC (cont'd).

Planned Work for FY 2012

The work to be done in FY 2012 will include all building construction to be completed by 12/31/2011, the delivery and installation of all line equipment by approximately 2/28/2012, and the testing of equipment and first production unit to be completed by 6/15/2012. Total project completion by 1/31/2013

Planned invoice costs to the Department of Energy in FY 2012:

- 1st quarter of FY 2012 $39,348,371
- 2nd quarter of the year $15,167,876

II.B.2 ARRA-supported Production Facility Project - Li-Ion Battery Manufacturing (LG Chem Michigan Inc.)

Kelly A. McDonald (NETL Project Manager)
Grant Recipient: LG Chem Michigan Inc. (formerly known as Compact Power, Inc.)

Kee Eun
1 LG Way
Holland, Michigan 49423
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Start Date: September 1, 2009
Projected End Date: May 31, 2013

Introduction

Description of facilities: This project is designed to directly address our interest in cell and battery manufacturing facilities. The completion of this effort will result in validated production capability for advanced lithium-ion battery cells in an all-new U.S. facility. The overall objectives of this project are to:

- Construct a new plant that will be fully equipped with state-of-the-art processes, machinery and equipment.
- Replicate production of Li-ion battery cells from Ochang, South Korea into a new manufacturing facility in Holland, Michigan.
- Begin manufacturing operation in 2012.
- Reach full-scale, integrated production of over 18 million battery cells annually by the end of 2013.

- The start of production of Li-ion battery cells in the Holland plant involves construction of a new facility, the installation of new equipment, and staffing the plant with operators, engineers, and administrative staff.
- Total Value of award: $151,387,000.00
- Percent of funds expended: Projected to be 61.3% by December 31, 2011.

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Progress and Current Status

Facility 1 – Phase I Production Facility for Li-Ion Polymer Batteries in Holland, Michigan

- Construction 100% complete. The building construction is being done in two phases, the first in 2011 to begin assembly operations. This first phase of construction started at the beginning of September, 2009 and was completed at the end of October, 2011. We broke ground in June, 2010 and followed that with a highly publicized official ceremony in July, 2010. The erection of the steel was complete in December, 2010. By February, 2011, the plant was completely enclosed. Our move-in was at the end of July, 2011. By the end of October, 2011, Phase I of construction was complete.
- Equipment installation is 70% complete. In the first phase of the project, to meet customer timing requirements, two assembly lines will begin operation in the second quarter in 2012, utilizing electrodes made in LG Chem's Korean-based plant. This permits timely supply and also provides an opportunity for experienced technical experts to fully develop the manufacturing equipment and processes that will ultimately be duplicated in Michigan. Phase I equipment installation began on January 17, 2011 and is on track to be complete by the end of February, 2012. It entails the installation of three separator lines and three assembly lines. All three separator lines completed installation of equipment and utility connections in September, 2011. The equipment installation and utility connections for the aforementioned three assembly lines were completed in October, 2011. By November, 2011, the unit process test run for separator lines #1, #2, and #3 was complete. By the end of December, 2011, the unit process test run for assembly lines #1, #2, and #3 will be complete. Also, the whole process test run of all three separator lines will round out the end of 2011.
- Production for the Phase I separator and assembly lines is projected to begin in March, 2012.
- LGCMI held three job fairs over the spring and summer of 2011. By the end of calendar year 2011, we will have 230 permanent team members on staff. These include administrative staff, engineers, and technical operators.
- Since Phase I construction is complete, there are currently no construction contractors on site; however, we are employing approximately 20 equipment contractors at this time. For the 2011

calendar year, there were a total of approximately 1,000 temporary/construction workers on site.

Facility 1 – Phase II

- Construction is 50% complete. The second phase of building construction began in June, 2011. It will be an addition of a high-volume electrode manufacturing line and a number of assembly lines that will more than double our capacity to 18 million cells per year by the end of 2013. We broke ground in August, 2011. The projected completion of Phase II is year-end 2012.
- Phase II Equipment installation is 5% complete. Equipment has been ordered. We are on track to complete Phase II equipment installation in August 2012.
- Start of production for electrode manufacturing will be in January, 2013.
- Electrode manufacturing will add 80 more permanent jobs, totaling 310 LGCMI team members.
- There are currently 90-100 temporary/construction team members on site for Phase II. In total for the 2011 calendar year, there were approximately 65 temporary/construction workers on site for this phase.

Pictorial Overview

Figure II - 26: LG Chem, MI, Production Facility – Street View – Front of Main Building (1st Qtr. 2011).

Figure II - 27: LG Chem, MI, Production Facility – Street View – Rear (Electrode Building on Left) (1st Qtr. 2011)

Figure II - 28: LG Chem, MI, Production Facility – Arial View of Entire Facility (October, 2011).

Figure II - 29: LG Chem, MI, Production Facility – Pre-Aging Area Equipment.

Figure II - 30: LG Chem, MI, Production Facility – Formation Area Equipment.

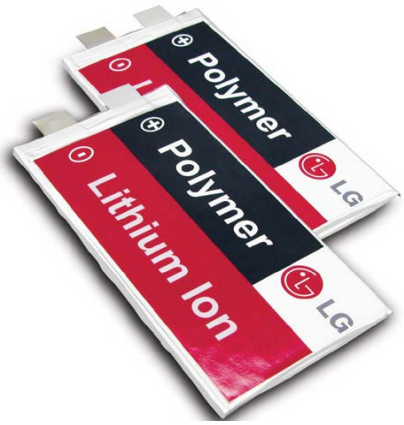

Figure II - 31: LG Chem, MI, Production Facility – Li-Ion Battery Cell.

Planned Work for FY 2012

The second phase of building construction for this project began in the second quarter of 2011. It entails an expansion to accommodate high volume electrode manufacturing, as well as more than doubling assembly capacity. Two assembly lines will begin operation in the second quarter of 2012 utilizing electrodes made in LG Chem's Korean based plant to produce five million cells in 2012. This permits timely supply and also provides an opportunity for experienced technical experts to fully develop the manufacturing equipment and processes that will ultimately be duplicated in Michigan. In our experience, it typically takes two years to reach stable production in terms of productivity, operator skill and high levels of product quality control. For this reason, in the first phase of production, it is essential that all production be done in an established plant location. This allows LG Chem to leverage all possible existing resources, know-how and expertise in our small-cell manufacturing until confidence in production capability and product quality is ensured. LG Chem will not sacrifice quality of product by putting a start-up facility in the demanding new product launch process. Concurrent with the start of assembly production, the new building will be expanded to accommodate new electrode manufacturing and added assembly equipment that will bring the capacity to 18 million cells per year by the end of 2013. As well, 80 more team members will be added to our staff for the electrode line. This project could bring valuable technology, manufacturing capability and jobs to the U.S. to serve the automotive industry and potentially many other future applications. When in full production, the LGCMI facility will create more than 300 jobs.

Other Information

1. Argonne National Laboratory news release
2. Holland Sentinel newspaper article
3. GM-Volt.com article

II.B.3 ARRA-supported Lithium-ion Cell Production and Battery Pack Assembly (EnerDel, Inc.)

NETL Manager Name: Christopher D. Johnson
Grant Recipient: EnerDel, Inc.

Primary Contact Name: Robert R. Kamischke
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E-mail: rkamischke@enerdel.com

Start Date: January 9, 2010
Projected End Date: January 28, 2013

Introduction

The project includes the expansion and upgrade of EnerDel facilities in the greater Indianapolis, Indiana area. Included is a new 421,000 Sq. Ft. facility located in Mt. Comfort fitted for production of battery modules and battery packs as well as final Li-ion cell formation processes. Also included is the upgrade of an existing Li-ion battery manufacturing facility (Hague Rd.) located in Indianapolis that houses battery cell electrode fabrication and assembly activities and finally, a 3rd site located in Noblesville, Indiana that houses battery pack test and validation equipment/activities.

The total value of the award is $236,936,232 under a 50/50 cost share. At the end of FY 2011, 46% of the project funds have been expended.

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Progress and Current Status

All Phase I facility fit-out and upgrades were completed by October 2010. Phase I battery module and battery pack assembly lines have been full qualified and PPAP certified since August 2010 and commercial production is ongoing (cells sourced from our Korean affiliate). Battery assembly operations team members have been trained and qualified to operate the equipment and achieve required quality standards.

As of June 2011, EnerDel has fully installed all Phase I equipment necessary to coat, cut, assemble, and form Li-ion battery cells. Validation and ramp-up of cell electrode fabrication and cell assembly lines have been the primary engineering activities since April 2011. These activities include on-going product validation runs to ensure all equipment/processes are fully capable of meeting product requirements at high volume and benchmark efficiency rates. During this period, cell operations team members have been trained and qualified to operate the equipment and achieve required quality standards.

EnerDel employed 285 people at the end of the 2011 FY, up from approximately 150 people at the start of the project. Temporary construction jobs have been negligible during the 2011 FY as most construction activities were substantially complete by October 2010. Final employment numbers will be dependent on commercial customer demand for our products. At the end of the 2011 FY, EnerDel was operating at a fraction of its Phase I installed capacity base.

Pictorial Overview

Figure II - 32: EnerDel Lithium-ion Cell Production and Battery Pack Assembly – Hague Rd. Facility.

Figure II - 33: EnerDel Lithium-ion Cell Production and Battery Pack Assembly – Mt. Comfort Facility.

Figure II - 34: EnerDel Lithium-ion Cell Production and Battery Pack Assembly – Dry-room Construction – Hague Rd.

Figure II - 35: EnerDel Lithium-ion Cell Production and Battery Pack Assembly – Facility Preparation – Mt. Comfort.

Figure II - 36: EnerDel Lithium-ion Cell Production and Battery Pack Assembly – Completed Dry-room – Hague Rd.

Figure II - 37: EnerDel Lithium-ion Cell Production and Battery Pack Assembly – Cell Formation Equipment – Mt. Comfort.

Figure II - 38: EnerDel Lithium-ion Cell Production and Battery Pack Assembly – Cell Assembly Equipment – Hague Rd.

Figure II - 39: EnerDel Lithium-ion Cell Production and Battery Pack Assembly – Unwinder Anode Coater – Hague Rd.

Figure II - 40: EnerDel Lithium-ion Cell Production and Battery Pack Assembly – Battery Module Assembly Line – Mt. Comfort.

Figure II - 41: EnerDel Lithium-ion Cell Production and Battery Pack Assembly – EnerDel Li Ion Battery Cell.

Figure II - 42: EnerDel Lithium-ion Cell Production and Battery Pack Assembly – EnerDel Battery Pack.

Planned Work for FY 2012

EnerDel will continue to respond to customer requests for battery pack and battery energy storage systems heading into 2012. Many of these applications are currently under development with the expectation that production contracts will be awarded in 2012.

The final activities to fully validate the US cell production system will be completed in early 2012 (EV cell). Other battery cell related validation activities will be initiated in 2012 including production validation of 2nd source raw material suppliers and production validation of EnerDel's PHEV cell.

The calendar year 2012 is expected to be a transitional period where performance measurement will be mostly milestone based (i.e., contract awards, capability). This is reflective of the long lead times associated with Li Ion application development and industry demand recovery in a market that is still in its developmental stages.

Other Information

- Ener1 Showcased for Innovation and Job Growth GREENFIELD, Ind., Jan. 26, 2011 /PRNewswire
- Li-ion Battery Maker Starts Phase II of Production to Supply C30 Electric Car WASHINGTON, June 9, 2011 /PRNewswire
- Ener1 and JSC Mobile GTES Sign Strategic, Five-Year Framework Agreement
- NEW YORK and ST. PETERSBURG, Russia, June 16, 2011 /PRNewswire
- Ener1 Announces Supply and Distribution Agreement with Lightning Motorcycles
- Ener1's lithium-ion battery solutions to be used in Lightning's growing product line of racing and commuter motorcycles and scooters
- NEW YORK, July 28, 2011 /PRNewswire
- Ener1 Powers Record-Breaking SuperBike Lightning Motorcycles Sets Top Land-Speed for an Electric Motorcycle
- NEW YORK, Aug. 24, 2011 /PRNewswir

II.B.4 Li-Ion Battery Pack Manufacturing (General Motors, LLC)

Rondle Harp (NETL Project Manager)
Grant Recipient: General Motors LLC

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GM Manufacturing Engineering
30001 Van Dyke Avenue, Mail Code 480-210-420
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Start Date: August, 2009
Projected End Date: September, 2013

Introduction

- Description of facilities: Brownstown Battery Assembly Plant, Brownstown Township, MI
- Total Value of award: $234.8M
- Percent of funds expended: 51% as of September 30, 2011

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Progress and Current Status

Activities for FY2011 reflect a continuation toward the overall project objectives.

- Establish and validate production capability for GM Li-ion battery pack manufacturing operations
- Provide specialized workforce training in advanced battery pack manufacturing technology
- Provide continuous improvement and innovation cycles to move battery pack technology down the cost curve

Significant progress was made toward completion of project goals during FY2011. A highlight of this progress was the successful Start of Regular Production (SORP) for the 2011 Chevrolet Volt Extended Range Electric Vehicle (EREV) battery pack at the Brownstown Battery Assembly Plant (Figure II - 43, Figure II - 44). 100% of the manufacturing equipment (Figure II - 45, Figure II - 46) for the 2011and 2012 model year battery pack design and 2011 calendar year volume has been installed. Cumulative jobs created or retained for the project activities based on ARRA guidelines was 72.6 Full Time Equivalents. Hourly and salary employment at Brownstown is 70 people, as of September 30, 2011.

Many things must come together to achieve a successful SORP. The product, process and people systems must be established and validated. Production systems were installed for the first two model years of production. Product builds, both preproduction and manufacturing validation, were completed to confirm the product and process designs, along with associated quality systems. Equipment and tooling designs were also validated during these builds. All components and the complete battery pack achieved full Production Part Approval Process (PPAP) status. Production acceleration has been matched to the vehicle assembly plant to meet market demands.

One of the key deliverables required by the DOE for ARRA funded projects is product testing. Witness testing of the 2011 EREV production battery pack was successfully completed at the GM Battery Systems Lab (Figure II - 47, Figure II - 48). Test data was reviewed and analyzed by an independent third party and passing results were received. Additional witness testing will be completed as required for future battery packs.

Capabilities at Brownstown were expanded by establishing preproduction build and battery pack refurbishment operations. The necessary equipment, tooling and processes were installed and validated to provide these capabilities.

Establishing a capable workforce is fundamental to achieving success. Engineering and plant teams were staffed and training was completed. Training focused on health and safety, Global Manufacturing System, technical maintenance, equipment and production operations.

In addition to the SORP for 2011 and 2012 EREV model years and the increased capabilities, efforts continued on subsequent model years for the EREV packs and future battery pack programs. Manufacturing Engineers continued work on process planning, and equipment and tooling procurement. Preproduction builds in support of these programs continued during FY2011. Design for Manufacturability concepts have been incorporated into product designs.

The third overall project objective of continuous improvement (CI) further enhances the capabilities of the production system, improving quality, cost and manufacturing flexibility. Deliverables from CI activities have been implemented in the production system upon plant review and acceptance. Key areas being worked for CI 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

Project status at the end of FY2011 reflects three key takeaways: 1) The SORP for the Chevrolet Volt EREV battery packs was successful and the system is poised to ramp volumes to meet market demand, 2) Future battery pack programs are on track and 3) Implementation of continuous improvement projects are solving complex challenges in real time.

The bottom line for the project is that GM's Li-Ion Battery Pack Manufacturing project creates and retains jobs, establishes US-based battery pack manufacturing capability, improves our nation's energy independence and drives significant advancement of electric vehicle battery pack manufacturing technologies.

Pictorial Overview

Figure II - 43: Facility location in Brownstown Township, MI.

Figure II - 44: GM Brownstown Battery Assembly Plant, Brownstown Township, MI.

Figure II - 45: Battery Pack Lift Assist.

Figure II - 46: Battery Pack Assembly on Automated Guided Carts.

Figure II - 47: 2011 Chevrolet Volt Battery & Specifications.

Figure II - 48: 2011 Chevrolet Volt Battery in the GM Battery Systems Lab in Warren, MI.

Planned Work for FY 2012

Planned activities for FY 2012 are a continuation of efforts toward the overall project objectives.

Specific efforts focus on increasing capacity and preparing for the future. EREV battery pack production for the Chevrolet Volt and Opel Ampera will be increased as required to meet market demand. With this increase, plant staffing and workforce training will continue. As previously announced, over 100 advanced technology jobs will be created or retained by GM at the Brownstown site.

Preproduction and Manufacturing Validation builds for EREV battery pack Model Year enhancements will continue in 2012. Preproduction builds allow for collection of data and provide early verification of manufacturing processes, assembly and test parameters and equipment concepts. Procurement, installation and

validation of additional equipment and tooling will be ongoing. Production Part Approval Process (PPAP) related activities will be completed. Continuous improvement results will be implemented into production processes. Witness testing of appropriate production properties will be conducted.

Future battery pack programs will continue preproduction builds, manufacturing process planning, and equipment procurement as needed to maintain project timing.

FY 2012 will see significant progress toward overall project completion. It is anticipated that up to 90% of the project will be completed by September 30, 2012.

Other Information

Li-Ion battery packs produced by GM Subsystems LLC will be utilized in multiple General Motors products.

The Chevrolet Volt received numerous awards during the 2011 FY. There were no specific economy or employment related news items for battery pack manufacturing during the timeframe. Shipping the first Chevrolet Volts to dealers was announced on December 13, 2010.

The Brownstown Battery Assembly Plant sponsored an “Open House” for the community as part of an overall GM facility open house program in 2011. Approximately 400 people attended the two-day event. Recognition of DOE funding support was provided at one of the tour stops.

II.B.5 Lithium-ion Cell Production and Battery Pack Assembly (Saft America, Inc.)

NETL Manager Name: Christopher D. Johnson
Grant Recipient: Saft America, Inc.

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Start Date: December 2009
Projected End Date: May 2013

Objectives

- Construct a 235,000 square foot Li-ion Factory of the Future in Jacksonville, FL for high volume production of batteries for military hybrid vehicles, smart grids, renewable energy storage, broadband and aerospace application.
- Provide a showcase of environmentally friendly and energy efficient design concepts
- Employ hundreds of U.S. workers in well-paid jobs
- Produce lithium-ion cells, modules, and battery packs at a competitive cost to enable renewable energy storage systems, smart grid, broadband systems, military hybrid vehicles and aviation, thereby achieving significantly reduced carbon emissions and fuel savings.

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Introduction

Saft is using its considerable experience in building factories for lithium-ion cell and battery manufacturing and expertise in lithium-ion technology to build a Factory of the Future capable of manufacturing and delivery of high quantities of lithium-ion cells, modules and batteries to the military hybrid vehicle, industrial energy, electric drive and aerospace markets.

Approach

Saft is investing immediately, along with DOE, in establishing the factory and manpower to support manufacturing which will be used in delivery of lithium-ion cells and batteries in high volumes. Saft is creating at least 280 jobs within 5 years of beginning the project, with the first year job creation starting at 106 new jobs. Saft is using lean manufacturing techniques to ensure that the factory is established with consideration for cost savings. Also, Saft is employing risk mitigation and risk management practices which will assure being able to provide on-time schedule and technical performance.

Saft is using the Earned Value Management System of assigning and managing project costs in respect to the financial objectives of the program. It is using LEED® green factory initiatives in the buildings, power usage and waste management; all of which are complemented by its recycling plan for batteries once used. The decision to use LEED® techniques in designing the Factory of the Future is consistent with the markets intended to be addressed, which are renewable energy related.

Accomplishments

Factory Design and Equipment Specification. The factory design was contracted to The Haskell Company and was completed in April 2010. The design is consistent with LEED® Silver requirements.

Equipment specifications for all equipment were completed by October 2010.

Factory Construction and Equipment Procurement. Construction of the factory began with site preparation starting in February 2010. The building was completed and Certificate of Occupancy issued by the City of Jacksonville in June 2011.

Figure II - 49: Saft Factory of the Future – completed

Procurement of all equipment for the first of three cell production lines is complete, and all items of equipment have been received. Procurement of all equipment for the second production line has begun, and all purchase orders have been released. Equipment fabrication is on-going.

Equipment Installation. The equipment received for the first production line have been installed. Equipment for the second production line is on order and scheduled to be installed during the second quarter of 2012.

Process and Product Qualification. This task started in July 2011 for Line #1 and is on-going.

Program Management. The Program Management Plan and Statement of Program Objectives have been submitted to DOE and updated quarterly as required. A Risk Assessment was conducted as part of the Risk Management Plan. Quarterly progress reports, Earned Value Management reports and ARRA progress reports have been submitted on time and are current.

EVMS indicators: SPI=0.93 indicating the program is two months behind schedule overall. Projected completion date for the project is 31 May 2013. CPI=0.88 indicating that spending is higher than initially planned. This is due primarily to an overrun of the cost of the building. Saft is projecting completion of the program on budget. The program is approximately 61% complete at end-September 2011.

Conclusions and Future Work

The Saft Factory of the Future program is proceeding and meeting its goals. There were over 200 construction workers employed on the factory site during 2010-2011, and there are now 110 Saft employees in Jacksonville. Saft has applied for LEED Silver certification and expects to be certified in late 2011. Saft expects to qualify its first production line in October 2011, start production and commence sales.

In 2012, Saft anticipates installation and qualification of a second production line. Furthermore, Saft anticipates commencing procurement and installation of equipment for a third and final production line during 2012-2013.

FY 2011 Publications/Presentations

1. 2011 DOE Annual Peer Review Meeting Presentation.

II.C Battery Materials Production Facilities

II.C.1 ARRA-supported Production Facilities (Celgard, LLC)

Bruce W. Mixer (NETL Project Manager)
Grant Recipient: Celgard (Grant Number EE0002611)

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Start Date: December 2009
Projected End Date: May 2013

Introduction

- The overall project objective is to develop new jobs and manufacturing capacity of Celgard® separator for the Electric Drive Vehicle (EDV) lithium-ion battery market. The project will be executed in a two-phase approach. Phase 1 will expand an existing manufacturing facility at the current Charlotte, N.C. site. Phase 2 will develop a new manufacturing facility at a site selected in Concord, N.C. The proven Celgard manufacturing process will be duplicated to minimize risk and allow rapid implementation of the new capacity to meet the development of the EDV market need.
- Celgard received notification of being selected for an award on July 31st, 2009. The project activity was started immediately but at a pre-award activity level. On December 22nd, 2009, DOE approved a pre-award spend period that covered work from July 31st, 2009 to the signing date. Subsequent meetings and discussions concerning the project detail and the final Terms and Conditions resulted in the award being signed February 1st, 2010.
- The total value of the award is $48,750,325. As of September 30th, 2011 approximately 81% of the award funds have been expended.

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Progress and Current Status

Phase 1 Facility – Charlotte, N.C.:

- This project provided an up-fit of the existing Charlotte, N.C. manufacturing facility, which consisted of moving the existing warehouse and installing the necessary manufacturing infrastructure. The general contractor on this project was Myers & Chapman, Inc. The moving of the existing warehouse has been successfully completed. All infrastructure elements and two new and complete manufacturing processes have been installed. The new manufacturing equipment is fully operational and the products achieved internal qualification in the first quarter of 2011. The manufacturing capacity is now fully commercial.
- The job creation in the Phase 1 project resulted in 100 permanent, full-time Celgard employees. The temporary jobs were due to the construction on the existing facility, services and installation of the equipment. The temporary jobs are estimated at a total of 93 directly on the project. This phase of the project is complete and no further project work is planned at this time.

Phase 2 Facility – Concord, N.C.:

- A new manufacturing facility was planned and constructed in Concord, N.C. The new building is approximately 150,000 square-foot and sits on 20 acres in the International Business Park in Concord, N.C. This is the second phase in Celgard's strategy to expand the separator production capacity for lithium-ion batteries used in EDVs. Merriman Schmitt Architects, Inc. designed the Concord plant and Myers & Chapman, Inc. served as the general contractor. Both companies are based in Charlotte. The estimated direct temporary jobs employed on the project to date are 140.
- Celgard celebrated the completion and grand opening of the new building in Concord on July 25th, 2011. Management and professional staff were hired over the course of 2011, trained on Celgard Separator technology, manufacturing systems and logistics at our Charlotte facility, and relocated into the new Concord facility immediately following the building opening. The hourly operations staff is currently at the 70% level with the final 30% targeted to be in place in Q1 2012. The total number of permanent jobs currently at the Concord facility is 92.
- All manufacturing equipment has been ordered and the majority of it has been received and is currently being installed. One complete manufacturing unit has been installed and is in the process of being

commissioned with internal qualification targeted by the end of 2011. Additional manufacturing units will be commissioned as they are installed.

Pictorial Overview

Figure II - 50: Completed warehouse (Phase 1 Project in Charlotte, N.C.)

Figure II - 51: Fully formed flat sheet membrane from new equipment (Phase 1 Project in Charlotte, N.C.)

Figure II - 52: Quality testing on the manufacturing floor (Phase 1 Project in Charlotte, N.C.)

Figure II - 53: Concord Building (Phase 2 Project in Concord, N.C.)

Figure II - 54: Grand Opening with Secretary Chu (Phase 2 Project in Concord, N.C.)

Figure II - 55: Equipment Installation Activity (Phase 2 Project in Concord, N.C.)

Figure II - 56: Operations' install and startup team (Phase 2 Project in Concord, N.C.)

Planned Work for FY 2012

Phase 1:

- Complete and no additional work planned.

Phase 2:

- Complete install of manufacturing equipment.
- Commission and internally qualify all equipment.
- Complete hiring of hourly personnel.

The overall Celgard project EE0002611 is on target to meet all award performance metrics on or before February 1st, 2013:

- Demonstrate the award level of annual capacity of Celgard® separator for use in the EDV markets.
- Create approximately 250 permanent new jobs.
- Complete within budget.
- Complete on or before February 1st, 2013.

Other Information

Additional information can be obtained from Celgard press release site located at: http://www.celgard.com/press-releases.aspx

II.C.2 Advanced Cathode Materials Production Facility (Toda America Inc.)

Christopher Johnson (NETL Project Manager)
Grant Recipient: Toda America Inc.

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Battle Creek, MI
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Start Date: February, 2010
Projected End Date: December, 2013

Introduction

- **Company:** Toda America Inc. is a jointly owned company by Toda Kogyo (Toda) and ITOCHU Corporation. Toda is a leading cathode materials supplier to Li-ion battery manufacturers worldwide. In this project the principal objective is to establish Toda America Inc. as a high volume cathode materials manufacturing facility to become a strong and supportive strategic supplier partner to the U.S. advanced battery industry. ITOCHU Corporation, a diversified global trading company, has partnered with Toda in this U.S. joint venture.
- **Description of facilities:** Toda America Inc. Advanced Cathode Materials Production Facility will produce oxide materials for lithium-ion battery cathodes (including LNCA and LNCM) as a battery materials source for electric drive vehicles. The project includes construction of an 80,000 square foot manufacturing facility and wastewater pre-treatment facility located within the Fort Custer Industrial Park in Battle Creek, Michigan, as well as procurement, installation, and validation of manufacturing equipment. The project will be executed in two phases with Phase 1 comprising two production lines and Phase 2 comprising two more lines, totaling four lines when project is completed.
- Total Value of award: $35 million
- **Percent of funds expended:** 45% of funds expended by September, 2011.

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Progress and Current Status

- At September 2010, end of FY 2010, Phase 1/Step 1 construction was 65% completed, with related equipment procurement and delivery 80% completed for Step 1.
- As of September 2011, end of FY 2011, Phase 1/Step 1 construction is 100% completed, all equipment installed and commissioned and operational..
- Managerial and technical staffing for Phase 1 is completed, adding 29 full time permanent jobs at the facility.
- Production validation was achieved and over 50 tons of cathode materials were successfully produced for samples and customer delivery.

Pictorial Overview

Figure II - 57: Toda America Inc. Battle Creek Facility, Phase 1.

Planned Work for FY 2012

During FY 2012, we expect that the second production line of Phase 1 will be substantially completed, with planned project to start in November, 2011. Once the two production lines of Phase 1 are completed, Toda will have capacity to produce nearly 2,000 tons of cathode materials annually. By end of FY 2012, Toda expects to employ 40 full time staff at the Battle Creek facility.

Other Information

Toda America Inc. has successfully produced and shipped advanced cathode materials produced at the Battle Creek facility for customer testing and use beginning 1Q2011. Samples for various customers are being shipped for current and future application programs, and operations and sales activity are progressing normally.

II.C.3 ARRA-supported Production Facility Project (Chemetall Foote Corp.)

Christopher D. Johnson (NETL Project Manager)
Grant Recipient: Chemetall Foote Corp.

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Start Date: April 2010
Projected End Date: May 2013

Introduction

- We are expanding lithium carbonate production in Silver Peak, Nevada by 100%, converting the main electrical source at that location to Geothermal energy which will reduce operating costs of the plant, and in Kings Mountain, NC expanding the company's capability to produce lithium hydroxide by more than 100%. Total award is $28,425,258. Amounts invoiced thus far thru September 28, 2011 is $9,374,747 which is 33%.

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Progress and Current Status

Lithium Carbonate

- Completed Construction: +/- 45% cost estimate
- Equipment Installed: +/-20% Equipment Installed
- Production Started: +/-0% Production Started
- Drilling activities for first lithium brine well (FM120A) have been completed. The second new brine well (FM-99C) is scheduled to be completed by mid-October.

Geothermal Power Plant

- Completed +/- 5% cost estimate
- Equipment Installed +/- 0% Equipment Installed
- Production Started +/- 0% Production Started
- A revised operations plan has been delivered to BLM (Bureau of Land Management) for consideration. The revised plan replaces references to using weak brine as drilling fluid with using fresh water as drilling fluid.
- Cost estimates to acquire and recondition the Turbine Generator Set have been received. Once competitive quotes have been evaluated and a supplier selected, CFC will consider the financial risks/benefits of moving forward with the purchasing aspect.

Lithium Hydroxide

- Completed 100%.
- Equipment Installed: 60% Equipment Installed
- Production Started: +/-0% Production Started
- Engaged an engineering firm to develop the detailed design of the plant. The detailed design is expected to be completed by the end of October 2011
- Received all major equipment plus equipment insulation, instrumentation, relief valves, rupture disks, structural steel, process piping, pressure and temp transmitters, safety showers and eye wash stations.
- Continue installing new structural steel. Begin erection of new pre-engineered building
- Completed installation of block walls for Firewater pump house and for new control room and I/O room, break room and rest rooms.
- Air Permit Exemptions have been received. Received construction permits for the erection of the structural steel, control room, fire water pump house and packaging building.
- Completed installation of the new 10" steam header and began installation of new 4"condensate header.
- City of Kings Mountain began installing 12" water line into the plant.

Planned Work for FY 2012

Lithium hydroxide plans to be mechanically complete by the end of the 1st qtr 2012 and begin production early 2nd qtr 2012.

Lithium Carbonate – 2012 plans are to complete all activities except the Brine Solar Evaporation Period which will run into 3rd Q 2013.

Geothermal power plan is currently waiting on the Environmental Assessment (EA) from BLM. Upon timely approval, the expected production wells should continue thru 2012 and the power plant systems should be purchased thereafter. Major decision points in 2012 will determine work planned for coming months after EA

Pictorial Overview

Figure II - 58: ARRA-supported Production Facility Project – Chemetall Foote Corp.

Other Information

N/A

II.C.4 High-Volume Manufacturing of $LiPF_6$ - A Critical Lithium-ion Battery Material (Honeywell)

Bruce Mixer (NETL Project Manager)
Grant Recipient: Honeywell International, Inc.

Brian O'Leary
101 Columbia Road
Morristown, NJ 07962
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E-mail: brian.oleary@honeywell.com

Start Date: April 16, 2010
Projected End Date: April 15, 2013

Introduction

Honeywell is building a U.S. manufacturing facility to produce a critical Li-ion battery material – lithium hexafluorophosphate, $LiPF_6$. Honeywell's $LiPF_6$ project directly supports the DOE's objective to build and validate production capability of battery materials in the U.S. This project will result in the first U.S. manufacturing facility for $LiPF_6$, establish a secure domestic supply for this critical material in the electric drive vehicle (EDV) supply chain, and help form the foundation of a sustainable domestic Li-ion battery industry.

All Li-ion batteries require $LiPF_6$ (Figure II - 59), a material that is not currently manufactured in the U.S. It is imperative that the U.S.-based Li-ion battery industry have secure access to the highest quality $LiPF_6$ to avoid disruptions in supply and/or quality from foreign sources. All domestic Li-ion battery manufacturers, and their EDV customers, will benefit from this secure and cost-effective supply of $LiPF_6$.

Leveraging our capabilities as the world's largest producer of hydrofluoric acid (HF), the Honeywell team developed a novel process to prepare high-purity $LiPF_6$ as demanded for high-quality lithium-ion batteries. HF is the key raw material required for $LiPF_6$ production (Figure II - 60) and Honeywell has over 50 years of experience in developing and scaling up new F-based molecules. Our project will leverage significant existing assets and knowhow, which enables us to bring $LiPF_6$ to market quickly

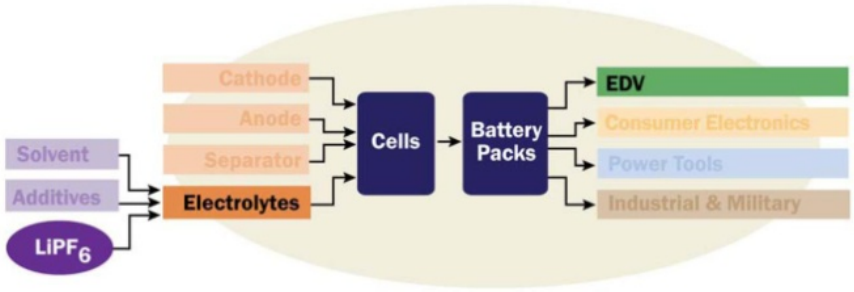

Figure II - 59: $LiPF_6$ is Required in all Li-ion Batteries.

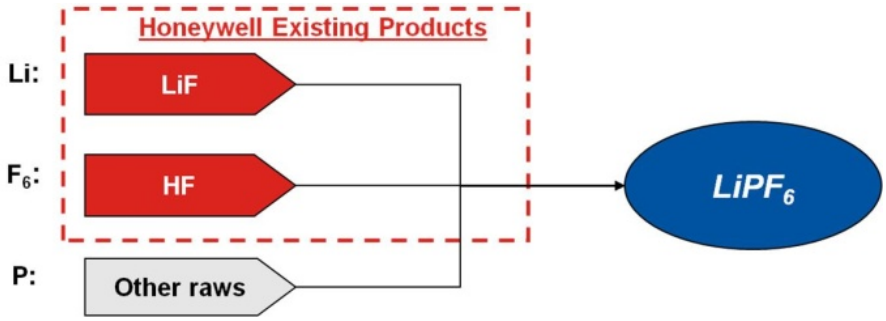

Figure II - 60: Honeywell Produces Key Raw Materials.

The objective of this project is to support the EDV Battery Manufacturing Initiative by commercializing Honeywell's novel $LiPF_6$ process into an operating commercial plant. The program has been divided into two phases. The first phase is the construction and operation of a smaller $LiPF_6$ plant at an existing Honeywell site in Buffalo NY. This plant will leverage existing infrastructure, including an existing building, to accelerate construction. This will allow customers to qualify product in their process quickly while the world-scale commercial plant is under construction. These customer samples will be integrated into batteries, tested and qualified for full-scale battery production. In the second phase of the project, a world-scale commercial plant will be built, which will be the first U.S. $LiPF_6$ production plant.

Honeywell began construction of the Buffalo, New York plant in 2010 and completed construction in the first half of 2011. This plant will produce sufficient quantities of $LiPF_6$ to enable our customers to begin the material qualification process. Engineering of the Phase 2 commercial plant began in 2011.

Our project will create 151 direct engineering and construction jobs to build the facility, as well as additional jobs with American equipment suppliers. Honeywell will also add 34 long-term professional and manufacturing jobs to manufacture this strategic Li-ion battery material.

The project is supported by a $27.3M grant from the U.S. Department of Energy under the American Recovery and Reinvestment Act (ARRA). As of the fiscal year end (Sept 30, 2011), $6.4M or 24% of the grant has been expended.

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Progress and Current Status

Facility 1 – Buffalo, NY Plant

The Buffalo NY facility is Honeywell's Center of Excellence for Fluorine products and was chosen as the location of the initial $LiPF_6$ plant because it was the fastest path to provide material for customer qualification. The $LiPF_6$ plant is able to leverage significant existing assets as well as a skilled workforce. Additionally, the technology team that invented the novel manufacturing process is based here.

Detailed engineering and construction began in 2010. 100% of the equipment is installed and construction was completed in the first half of 2011. The plant is currently being commissioned and will start production shortly. This plant will produce sufficient quantities of $LiPF_6$ to enable our customers to begin the material qualification process.

Currently, there are 11 permanent employees and 4 temporary employees. During construction, the project reached a maximum of 33.5 temporary employees in addition to the 11 permanent positions. Once the Phase II facility is operational and the project is complete, there will be a total of 34 permanent employees across Honeywell sites.

Facility 2 – World-Scale Commercial Plant

In Phase II, Honeywell will construct a world-scale manufacturing facility in Illinois. Engineering for this facility began in 2011. Construction has not begun and no equipment has been installed at this location.

This phase of the project will create a maximum of 151 engineering and construction jobs. Once the Phase II facility is operational and the project is complete, there will be a total of 34 permanent employees across Honeywell sites.

EVMS Metrics

Honeywell uses EVMS metrics track adherence to schedule and cost. A cumulative CPI of 0.97 indicates that the project is slightly over budget and a cumulative SPI of 0.97 indicates that it is slightly behind schedule.

Pictorial Overview

Figure II - 61: Aerial view of Honeywell's Buffalo, NY facility.

Figure II - 62: Buffalo NY $LiPF_6$ plant.

Figure II - 63: Special container for shipping finished product.

Planned Work for FY 2012

In FY 2012, Honeywell will safely operate the Buffalo facility to provide $LiPF_6$ samples for our customers to qualify. Once the material is qualified, we will also negotiate and execute supply agreements. Engineering on the Phase II facility will also continue.

Other Information

- Customer details are covered by non-disclosure agreements and cannot be shared in this report
- 2011 DOE Annual Merit Review poster session
- "Honeywell sample lithium plant finished," *The Buffalo News*, March 31, 2011 (http://www.buffalonews.com/business/article380724.ece)

II.C.5 Construction of a Li-ion Battery Cathode Production Plant (BASF)

John G. Tabacchi (NETL Project Manager)
Grant Recipient: BASF Corporation

Joe DiCarlo (Principal Investigator)
39 Veronica Avenue
Somerset, NJ 08873
Phone: (732) 545-5100 ext: 4119; Fax: (732) 249-0271
E-mail: joe.dicarlo@basf.com

Start Date: February 2010
Projected End Date: June 2014

Introduction

BASF has made a commitment to become a major lithium ion cathode producer in the United States as well as on a global scale. Prior to making this commitment, BASF secured a license from Argonne National Lab for the portfolio of materials in the lithium nickel, cobalt, manganese phase space. These materials are currently the materials of choice by many cell manufactures for the automotive PHEV market due to their superior performance, cost and safety properties. Another factor that led to BASF's commitment was a favorable feedback from some of our customers on the performance of our cathode materials supplied by our US based pilot facility. These factors, along with BASF's technical competence in scale up of inorganic oxide materials, formed the base of our commitment for our investment in a US cathode production facility.

The total value of the award for this program is $24,604,762 and at the end of FY-2011, BASF has spent between 25-30% of the award.

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Progress and Current Status

BASF is current on schedule for this project. At the conclusion of this project, BASF will have a state of the art cathode facility capable of making a variety of NCM cathode materials. At the end of FY-2011 (September 30, 2011), BASF had essentially completed the erection phase of the program. This milestone was critical for BASF since with the exterior of the building complete, interior work can continue during the cold winter months. The interior work to be done in the first six months of FY-2012 will include all the piping, electrical and other interior work. At the end of FY-2011, BASF had approximately 75% of all the engineering design packages completed which include civil, structural, piping, and electrical and instrumentation. In addition, BASF has issued more than 60% of the purchased orders for this project. Also, BASF has begun to receive the manufacturing equipment and has leased a warehouse near by the facility to hold this equipment until the necessary interior work is completed and at that point the equipment will be moved.

BASF has a significant workforce on site. The numbers fluctuate greatly however during the past six months an average of 20-30 outside contractors have been performing construction and engineering services for BASF. Also BASF has about 5-10 full time employees that supervise these activities and will begin staffing the facility in 2012 as the target for the commissioning of the faculty is fourth quarter 2012.

Pictorial Overview

Figure II - 64: Current Picture of BASF Cathode Facility.

Planned Work for 2012

BASF intends to complete all the construction of the cathode facility in FY-2012. A key milestone for 2012 will be the commissioning of the faculty in the fourth quarter. BASF is on schedule and currently sees no major obstacles in our way of accomplishing this goal.

Other information

BASF is in qualification with a number of cell manufactures for our NCM cathode materials. Qualifications cannot be fully completed until lots are received from our production facility slated to be on line in the fourth quarter of 2012.

II.C.6 ARRA-supported Nanoengineered Ultracapacitor Material Production Facility Project (EnerG2, Inc.)

John G. Tabacchi (NETL Project Manager)
Grant Recipient: EnerG2, Inc.

Primary Contact: Chris Wheaton
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Start Date: April 20, 2010
Projected End Date: March 1, 2012

Introduction

EnerG2, Inc. will build the first facility in the world dedicated to the commercial scale production of synthetic, high-performance carbon electrode material and the only U.S. facility to manufacture electrode materials for ultracapacitors (a market currently dominated by Japanese suppliers). Our products, the V2- and P2- Series Electrode Carbons, will result in a next generation ultracapacitor with significantly higher power density and much lower cost per kW. This achievement will enable the combination of ultracapacitors and batteries in electric drive vehicles to reduce battery replacement costs, improve mileage efficiency, and increase vehicle road performance.

The new plant will produce enough electrode carbon materials to supply production of 60,000 EDVs annually. The total value of award is $28,400,000 with an end date of March 1, 2012. Approximately seventy percent of the funds have been expended to date.

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Progress and Current Status

With the conclusion of Phase IV of the project, EnerG2 will perform testing and integrate all equipment and control systems, generating first batches of finished product, and process optimization to meet all specifications. Final operating personnel are also hired and trained. The project will create more than 150 temporary construction jobs and EnerG2 expects to hire more than 35 permanent position jobs when the factory is at full capacity.

Pictorial Overview

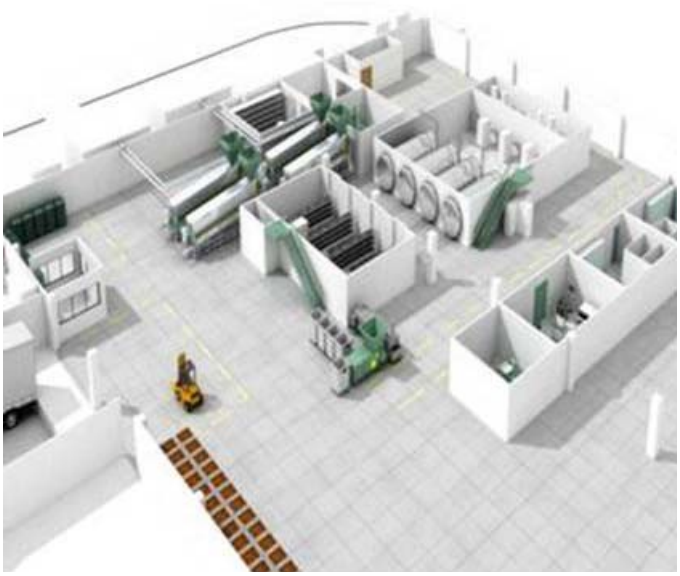

Figure II - 65: Artist's Rendering of Albany, Oregon Plant Floor plan (EnerG2, Inc.)

Figure II - 66: Kiln Reactor Commissioning.

Figure II - 67: Process Gas Insulation.

Figure II - 68: Refrigeration Compressor Insulation.

Planned Work for FY 2012

Throughout the rest of 2011 and most of 2012, EnerG2 and project subcontractors will be working to establish an integrated manufacturing line, based on EnerG2's proprietary manufacturing processes, to meet the carbon electrode demands of 60,000 EDVs per year. As of October 31, 2011, construction is over seventy percent complete.

Other Information

Recent News Article

35 new jobs are headed to Albany

It's been over a year since Rick Luebbe and Herb Aschkenasy made the announcement that the partnership between their two companies would provide jobs for Albany.

Luebbe, CEO of Energ2, the Seattle-based technology firm said Monday that up to 35 positions will soon be needed at the new manufacturing facility in Albany.

He and Aschkenasy, head of Oregon Freeze Dry, dedicated a former OFD distribution center in August of last year. Since then it has been transforming into the new plant for the production of a carbon electrode material that will enhance power storage for electric vehicles.

"We plan to start throwing switches to full production soon," said Luebbe. "The plan is to be up and running by the end of the fourth quarter."

Financed in part with $21.3 million in federal stimulus money, the project already has generated excitement with end users according to Luebbe.

To that end, Energ2 will be hosting a job and career fair on Thursday, Oct. 13 at the Holiday Inn Express, 105 Opal St. N.E. in Albany from 9 a.m. to 6 p.m. The company is looking to fill five key engineering and operations positions prior to opening, according to Shaun Mortensen, plant manager.

Luebbe said that different vendors have been in charge of different phases of the process and shipping them to Albany. Once everything is in place, there will be a matter of fine-tuning the process before operations begin in earnest.

Mortensen said pieces of equipment have been arriving almost daily and he expected that all of the components would be in the plant by the end of October.

Once the operation begins the prediction is to expand within 16 or 18 months and add more jobs.

(Author: Steve Lathrop)

(The Albany Democrat-Herald, Tuesday, October 4, 2011)

II.C.7 ARRA-supported Production Facility Project (Novolyte Technologies)

Dr. Christopher Johnson (NETL_Manager)
Grant Recipient: Novolyte Technologies, Inc.

Primary Contact: Ralph Wise
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Independence, Ohio 44131
Phone: (216)-867-1040 Fax: (216)-867-1089
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Start Date: April 30th 2010
Projected End Date: April 29th, 2015

Introduction

- The project is a two phase $40 M plant expansion effort. The first phase of the project increases Novolyte's electrolyte manufacturing capacity at its Zachary, LA facility from 1500 metric tons (MT) to 4,500 MT. The goal of the second phase of the project is to increase plant capacity from 4,500 MT to 10,000 MT.
- Total Value of Award: $20,618,047
- Percent of funds expended: 2.5%

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Progress and Current Status

Novolyte's electrolyte plant capacity expansion is a two phase project, timed to intersect with future market demand. Project risk is carefully managed by working closely with domestic customers to forecast and foresee project delays or to accelerate the completion of key tasks, if necessary.

Phase I tasks of the expansion project, starting in 2010 and going through 2013 include the installation of a new large scale raw material storage tank and associated equipment, building a new motor control center (MCC) building, upgrading the solvent distillation system, building a new control room center, upgrading the high voltage transformer, installing a new steam boiler and new vessel cleaning station and upgrading the lab and flammable storage building.

With a new market forecast completed in early 2011 and with assistance from DOE, Novolyte rescaled the expansion project to include incremental expansion, cycle time reductions and deferring additional reactor volumes. An engineering study was conducted to develop a project scope, capital cost estimate, and process control system functional specifications for an incremental expansion of the existing reactor volume if it was determined incremental capacity would need to be implemented quickly. Procurement of 400 new 215-L electrolytes shipping containers is currently underway and should be received before the end of calendar year 2011.

During the 4th calendar quarter of 2010, 300 electrolyte shipping vessels were received. Piping upgrades to the sample reactor were completed and an order placed for fittings for 75 of the new shipping vessels. Engineering studies were completed for an incremental capacity expansion through upgraded process controls. Engineering was done on a new nitrogen heater and moisture analyzers for the vessel cleaning operation.

During the 1st calendar quarter of 2011, a revised Project Management Plan scaled to updated market forecasts was developed and presented to DOE. The fittings for 75 of the new shipping vessels were received and the new vessels were placed into service. A new portable weigh scale was purchased and upgrades were specified and placed on order for small packaging of electrolyte samples.

During the 2nd calendar quarter a project was approved for procurement of twelve new small electrolyte shipping containers. The containers were received, and fittings were also obtained and received. Another project was developed and approved for upgrading transfer lines in the electrolytes production facility to stainless steel.

During the 3rd calendar quarter, a project was approved in for the procurement of 400 new electrolyte shipping containers at an anticipated cost of $500,000. The containers are currently in fabrication and should be received before the end of the calendar year. Progress has been made on a project involving upgrading of transfer lines in the electrolytes unit to stainless steel.

Facility 1 – description

- Construction complete (1%)

Construction and fittings for 700 215L shipping vessels, re-piping of the sample reactor and warehouse upgrades for the storage of raw materials were completed. Sample and 150-gal. reactor piping upgrade, Automation Engineering, upgrade transfer lines to stainless steel.

- Equipment Installed (7.5%)

An ion chromatograph was received and installed, a production portable scale was purchased and placed into service, an electrolyte sump pump was installed and a vacuum sealer for small sample packaging for EV

customers is to be received in the fourth calendar quarter of 2011.

- Production Started (0%)

Phase 1 production upgrades: No new production capacity has been implemented to date. Plans are being made for implementation of capacity expansion through debottlenecking of existing reactors as well as through installation of additional reactor capacity.

Jobs: permanent (9 current, 18 at project completion)

Jobs: temporary/construction (0 current, 65 maximum)

Pictorial Overview

Figure II - 69: Several examples of the 400 215-L Electrolytes shipping vessels purchased in 2010.

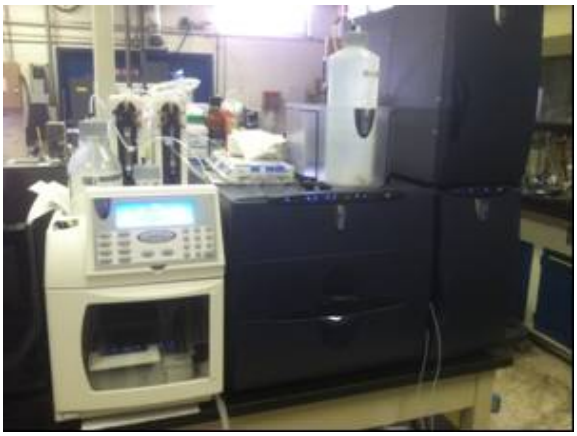

Figure II - 70: Ion Chromatograph.

Figure II - 71: Two examples of the small Electrolytes shipping vessels purchased in 2011.

Planned Work for FY 2012

To continue progress on Phase 1, the following activities are planned for FY2012: Purchase hot box, purchase oven for additives, install new sample reactor, upgrade HVAC unit, install dew point meter on vessel drying station, implement capacity expansion through debottlenecking projects, install chiller unit, upgrade production control room, purchase additional 215-L electrolytes shipping vessels, purchase additional small electrolytes shipping vessels, reactor temperature and pressure monitoring on distributed control system (DCS), reactor weigh scales on DCS, warehouse/storage upgrades, install additional reactor capacity, building expansion and upgrades, concrete upgrades, storage tanks, product loading system.

To prepare for implementation of Phase 2, the following activities are planned for FY2012: Begin site selection for Phase 2, begin engineering for reactor expansion, reach go / no-go decision point on reactor expansion, complete EA for new site, if required, reach go / no-go decision point on Phase 2 and complete reactor expansion if required.

II.C.8 ARRA-supported Production Facility Project (FutureFuel Chemical Company)

John Tabbachi (NETL Project Manager)
Grant Recipient: FutureFuel Chemical Company

Gary McChesney (Principal Investigator/Project Director)
PO Box 2357
Batesville, AR 72501
(870) 698-5379
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Objective

Establish and expand commercial production of graphite anode materials for high performance lithium-ion batteries.

Introduction

- **Description of Facilities:** FutureFuel Chemical Company (FFCC) designed and constructed, and is currently operating a commercial-scale plant to produce Intermediate Anode Powder – the key component in ConocoPhillips' (COP) line of CPreme® Anode Materials. FFCC retrofitted an existing manufacturing plant located in Batesville, Arkansas, to produce the Intermediate Anode Material. The Intermediate Anode Material plant has the capacity to produce 10,000,000 pounds per year of material.
- Total Value of Award: $12,595,762
- Percent of Funds Expended as on 9/30/2011: 97.3%

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Progress and Current Status

Construction for the Intermediate Anode Material plant is complete. The plant has been commissioned and qualified. Approximately 128,000 pounds of qualification material was produced and tested. Process and equipment adjustments required based on the results of the qualification run have been largely completed and the plant is currently producing commercial material.

Construction of the supporting nitrogen separation plant is greater than 95% complete. The nitrogen plant is expected to start production in late November 2011 eliminating the expense of purchasing nitrogen for the Intermediate Anode Material plant.

Facility 1 – Intermediate Anode Material Plant

- Construction Complete (98%)
- Equipment Installed (100%)
- Production Started (100%)
- Permanent Jobs (15)
- Temporary Jobs (120)

Pictorial Overview

Figure II - 72: FutureFuel – Loading Dock Foundation.

Figure II - 73: FutureFuel – Loading Dock.

Figure II - 74: FutureFuel – Xylene Tanks-1.

Figure II - 75: FutureFuel – Xylene Tanks-2.

Figure II - 76: FutureFuel – Dryer Baghouse-1.

Figure II - 77: FutureFuel – Dryer Baghouse-2.

Figure II - 78: FutureFuel – Pitch Loading Hopper.

Figure II - 79: FutureFuel – Coke Loading Hopper.

Figure II - 80: FutureFuel – Anode Material Bag Out.

Figure II - 81: FutureFuel – Anode Material.

Planned Work for FY 2012

FFCC will complete construction and commission the supporting nitrogen separation plant. FFCC will commercially produce Intermediate Anode Material as necessary to fill orders from COP.

Other Information

FFCC produces Intermediate Anode Material under contract exclusively for COP. FFCC's only customer for Intermediate Anode Material is COP.

II.C.9 ARRA-supported Production Facility Project (Pyrotek Incorporated)

John Tabacchi (NETL Project Manager)
Grant Recipient: Pyrotek Incorporated

Michael J Sekedat (Finance Manager – Energy Group}
9503 E Montgomery Avenue
Spokane Valley, WA 99206
Phone: (509) 921-2854; Fax: (509) 927-2408
E-mail: micsek@pyrotek-inc.com

Start Date: October, 2009
Projected End Date: December, 2011

Introduction

- Description of facilities: This project is adding ninety-three thousand square feet of manufacturing and storage space within three joined buildings. In addition, specialty equipment will increase our graphitization capacity needed for the production of anode material for the lithium-ion battery manufacturers.
- Total Value of award: $11,334,652 (which represents 43.6% of the total project of $26,010,254)
- Percent of funds expended: As of the end of Sept 2011, over 96% of the award had been drawn down.

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Progress and Current Status

Facility 1 – Material Handling Building

As of the end of Sept 2011, the Material Handling Building is 100% completed. This is an insulated, steel shell building over a steel skeleton, on a concrete floor, with 30,000 sq ft of manufacturing space. This is a clear span space, with zero support posts within the manufacturing space. It is the only building where the material is exposed to the open air. It contains four (4) material handling systems, as well as a material testing lab and storage racking needed to house the material totes as they move through this building in preparation for graphitization, and for when the material returns after graphitization is completed. With regard to equipment, this building contains a specialty dryer, which is the first step required after receiving the material into our facility. The material is then moved to the second piece of equipment, which loads the material into containers for the graphitization process (performed in the adjacent bldg). Each system is critical in the overall production efficiency, and the goal of the loading station is to maximize the volume of material in each container, so as to maximize the throughput of each furnace. Once the material is graphitized, the containers are returned to the Material Handling building, where the end product is removed from the containers and placed back into clean totes. At present, these totes are being returned to our customer, ConocoPhillips, who performs the final step of blending, screening and bagging of the material for shipment to their end customer battery manufacturers. A blending, screening and bagging operation has been built within our Material Handling building. This is the fourth and final material handling system. It will be commissioned in early November 2011. Once operational, this will eliminate the need for returning the material to our customer. We will then ship direct to the battery manufacturers, as directed. All of this equipment has been (100%) installed. As of the end of Sept 2011, only the final operation (the blending/screening/bagging system) remained to be commissioned. Production in all other areas of this building started during July 2011. Our experienced and newly hired production personnel continue to learn the nuances of these new material handling systems. Concurrently, system adjustments are in process as we continue to develop the processing efficiencies needed. As of the end of September 2011, we had added 36 new, permanent employees to our Sanborn operation. This number will grow to around 50 new employees when all of the equipment is operational. While we do not know the exact number of vendor employees who worked on our construction project, most weeks saw in excess of 25 workers involved and on-site during this significant construction effort.

Facility 2 – Graphitization Building

As of the end of Sept 2011, the Graphitization Building was also (100%) completed. This is also a steel shell building over a steel skeleton, on a concrete floor, with 45,600 sq ft of manufacturing space. This building has space for 12 of our proprietary graphitization furnaces, as well as for the water cooling equipment. The furnaces are arranged in groups of three to maximize the operating efficiencies. As of the end of September 2011, the first three furnaces were operational, with 6 more furnaces in the process of being installed and fully setup for production. The final two furnaces will be completed during November 2011. The first furnace was put into production in June 2011, and the remaining two of this first set were operational during the final quarter of the fiscal year, as material volumes were available. With a

twenty-four hour operation, seven days a week, and a long training period for new employees, the hiring began well before the production was available. New employees were hired and trained within our existing Graphitization Department, and a mixture of experienced and new employees were selected to man the new furnaces when they were brought online. Of the 50 new employees that will be working when the plant is at full capacity, 32 will be manning the graphite furnaces, and the remaining 18 will work within the material handling building and finished goods.

Facility 3 – Storage Building

This final building was also 100% completed by the end of September 2011. This 18,000 sq ft building is of the same construction as the Graphitization Building, and brings our total facility size to 93,600 sq ft. This building presently houses furnace spare parts and materials, and will continue to be used as a warehouse to support the production plant. Looking forward, it is anticipated that additional graphitization capacity will be needed. As such we have added the necessary infrastructure to this final building which will enable us to place and operate 6 additional graphitization furnaces when the anode material demand grows to support that higher level of production volume.

Planned Work for FY 2012

Our expansion project will be concluded by the end of Novermber, 2011. The remaining two furnaces will be finalized by the middle of the month, and all other tasks are (like a small amount of landscaping) will also be completed. We expect the final expense reports to be submitted by the end of December, with the Quarterly reports in Janauary to complete that process as well. Limited production started prior to the end of FY2011, with volume increases beginning in November. While we continue to gain experience with the new Material Handling equipment, and the entire flow of material through our new facility, efforts will continue to focus on increased equipment throughput. At present, we are experiencing efficiencies that will enable the production of four millions pounds on an annual basis. Our staff level has grown by over forty employees, and efforts are ongoing to fully staff our seven day, twenty-four hour operation.

Other Information

As explained in our Award application, our graphitization service is provided to our single customer, to heat treat their raw material, producing the specialty anode material. Pyrotek does not own the material, nor do we sell it to the end users – battery manufacturers. The science behind the material is owned by our customer, as their proprietary information, while we own the proprietary heat treatment process.

Pictorial Overview

Figure II - 82: Pyrotek Production Facility Project – Construction.

Figure II - 83: Pyrotek Production Facility Project – Facilities.

Figure II - 84: Pyrotek Production Facility Project – Equipment.

II.C.10 Manufacture of Advanced Battery Components (HTTM LLC, H&T, Trans-Matic)

Christopher Johnson (NETL Project Manager)
Grant Recipient: HTTM LLC, H&T, Trans-Matic

Dan Moffa (H&T DOE Program Coordinator)
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Start Date: May 1, 2010
Projected End Date: April 30, 2013

Objectives

- Design and engineer unique U.S.-based product development and manufacturing processes which will produce cylindrical and prismatic metal outer shell (can) containers, covers, cover assemblies, and other components and assemblies for sustainable lithium-ion battery products for automotive and other applications;
- Develop and expand a highly skilled technical workforce through hiring & training several new professional, semi-skilled and skilled technicians; and,
- Install the designed processes at the Holland, Michigan facility and begin production.

Technical Barriers

Given the nature and ultimate operating use of the battery container components and other associated parts, the choice of base materials is critical, along with the manufacturing conversion process. Typical commercial grade materials do not normally have the consistency of gage and physical properties required for this application, especially when considering lot to lot variation. This is especially important in the areas of cleanliness and safety vent design. Safety vent consistency and predictability is directly proportional to the base material consistency, tooling precision and process capability.

In addition to the tight control of base material properties, the level of residual particulate matter present on the components after fabrication is critical. The low particle count and surface finish requirements as specified by battery OEMs are well beyond normal manufacturing protocol. In each case plans are developed to address all of these issues including tool materials and finishes, primary lubricants and coolants, verification and handling of raw materials and components during fabrication and assembly, and immediate in-line final cleaning equipment, followed by immediate inspection and packaging/sealing using specialized containers and dunnage.

Technical Targets

- Develop a metal battery cell container (can) and cover assembly system to meet OEM technical, quality, durability, safety, and cost objectives.
- Develop the manufacturing technology to produce drawn, stamped, impact extruded, and fold & welded containers, depending upon OEM customer requirements.
- Develop the capability to produce components in low carbon steel, stainless steel, and various grades of aluminum.
- Design and install a manufacturing process to produce consistent hermetically sealable container components for automated assembly at the customer's location.
- Design and produce safety vent features that can be incorporated into the can or cover, whether integral or separate component, that produce a specified range of burst pressures, from 2 bar to 25+ bar, as specified by OEM customers.
- Create and implement an in-tool automated vent feature measurement system that provides accurate and dynamic feedback on 100% of the parts produced.
- Develop an in-line cleaning system that meets Dyne and particulate matter cleaning requirements as specified by OEM customers.

Accomplishments

- Design simulation, development, prototyping, and production capabilities for both cylindrical and prismatic deep drawn, impact extruded, and fold & weld cell cases have been accomplished.

- A variety of steel and aluminum materials have been used for prototyping, preproduction and production components.
- Design and development of vent design features in cell cases and covers that maintain a statistically valid bursting range of 4 bar. Separate vent disc components have been designed and are being developed and tooled for OEM applications.
- Specialized equipment has been developed and is in use to precisely verify (non-destructively) safety vent physical features during production runs. Statistically capable burst testing equipment is also online and in use for all production runs.
- Currently in development with a new process for attachment of terminals to covers/cans that will result in cost reduction and quality improvements.
- Development of an integral termination feature for cell covers as a future value engineering change for additional cost reduction.
- Volume production is underway and products have been delivered to customers on time.

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Introduction

- Description of facilities: The facility utilizing the grant funding is located in Holland, MI. The HTTM JV utilizes portions of the existing Trans-Matic Manufacturing Co. floor space for new equipment required for manufacturing and assembly of the advanced battery components, as well as storage of WIP and finished goods.
- Total Value of the Award: $5,040,000
- Percent of Funds Expended: 40% (estimated as of: September 30, 2011)

Progress and Current Status

This project did not involve the construction of new facilities. The project did require some minor building modifications to the Trans-Matic facility and the installation of primary and ancillary production presses, assembly, cleaning, and packaging equipment.

- Construction complete: 100%
- Equipment installed: 100% of Lines 1 and 2
- Production Started: 90% (first production orders are at ramp-up volume levels on Lines 1 and 2)
- Jobs: Current, End of Program
- Jobs-permanent: 8, 19 (varies per actual workload)
- Jobs-temporary: 4, 8 (varies per actual workload)

Pictorial Overview

Figure II - 85: HTTM LLC, H&T, Trans-Matic Manufacturing Facility.

Figure II - 86: HTTM LLC, H&T, Trans-Matic Equipment – Battery Can Stamping Press.

Figure II - 87: HTTM LLC, H&T, Trans-Matic Equipment – Battery Cover Assembly Equipment.

Figure II - 88: HTTM LLC, H&T, Trans-Matic Component Pre-Cleaner.

Figure II - 89: HTTM LLC, H&T, Trans-Matic Website (www.httmllc.com).

Results

HTTM (H&T and Trans-Matic) have been successful in working with OEM advanced battery customers to provide the expertise, products and processes needed to be successful in the advanced energy storage market.

HTTM has prototype and production orders with several OEM cell producers to provide cell containers and cover assemblies for various cylindrical and prismatic battery cell systems.

Tooling and processing equipment design and fabrication have been completed on schedule and on budget for the current projects. Additional customer projects are in play. Facility modifications have been completed to support 2011-2012 volume production requirements.

HTTM has established itself as a subject matter and manufacturing expert for the development and production of advanced battery container components. HTTM utilizes its capabilities on a global basis and has delivered specialized development expertise and flexible manufacturing centers to create high quality and cost effective solutions for its customers.

Conclusions and Future Directions

The H&T and Trans-Matic core businesses and technology experience has been successfully transferred to HTTM and effectively applied to the advanced energy storage market.

Building upon its existing relationships with several of the key OEM players, HTTM has won the development and production orders of several OEM battery producers. As the industry, market, and technology evolve, HTTM has the flexibility and capability to deliver optimum metal container systems in a variety of configurations to satisfy any USABC, VDA, or other OEM requirements.

Several new product developments are underway with additional customers for metal cylindrical and prismatic container systems (cans and cover assemblies). Additional manufacturing press and assembly equipment is being built in anticipation of this new work. Production capacity is available.

Other Information

Publicly announced current customers include JCS and Saft. Additional customer work is in process within confidentiality agreements.

Jeff Lauinger was made General Manager of the HTTM Joint Venture on May 17, 2011.

Several articles have been published about HTTM and Trans-Matic in MIBIZ, Grand Rapids Press, Grand Rapids Business Journal, Holland Sentinel and other publications.

FY 2011 Publications/Presentations

1. 2011 USABC Conference – Detroit, MI
2. 2011 Fabtech Exposition – Chicago, IL
3. 2011 Battery Show – Novi, MI
4. 2011 SAE Vehicle Battery Summit – Shanghai, China
5. 2011 Beijing Battery Fair – Beijing, China
6. 2011 AABC Conference – Pasadena, CA
7. 2011 AABC Conference – Mainz, Germany
8. 2011 Advanced Energy Storage Taskforce – Holland, MI

II.D Battery Recycling Facilities

II.D.1 ARRA-supported Production Facility Project (Toxco, Inc.)

Bruce Mixer (NETL Manager)
Grant Recipient: Toxco, Inc.

Todd Coy
125 E Commercial St STE A
Anaheim, CA 92801
Phone: (714) 278-9211; Fax: (714) 278-9745
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Start Date: April 14, 2010
Projected End Date: March 2013

Introduction

- Description of facilities: An advanced recycling facility for the recycling and refurbishing of advanced lithium chemistry batteries.
- Total Value of award: $9,517,951.00
- Percent of funds expended: $1,368,011.06 (14.34%) expended through FY2011.

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Progress and Current Status

Facility 1 – LIB Recycling Plant, Lancaster, OH

- Construction complete 25%
- Equipment Installed 0%
- Production Started 0%
- Jobs: 43 permanent at project completion
- Jobs: 40 construction/temporary

Pictorial Overview

Figure II - 90: Toxco – Site Development.

Figure II - 91: Toxco – Concrete Pad – Site Development Facilities.

Figure II - 92: Toxco – Preliminary Building Site.

Figure II - 93: Toxco – Base Construction.

Planned Work for FY 2012

Work planned for FY 2012

1. Complete facility constuction and begin operations.
2. Conduct pilot operation of the Lithium Cobalt and NiMH line.
3. Install the lithium mixed metal oxide processing line.
4. Install battery refurbishing process line.
5. Conduct pilot operation of the battery refurbishing process line.

Other Information

1. **New York Times**
   - Article: "When Electric-Car Batteries Die, Where Will They End Up?"
   - Author: Don Sherman
   - Published: June 11, 2010
   - http://www.nytimes.com/2010/06/13/automobiles/13RECYCLE.html
2. **Green Diary**
   - Green Echoes: DOE grants $9.5 million for lithium battery recycling
   - Author: Aditi Justa
   - Published: August 12, 2009
   - http://www.greendiary.com/entry/green-echoes-doe-grants-95-million-for-lithium-battery-recycling/
3. **Autoblog Green**
   - Article: Toxco gets $9.5 million DOE grant for battery recycling.
   - Author: Sam Abuelsamid
   - Posted: August 18, 2009
   - http://green.autoblog.com/2009/08/18/toxco-gets-9-5-million-doe-grant-for-battery-recycling/
4. **Technology Review published by MIT**
   - Article: Lithium Battery Recycling Gets a Boost
   - Author: Tyler Hamilton
   - Published: August 12, 2009
   - http://www.technologyreview.com/printer_friendly_article.aspx?id=23215&channel=energy&section=

II.E Battery Research Facilities

II.E.1 ARRA-supported Prototype Cell Fabrication Facility (ANL)

Brian Cunningham (DOE Contact Person)
Grant Recipient: Argonne National Laboratory

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Argonne National Laboratory
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Start Date: April 2010
Projected End Date: July 2011

Introduction

Equipment was purchased in this project to support the establishment of a prototype cell fabrication facility at Argonne to fabricate advanced lithium-ion cells for use in its applied R&D program. A new state-of-the-art dry room and equipment for fabricating prototype cells is now operational. The equipment purchased in this project includes electrochemical cycle testers (for forming and evaluating newly fabricated cells), environmental chambers (for use in extreme temperature testing of these cells), a multi-channel impedance analyzer (for conducting in-depth electrochemical studies on selected cells), an accelerating rate calorimeter (for quantifying thermal abuse characteristics of selected cells), a new controlled-atmosphere glove box (for use in filling the cells with electrolyte), and a new X-ray diffraction unit (for use in quality control of cathode powders that will be used in these cells).

The total funding for this project was one million dollars. The project was completed at the end of July 2011 and essentially all the funds have been spent.

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Progress and Current Status

Facility 1 – description

- All equipment have been identified and the orders placed
- All equipment have been received and installed
- List of equipment purchased and installed
- Prototype cell testing and formation equipment (see Figure II - 94)
- Environmental chambers and ovens (see Figure II - 94)
- X-ray powder diffractometer (see Figure II - 95)
- Accelerating rate calorimeter (ARC) system (see Figure II - 96)
- Inert atmosphere glove box
- Multi-channel electrochemical test station and impedance analyzer (see Figure II - 97)
- Instron Materials Testing Instrument

Pictorial Overview

Figure II - 94: Maccor Series 4000 Automated Test System for testing and formation of prototype cells with environmental chambers and ovens.

Figure II - 95: Bruker D8 advanced powder diffraction system.

Figure II - 96: ARC-254 from NETZSCH.

Figure II - 97: Solartron (Ametek) eight channel electrochemical test station and impedance analyzer.

Planned Work for FY 2012

As this project was completed in July, no further work is planned.

Other Information

- Argonne Press Release (January 19, 2010): Funding will push Battery Technology from Argonne to the Marketplace
- BatteryPower (March 11, 2010) publishes article on Argonne's ARRA funded battery facilities

II.E.2 ARRA-supported Material Scale-Up Facility (ANL)

Brian Cunningham (DOE Contact)
Grant Recipient: Argonne National Laboratory

Primary Contact: Gregory Krumdick
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Start Date: April 1, 2010
Projected End Date: September 28, 2012

Introduction

Description of facilities: The objective of this project is to design and set up a laboratory-scale battery-materials production facility (Materials Engineering Research Facility or MERF) to rapidly scale up battery chemistries developed on the bench scale and produce bulk quantities of the materials for evaluation in prototype cells to enable quick turnaround validation of the materials chemistries.

The Materials Engineering Research Facility (MERF) will provide a new capability to Argonne's existing battery facilities, capabilities, and expertise. While the MERF will support Argonne's R&D program in batteries and ultra-capacitors, it will be an open facility and access will be available to other organizations, including other national laboratories, universities, and industry, for the validation of new materials and materials processing schemes. The new facility will also support strategic Argonne partnerships to enable a domestic battery manufacturing industry, such as the Kentucky-Argonne Battery Manufacturing R&D Center. As such, the MERF will enable substantial progress to be made in the development, validation, and ultimate commercial implementation of advanced battery-materials chemistries. Such a facility is a key missing link between the bench-scale development of battery technology and high-volume manufacturing of large-format advanced batteries for transportation applications.

This project consists of two tasks: a) Construction of the MERF, and b) Specifying and ordering equipment for the facility.

- Total Value of award:
  - Facility construction award = $3.3M
  - Equipment award = $2.5M
- Percent of funds expended:
  - Facility construction funds expended = $668,840 20.2% by end of FY 11
  - Equipment funds expended = $2,349,561
  - 93.9% by end of FY 11

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Progress and Current Status

Construction
Milestone 1 Complete full facility design (CDR) (10/1/2010). – **COMPLETED 8/19/2010**
Milestone 2 Award full facility construction contract (2/1/2011). – **COMPLETED 11/22/2010**
Deliverable 1 Open interim facility (9/30/2010). – **COMPLETED 9/17/2010**
Deliverable 2 Complete full facility construction (2/1/2012). – **ON SCHEDULE**
Deliverable 3 Open full facility (3/31/2012). – **ON SCHEDULE**

Equipment
Milestone 1 Interim facility equipment purchased & installed (12/31/2010). – **COMPLETED 9/17/2010**
Milestone 2 Production scale-up facility (MEF) equipment purchased & accepted (12/31/2011). – **PENDING FUNDING**
Deliverable 1 Interim facility open (9/30/2010). – **COMPLETED 9/17/2010**
Deliverable 2 Full facility open (3/31/2012). – **ON SCHEDULE**

Facility 1 – Materials Engineering Research Facility

See construction site pictures below.

- Construction complete (70%)
- Equipment Installed (0%)
- Production Started (0%)
- Jobs: permanent (7)
- Jobs: temporary/construction (30)

While the Materials Engineering Research Facility is under construction, interim electrolyte and cathode materials scale-up facilities have been established.

Facility 2 – Interim Electrolyte Materials Scale-up Facility

See interim facility picture below.

- Construction complete (100%)
- Equipment Installed (100%)
- Production Started (100%)

- Jobs: permanent (3, note, these jobs are also included in the Facility 1 values)
- Jobs: temporary/construction (0)

Facility 3 – Interim Cathode Materials Scale-up Facility

See interim facility picture below.

- Construction complete (75%)
- Equipment Installed (75%)
- Production Started (0%)
- Jobs: permanent (4, note: these jobs are also included in the Facility 1 values)
- Jobs: temporary/construction (0)

Pictorial Overview

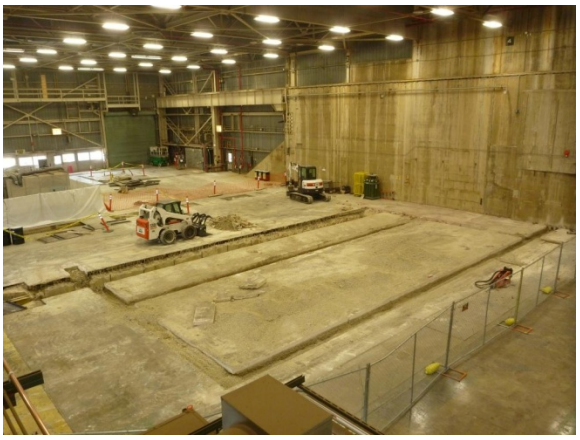

Figure II - 98: MERF Construction site 5/6/2011.

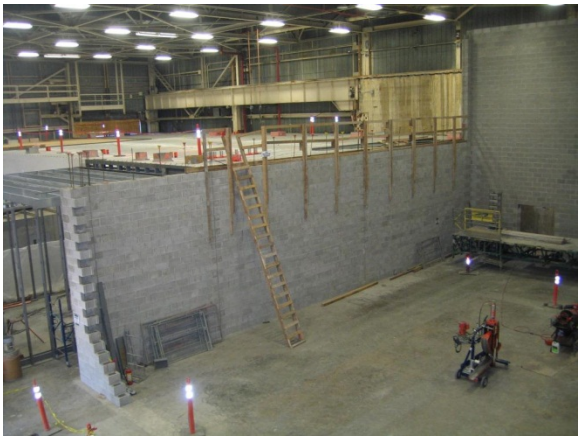

Figure II - 99: MERF Construction site 10/24/2011.

Figure II - 100: Electrolyte Materials Scale-up Facility.

Figure II - 101: Cathode Materials Scale-up Facility.

Figure II - 102: 20L Electrolyte Materials Reactor.

Figure II - 103: ICP for Cathode Materials Analysis.

Figure II - 104: XRD for Cathode Materials Analysis.

Figure II - 105: Redox Shuttle ANL-RS2, First Material Scaled in the Electrolyte Materials Lab.

Figure II - 106: Additional Electrolytes and Additives Scaled in the Electrolyte Materials Lab.

Planned Work for FY 2012

Construction of the Materials Engineering Research Facility will be completed in early FY 2012. All Interim Scale-up Facilities will be relocated to the Materials Engineering Research Facility shortly after construction is complete. We expect to continue our scale-up work in both electrolyte and cathode materials. We expect to scale-up four electrolyte materials and two cathode materials in FY 2012, pending available operating funds.

Other Information

- News Item 1 – New materials engineering labs see early success
- http://www.anl.gov/Media_Center/News/2011/news110913.html

II.E.3 Post-test Laboratory Facility (ANL)

Christopher Johnson (NETL Project Manager)
Grant Recipient: Argonne National Laboratory

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9700 South Cass Ave.
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Start Date: April 1, 2010
Projected End Date: December 31, 2011

Introduction

- The objective is to establish a dedicated facility for the post-test examination of new and aged cells and batteries. In a controlled environment, components will be harvested from new and aged cells and thoroughly characterized to establish the chemical and physical changes that occur during aging. Post-test characterization of these materials can provide critical information about the degradation mechanisms, which, previously, could be only hypothesized. Physical, spectroscopic, metallographic, and electrochemical tests will be used to aid the further improvement of a given technology by elucidating failure modes.
- The approach is to renovate an existing laboratory space to accommodate the needs of the new facility. Purchase a glove box, spectroscopy, microscopy, electrochemical, and metallographic equipment to conduct post-test characterization. Use the experience and techniques developed in DOE's applied battery program in a standardized fashion, similar to the performance test protocols.

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Progress and Current Status

The overall design of the laboratory is shown in Figure II - 107. The design shows the approximate placement of the major pieces of equipment.

An existing laboratory was modified to accommodate the new facility. The existing laboratory was completely demolished and was brought up to current building codes. Figure II - 108 shows the progress in the facility, from its starting point to having equipment installed.

Milestones:

Item	Due date	Status
Complete design for post-test laboratory construction	7/30/2010	Complete
Start construction of post-test laboratory	9/30/2010	Late start date: 12/2/2010
Post-test laboratory construction complete	3/31/2011	Complete
Post-test equipment identified	7/30/2010	Complete
Issue solicitation for glove box and equipment	9/30/2010	Complete
Complete construction of post-test facility	12/31/2011	On schedule

Financial data:
Total project duration: 21 mo.
Laboratory modifications $300K/6 mo.
Equipment: $2000K/17 mo.

Almost all the equipment has been set up and calibrated (Figure II - 109(a) and (b)). The remaining items to be installed are high-pressure nitrogen for the HPLC/GPC unit and the benchtop grinding/polishing equipment. These items are expected to be completed by the end of November 2011.

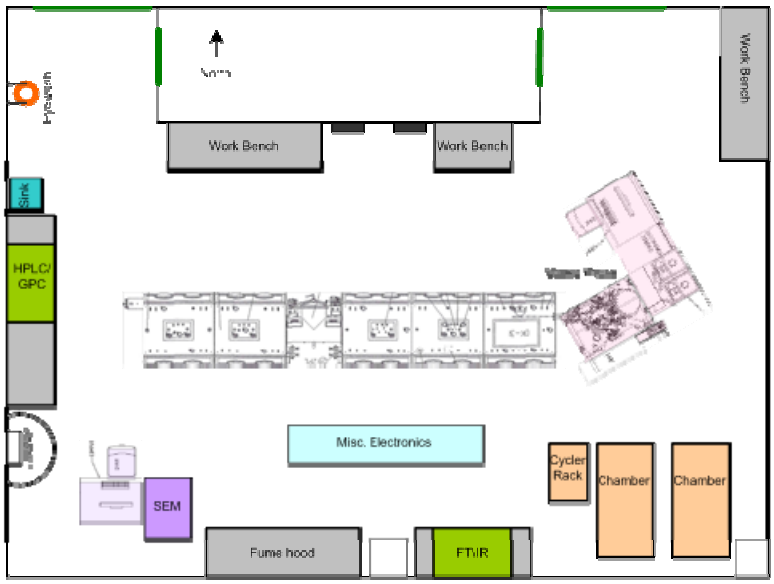

Figure II - 107: Overall design of the post-test facility. The large, open area at the top of the figure is not part of the post-test facility. The VersaProbe X-ray photoelectron spectrometer (XPS) was purchased with funds from the US Department of Defense.

Figure II - 108: Photographs showing progress in modifying the laboratory space. Clockwise, from the upper left: starting condition; installing glove box in facility after renovation; installing the thermogravimetric analyzer in glove box; and attaching the XPS unit to the glove box.

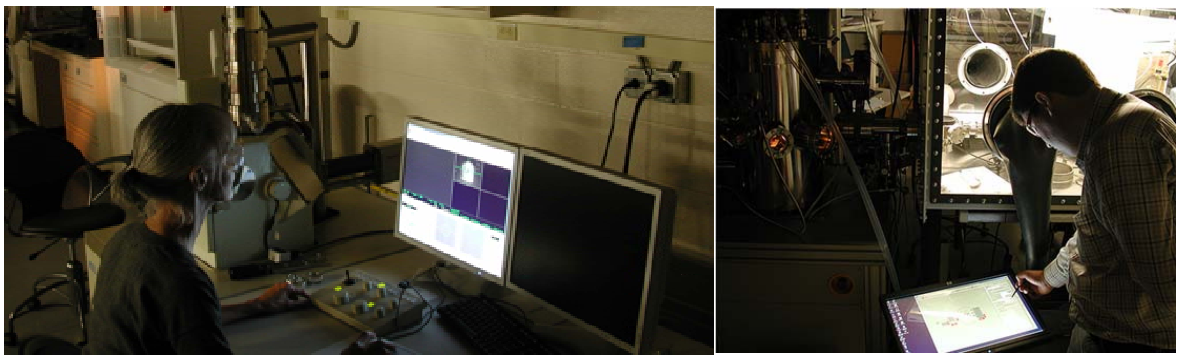

Figure II - 109: (a) The environmental SEM being calibrated and tested. (b) The XPS being tested.

Table II - 2: Status of equipment purchases.

Equipment	Purchased?	Delivered?
Custom glovebox	Y	Y
FT-IR	Y	Y
Raman	Y	Y
Metallography equipment (saws, polishers, grinders, etc.)	Y	Y
Optical microscope	Y	Y
Electrochemical Impedance Spectroscopy (8-ch frequency analyzer and potentiostat)	Y	Y
Environmental SEM	Y	Y
XPS	Y	Y
HPLC/GPC	Y	Y
Coin cell cyclers	Y	Y
Environmental chambers	Y	Y

Establishing the post-test facility requires procuring many pieces of equipment. The progress made in procuring equipment is shown in Table II - 2.

Planned Work for FY 2012

In summary, the facility is currently about 95% operational. A few items remain which should be complete by December 2011. Our next steps are as follows. These are aimed to gain experience in the facility as well as to develop our post-test procedures.

- Use commercial, 18650-sized cells to develop tear-down procedures and methods to sample head-space gas and electrolyte. Develop methods to cycle/electrochemically characterize aged cell materials (EIS; small-cell cycler)
- Examine initial cell builds from Argonne's Cell Fabrication Facility to help elucidate possible issues that could limit performance and life
- Examine old (~13 y) cells from the ATD program to characterize the long-term changes present in the cells
- Collaborate with ABR, BATT and USABC programs

Other Information

None.

II.E.4 High-Energy Battery Testing Facility (INL)

Brian Cunningham (DOE Contact)
Grant Recipient: Idaho National Laboratory

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Idaho National Laboratory
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timothy.murphy@inl.gov

Start Date: March 1, 2010
Projected End Date: April 30, 2013

Introduction

- This project is for equipment and facility upgrades needed to fully build and operate the new Idaho National Laboratory (INL) High Energy Battery Test Facility that will be constructed at the INL site in Idaho Falls, Idaho.
- Project Time Line: 03/01/10 – 04/30/13.
- Funding: $5.0M received from DOE.
- Funds Expended through 9/30/11 $3.0M
- This project is supporting the nation's economic recovery by creating U.S. based national laboratory jobs; the INL is building a new 10,000 sq. ft. high energy battery test facility.
- The INL project is in response to an identified capability shortfall within the DOE-EERE battery test facility complex. The DOE national laboratories lead test facilities' capability to test full size high voltage battery systems and high energy battery cells will not be able to meet the testing demand in support of DOE EERE battery development and manufacturing projects over the next five to ten years. Several DOE/USABC development contracts are scheduled to deliver full-size vehicle battery systems and large numbers of high energy battery cells in the next several years. These currently include deliverables from A123 Systems, CPI/LG Chem, Johnson Controls, and many others.
- The awarded equipment funding will enable electrical performance testing of five additional full-size battery systems and large numbers of high energy battery cells. This new capability also will enable expanded exposure by DOE battery developers to the testing operations, increasing overall quality and reducing costly procedural errors. In addition, the creation of a new test facility focused on high voltage systems and high energy cells will allow existing facilities to further increase capability for testing DOE-EERE battery deliverables. Lastly, this capability expansion will greatly enhance the INL mission focus on diagnostic testing, providing cradle-to-grave analysis of cells, modules, and full systems, targeting mechanistic-level knowledge that will enable determination of failure mechanisms and subsequent technology improvement and optimization for the intended automotive applications.

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Progress and Current Status

Equipment received to date:

- 1- Vibration test station
- 8- High current calendar and cycle life test
- channels
- 1- 500 Volt / 350 Amp tester
- 8- 1.5 ft^3 temperature chamber
- 2- Pack sized temperature chambers
- 2- Pack level calibrations systems

Equipment to be received in FY 2012:

- 4- 500 Volt / 350 Amp testers
- 22- 1.5 ft^3 temperature chambers
- 15- 7ft^3 temperature chambers
- 2- Walk-in temperature chambers
- 1- Control room system

Power and HVAC upgrades during construction of the building

The high current calendar and cycle life test channels will increase the number of cells that can be tested by 128, 96 channels to be used for calendar life testing and 32 channels to be used for cycle life testing. The current battery test lab has 31 high current cell level cycle life channels, 80 high current cell level calendar life channels, 20 module level channels, and 3 pack level channels. The other 378 channels are used for small experimental cell chemistry and materials developmental testing.

Lithium ion cell performance is sensitive to temperature. All cell, module, and pack level testing is performed within high precision temperature chambers to add a level of accuracy and safety to the testing.

Figure II - 110 is the floor plan for the High Energy Battery Test Facility Figure II - 111 and Figure II - 112 show the current progress on the building for the equipment purchased for this project. Figure II - 111 is a portion of the wall that can be viewed from the street. Figure II - 112 is the concrete slab where the building will

stand. Figure II - 113 is the first pack level tester that was purchased and has been connected to electrical power for evaluation in the current battery test laboratory. Figure II - 114 shows the vibration test stand in its final location in IF605, the current battery test laboratory.

Facility description

- Building construction is 20% complete.
- Equipment installed: 5% (the majority of the equipment will remain in storage until after the completion of the building
- Production started: 0 %
- Jobs: 5 permanent (at project completion)
- Jobs: 30+ temporary construction

Pictorial Overview

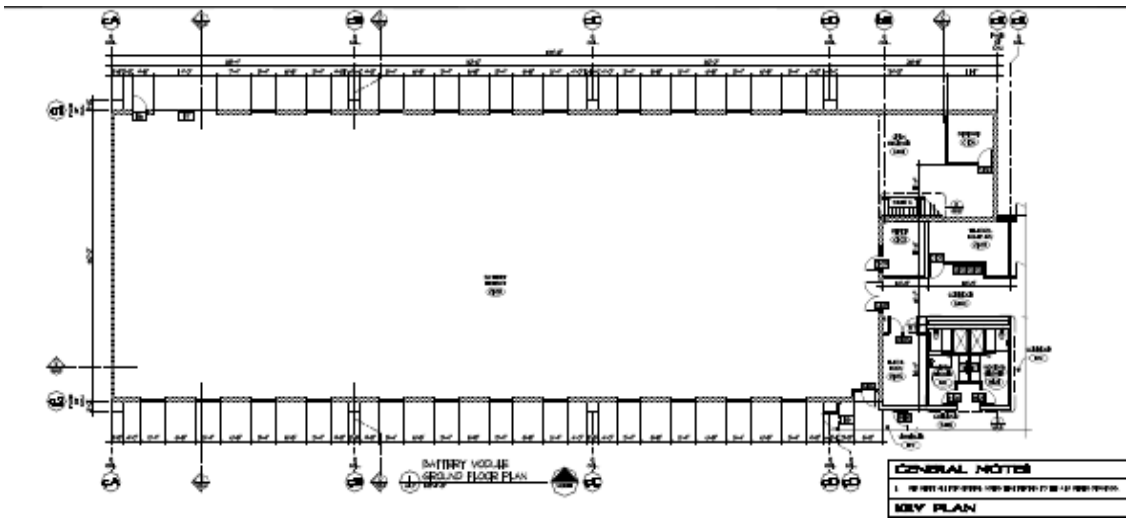

Figure II - 110: Floor Plan for the High Energy Battery Test Facility.

Figure II - 111: Street view of building under construction, new INL High Energy Testing Facility construction began in Aug.of 2011.

Figure II - 112: Long view of the 10,000 sq. ft. foundation and start of wall construction process in Sept. 2011.

Figure II - 113: View of large 500V test channel received in FY 2011 for the new laboratory. 2 units have been received with 4 additional units scheduled for FY12 delivery.

Figure II - 114: Vibration testing system for full size vehicle battery pack testing received in FY 2011.

Planned Work for FY 2012

Construction on the new INL High Energy Battery Test Laboratory building will continue and be completed by August 2012. Occupancy will begin in September 2012, with the start of equipment moves from storage for installation. Equipment moves, staging, and installation is expected to continue into January of 2013. However, a limited amount of battery and cell testing is expected to begin as early as November of 2012. It is expected that the new facility will be approximately 50% operational by the end of December 2012, and become fully operational by the project end date of April, 2013. The equipment funding will add fourteen new testers, with 128 or more new test channels to the current 512 test channels for a total of 640 or more total test channels, and equipped with accompanying thermal test chambers. The funding will also create five new full time positions at the INL.

II.E.5 Battery Thermal Test Laboratory (NREL)

Brian Cunningham (DOE Contact)
Grant Recipient: National Renewable Energy Laboratory

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Start Date: March 1, 2010
Projected End Date: June 2013

Introduction

To facilitate and accelerate the commercialization of advanced energy storage technologies by the U.S. industry, the Department of Energy awarded the National Renewable Energy Laboratory (NREL) $2M to expand and upgrade its battery thermal facility under the 2009 American Recovery and Reinvestment Act (ARRA). Proper thermal design and performance are critical in achieving desired battery life, performance, and cost targets. In this facility, NREL will perform thermal evaluation and characterization of batteries developed by U.S battery developers to aid them in understanding their thermal characteristics to improve thermal design.

NREL performs thermal testing, analysis, and modeling for two purposes: (1) assisting DOE and the United States Advanced Battery Consortium (USABC) battery developers in designing cells/modules/packs for improved thermal performance; and (2) benchmarking and validating the thermal performance of cell/module/pack deliverables from DOE/USABC battery developers and suppliers.

Benchmarking cells, modules, and packs under development has been a critical effort for integrating battery systems in advanced vehicles. NREL's current thermal test facilities identify areas of thermal concern as well as characterize the efficiency and heat generation of cells (with different chemistries) and sub-modules under various drive profiles and at various temperatures. NREL's equipment can also benchmark how changing the design of the cell using a different cathode, anode, current collector, electrolyte, or separator affects the overall performance of the cell.

The information garnered from these tests helps battery and car manufacturers design thermal management systems that reduce the life-cycle cost of battery systems in advanced vehicles. Because DOE's energy storage program has expanded over the past year, we have a backlog in thermal characterization and testing of prototypes, particularly in heat generation measurement. With anticipated growth in the DOE program and an increase in the number of batteries coming from domestic battery manufacturing facilities under ARRA funding, we plan to add capacity and enhanced capability by adding new equipment and additional space in our existing facilities. We will add calorimeters, thermal conductivity measuring instruments, pack thermal evaluation equipment, environmental chambers, and high-power cell and module battery cyclers.

- Total value of award: $2 million
- Percent of funds expended: 82% - End of FY11

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Progress and Current Status

TTF Laboratory Facility. NREL identified 1000 ft^2 of space adjacent to the existing energy storage test laboratory in the Thermal Test Facility (TTF) for a large portion of the new equipment purchased under the ARRA program. This additional laboratory space needed to be modified and upgraded to accommodate the new equipment. In particular, the space required electrical, chilled water, and safety modifications before it could be used for energy storage activities. NREL, in conjunction with DRG construction (outside contractor), modified the space and completed all facility modifications by the end of March 2011.

Since the completion of the new laboratory, all the battery cyclers and environmental chambers acquired with ARRA funds are operational, calibrated, and in use. The ABC-150 battery cycler is being used to test the A123/USABC PHEV10 pack as well as the JCS/USABC PHEV20 pack. The newly acquired Bitrode cyclers are being used for testing USABC cells from A123, JCS, K2, and SK. We have begun using the ARRA-purchased thin film and bulk thermal conductivity meters as well as the coin cell calorimeter. Furthermore, we have completed the fabrication of all the component pieces for the new custom-designed cell calorimeter and are presently assembling the pieces into the final product. We filed U.S. Provisional Patent Application 61/532,869 entitled "Calorimeters for Testing Energy Storage Systems and Power Electronics" (NREL ref. 11-102) that outlines the innovative features of the cell calorimeter developed with ARRA funds. Finally, we have purchased an electrochemical impedance spectroscopy (EIS) unit that will aide NREL in developing new battery materials and

have purchased many of the component pieces for the battery thermal management test loop.

- Construction complete: 100%
- Equipment Installed: 90%
- Production Started: 90%
- Jobs: 1 regular employee was hired at NREL for specifying, purchasing, installing and operating the equipment. We anticipate this position to continue for testing batteries in the coming years
- Jobs: We estimate that 4 temporary/construction jobs were created over the two years of the project so far.

Pictorial Overview

Following are photographs of the new NREL laboratory space and equipment purchased under the ARRA program.

Figure II - 115: TTF Laboratory before Construction.

Figure II - 116: TTF Laboratory Chilled Water and Electrical Installation.

Figure II - 117: TTF Laboratory after Construction and Equipment Installation

Figure II - 118: TTF Laboratory Environmental Chambers (3/5) with JCS and A123Systems PHEV battery packs under test.

Figure II - 119: TTF Laboratory Bitrode Battery Cyclers.

Figure II - 120: Thin film thermal conductivity meter, coin cell calorimeter, and bulk thermal conductivity meter (clockwise from upper left)

Figure II - 121: NREL-designed/fabricated cell calorimeter.

Planned Work for FY 2012

The NREL Battery Thermal Test Facility, including the purchase and installation of equipment, will be finished by June 2012. The remainder of the work for FY12 will concentrate on completing the fabrication of the battery thermal management test loop and the custom-designed cell calorimeter. We will also be vetting these two systems to determine how well they perform and adjust the design as necessary.

II.E.6 Battery Abuse Test Facility (SNL)

Brian Cunningham (DOE Contact)
Grant Recipient: Sandia National Laboratory

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Start Date: April 2010
Projected End Date: March 2012

Objectives

- Redesign and upgrade the Sandia Battery Abuse Test Facility.
- Update our testing equipment, add testing/characterization capabilities, increase our testing throughput, and upgrade the safety features of the facility to accommodate testing larger PHEV and EV battery packs.

Accomplishments

- Construction phase 95% complete
- 90% of the equipment for the facility has been received or is in transit.
- Installation and staging of new equipment is 60% complete. Balance to be completed by 23 December 2011.

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Introduction

In 2010, Sandia National Laboratories was awarded funding through the American Reinvestment and Recovery Act (ARRA) for facility upgrades to the Battery Abuse Testing Laboratory. Upgrades to the facility were focused on improving the safety engineering controls and systems required to accommodate abuse testing PHEV and EV sized battery packs, improving our testing efficiency and throughput, updating laboratory equipment and systems to facilitate the growing demand for safety testing and increasing overall documentary efficiency.

With the widespread commercialization of PHEVs and EVs using lithium-ion batteries, the demand for testing the safety and reliability of these systems by the battery developers and auto manufacturers has increased. Sandia has developed a unique testing and characterization facility for these systems over the past decade and the upgrades to the facility outlined in this project has already advanced our capabilities and as more equipment is installed, our capability will continue to grow to meet the needs of our customers now and well into the future. Safety system improvements and facilities upgrades include, upgraded laboratory power and relocated power out of the hardened test bays for safer operation, fire/explosion proofed test bays (lighting, equipment panels, etc.), and added fire suppression capabilities for large test articles. We have upgraded the exhaust/scrubber systems to the facility to ensure safe testing of large scale systems.

Our equipment recapitalization reflects the growing demand for larger scale batteries (> 5 kWh) as well as our vision for adding capabilities to support our testing and R&D programs. Equipment upgrades included high voltage/high current power supplies and battery cyclers, analytical characterization equipment, updated battery calorimetry instrumentation, mechanical test equipment large enough for full PHEV and EV pack testing, large thermal test chambers, and an X-ray computed tomography system for failure analysis. In addition, we have completely renovated our data acquisition systems to allow for fully integrated (data, video, and audio) parallel testing which has significantly improved our efficiency and throughput and will continue to improve as more of the new capability is brought on line.

Progress Update

Facility Renovation. Facility design was completed in December 2010 and construction work on the facility began January 2011. The bulk of construction work was completed in September 2011 with a few remaining items to be completed in FY12. Upgrades to the facility include:

- Mechanical: removal of unused utilities, relocation of process gases and building exhaust to accommodate new calorimetry/glove box equipment, upgrading the scrubber system, increasing and rebalancing test bay exhaust, redesign common space floor plan to maximize efficiency and usable area.
- Electrical: Complete laboratory redesign and upgrade in power with three new electrical service panels (480 A total capacity) to accommodate large testers (>500V), relocation of power for safer operations
- Fire protection: explosion proof lighting, explosion proof equipment panels, relocation of power outside test bays, CO_2 fire suppression systems for module and pack tests

- Analytical: Gas product composition analysis; increased data acquisition rates, channels & quality; durable parallel test hardware support; increased real-time a/v capability.

The construction phase is 95% complete with a few outstanding punch-list items for resolution. Installation of new analytical, control, analysis, and documentation upgrades is approximately 60% complete with the balance expected to be complete by 23 December 2012 (see Figure II - 122).

Equipment Upgrades. Equipment identified for the facility has been identified and the procurement process nearly complete. In fact, > 80% of the instrumentation (by dollar amount) was received and costed by FY11. Equipment was chosen to support our core testing programs as well as to expand our testing/characterization capabilities. The key equipment are listed in Table II - 3.

Table II - 3: Key Equipment Listing

Equpiment for Battery Abuse Test Facility Upgrade
Electrical Test Equipment
Battery Cycler
Cell Level Tester
Pack Level Tester
Analytical Equipment
IR spectrometer
Mass spectrometer
Thermal Test Equipment
Thermal Chambers
Pack Thermal Chamber
Mechanical Abuse Equipment
Hydraulic Press and Controller
Calorimetry and Characterization Tools
IR laser diagnostic platform
X-Ray CT
ARCs (2)
Cell Reaction Calorimeter
Microcalorimeter
Glove Box

The cyclers and testers will facilitate C/D cycling, overcharge abuse, and overdischarge abuse testing of vehicle scale, high energy batteries (>15 kWh). The upgrades to the spectroscopy tools (mass spectrometer and IR spectrometer with heated transfer lines) will facilitate real-time quantitative gas analysis for degradation products from the abuse of these batteries. Additional accelerating rate calorimeters (ARCs, one large and one small volume) will improve our testing throughput of materials, 18650 cells, and will also allow us to perform additional ARC experiments on large format PHEV and EV cells for our DOE programs. The X-ray CT system gives full CT images with resolution on the order of tens of microns (Figure II - 123). This will expand our capabilities to performing failure analysis/forensics on cells and even modules post-test. This will give us some insight *in situ* into failure mechanisms for these systems (e.g. internal short circuit, etc.)

Figure II - 122: Completed renovated test cell in the abuse facility.

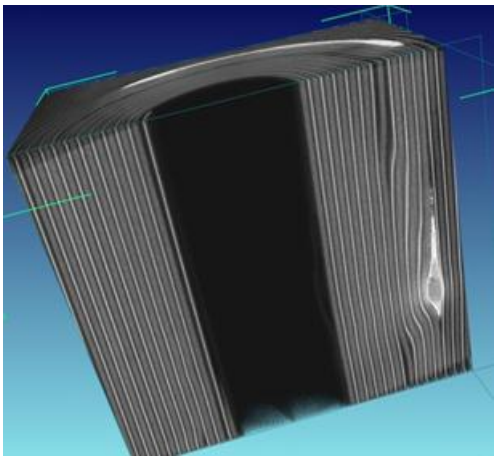

Figure II - 123: CT image of an 18650 lithium-ion cell with a large defect in the roll.

Planned Work for FY 2012

An overview of the remaining schedule for this project is listed below in Table II - 4.

Table II - 4: Project Schedule.

Schedule Overview for the Battery Abuse Test Facility Upgrade	
November 2011	Close out construction activities
December 2011	Installation of new equipment completed
January 2012	Evaluation of capabilities
February 2012	Complete updating test software
March 2012	Project completed

The final design of the facility was completed as planned in December 2010. The facility modifications will be completed in November 2011. Installation of new equipment began in July 2011 and the facility is scheduled to be 100% operational by March 2012.