Electric Drive Component Manufacturing Facilities

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Project ID #
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A technology leader in the development and manufacture of high performing, power dense and energy efficient:

- electric motors
- generators
- power electronic controllers

..........for vehicle electrification.

Location: Longmont, CO (22 miles north of Denver)
Employees: 76
Exchange: American (AMEX:UQM)
Project Overview

➢ **Time Line**
  - Start- July 2009
  - Finish- September 2012
  - 22% Complete

➢ **Budget**
  - Total Project funding-$90,291,039
  - 50% cost match with the DOE over the four year period

➢ **Barriers**
  - Markets to sustain volume production
  - Maintaining accelerated time lines
  - Ability of our key electronics suppliers to meet production ramp up timing
  - Complexity and timing impact of motor winding equipment

➢ **Partners**
  - BorgWarner
Completed Objectives

- Develop a low cost electric propulsion system that can be manufactured in volume
  - Follow all Advanced Product Quality Planning and Control plans to insure a quality product that meets SAE standards
- Purchase an existing manufacturing facility that allows us to meet current customer requirements and provides plenty of room for future growth
- Set up production to support an initial rate of 20,000 units a year, meeting near-term requirements on a single shift
- Establish multiple electronic suppliers for key components to minimize timing and volume delivery risks
- Design manufacturing equipment that can meet takt time while remaining flexible enough to keep up with evolving and changing technologies
Ongoing Objectives

- Continue existing and develop new relationships with OEM’s to increase production volume
- Work with multiple automotive OEMs to ensure that the products apply to many vehicle platforms to reduce exposure caused by one or more unsuccessful platforms
- Develop internal company processes to support growth without losing focus on managing the details of the execution
- Move our current ISO certification to a TS certification to better appeal to automotive customers
- Continue to use our technology development group to stay ahead of new developments in the electric propulsion industry and evolve our products
- Become an OEM supplier with satellite locations that can support volumes up to and exceeding 160,000 units a year based on requirements
## Targets and Slated Completion Dates

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<tr>
<th>Activity</th>
<th>Scheduled Completion</th>
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<tr>
<td>Facility Selection and Preparation</td>
<td>June 2010</td>
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<td>Design Validation of the 100kW System</td>
<td>May 2010</td>
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<td>Process Design for the 100kW System</td>
<td>June 2010</td>
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<tr>
<td>Order Production Equipment</td>
<td>June 2010</td>
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<td>Installation of Production Equipment</td>
<td>Aug. 2010</td>
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<td>Completion of Dyno Test Area in New Facility</td>
<td>April 2011</td>
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<td>PPAP of 100 kW Production Line</td>
<td>March 2011</td>
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<td>Design Validation of the 135kW system</td>
<td>Jan. 2011</td>
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<tr>
<td>Design of a production intent 200kW system</td>
<td>July 2011</td>
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Electrifying Vehicles

Product Technical Approach- Motor

- High energy permanent magnets
- High pole count
- Proprietary winding patterns
- Short winding end turns
- Optimized material utilization
  - Minimize copper, iron and magnets
- Advanced control techniques
  - Field oriented control
  - Full wave commutation
  - Phase advance
- Low cost cast housings
- Designed for manufacturability
- Low cost, highly efficient magnet retention system
Product Technical Approach- Controller

- Integrated EMI filter
- Modular design
- Integrated safety features
- Low cost cast housings and covers
- Layered design for improved manufacturability
Approach - Building a Reliable System

- Began DV testing in March 2010 of the PowerPhase® 100 system to SAE J1113, SAE J1455 and various MIL specs to insure the broadest possible market.
Approach - Building a Reliable System

- **Mechanical Vibration** - SAE J1455 Heavy duty truck standard: Passed
- **Mechanical Shock** - SAE J1455 Heavy duty truck standard: Passed
- **Humidity Cycle** - SAE J1455 Heavy duty truck standard: Passed
- **Salt Fog** - SAE J1455 Heavy duty truck standard: Passed
- **Thermal Cycle** - SAE J1455 Heavy duty truck standard: Passed
- **Water Immersion** - SAE J1455 Heavy duty truck standard: Passed
- **Liquid Contaminant Splash** - SAE J1455 Heavy duty truck standard: Passed
- **Pressure Wash** - DIN 40 050: Passed
- **Electrical System Qualification** - UQM Designed battery of tests based on previous experience: Passed
Approach - Building a Reliable System

- Manufacturing and quality engineering involved with design engineering from the concept stages.
- Worked with several equipment suppliers throughout the design of the system to insure the best possible manufacturability.
- Utilized 20 years of lessons learned based on previous experience with products and customers from several different industries.
- Hired employees with both automotive and volume electric systems experience as the project moved forward.
- Working with OEM’s has helped us understand what is required and we now have those requirements built into our systems for future customers.
Purchased an existing facility in December of 2009 and began renovations in March 2010

- Utilizing recycled building materials whenever possible
- Goal is a zero waste facility
- Low VOC flooring installed
Approach - Expanding Manufacturing Space

Current new facility layout with 100kW production lines in place
Major Accomplishments

- Won supply contract with CODA Automotive to supply 20,000 systems over the first two years of production, set to begin next year
- 100kW DV went as expected with the system meeting all of the performance and reliability goals as set in our SAE based DV plan
- Negotiating supply contracts with multiple automotive OEM’s for additional volume commitments
- Hired three engineers and a new manager to our quality department to insure that we protected our customers as the volumes expanded
- Hired five manufacturing engineers in order to support the design of the system and the layout of the production lines
- Hired a facilities engineer to manage the renovation of our new building
- Hired five technicians to begin training for the future growth
Major Accomplishments

- Renovation of the new manufacturing facility is 98% complete and on track for the completion in March 2011
  - This will enable the company to meet aggressive production timelines
- 100% of major motor line equipment ordered from American vendors
- 100% of the major controller line equipment ordered from American vendors
Future Work

- Finish Production Part Approval Process (PPAP) - June 2011
- Develop our next generation 135kW system - Feb. 2011
- Develop a production ready 200kW system in order to increase our product offerings and potential customer base - June 2011
- Increase production capacity to support each system and its customer base
Summary

- By June of this year, UQM will have a design validated 100kW system in production with initial capacity of 20,000 units a year
  - We can double that capacity by adding a second shift
- Currently in negotiations with several major OEMs for volume projects based on a similar platform
  - Two fleet builds in progress
- A second generation, 135kW system already began in the PPAP process
- A completely redesigned 200kW system should be ready for testing late in 2011
- New facility and supplier relationships will give us the capability to increase volumes within a very short lead time, supporting new vehicle platforms