Electrifying Vehicles

Electric Drive Component Manufacturing Facilities

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UQM Technologies

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Project ID #

ARRAVT026

Company Overview

Electrifying Vehicles

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:	**Frederick, CO (20 miles north of Denver)**
FY 2009 Sales:	**$8.7 million**
Employees:	**70**
Exchange:	**American (AMEX:UQM)**

Project Overview

Electrifying Vehicles

- **Time Line**
  - Start- July 2009
  - Finish- September 2012
  - 20% 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

Objectives

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- **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**

Objectives

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- Continue existing and develop new relationships with OEM's to increase production volume to 80,000 by the second quarter of 2011
- 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

Product Technical Approach- Motor

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- 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

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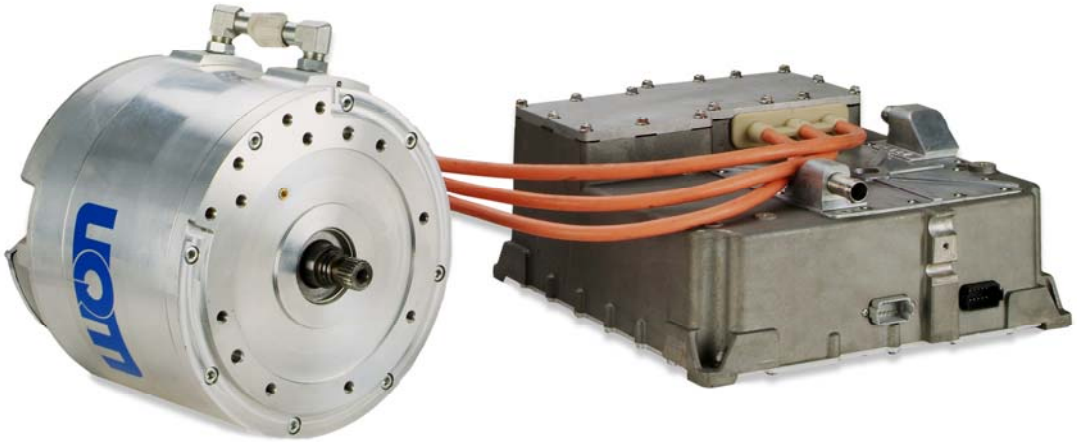
- Integrated EMI filter
- Modular design
- Integrated safety features
- Low cost cast housings and covers
- Layered design for improved manufacturability



Approach- Building a Reliable System

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- 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

UQM
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- 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

Current Manufacturing Capability

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Overview

- Focused factory, demand flow production
- 100% automated testing
- Advanced Product Quality Planning procedures
- ISO 9001:2000 quality certified

PowerPhase® 100 System Production Ramp

- Expanding manufacturing space
- Adding people
- Adding tooling and equipment

Approach -Expanding Manufacturing Space

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- **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

Production Ramp-Up

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- Adding people
- Adding tooling and equipment

Major Accomplishments

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Key Milestones	Date Completed	Total Hires
Establish First Major Volume Customer at 20,000 units a year	July 27 2009	2
Purchase New Facility	December 15 2009	0
Complete Initial Design of New 100kW System	February 5 2010	3
Complete Production Process Flow Charts	February 15 2010	1
Purchase of Major Manufacturing Equipment	February 26 2011	2
Completion Of DV for the 100kW System	April 30 2010	2

Major Accomplishments

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- 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 two engineers to our quality department to insure that we protected our customers as the volumes expanded
- Hired three manufacturing engineers in order to support the design of the system and the layout of the production lines
- Hired a program manager to support our volume customers
- Hired a facilities engineer to manage the renovation of our new building
- Hired five technicians to begin training for the future growth

Major Accomplishments

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- **Renovation of the new manufacturing facility is 80% complete and on track for the completion of the production area in April, with a full move completed in late June**
  - This will enable the company to meet aggressive production timelines
  - The aggressive schedule has increased the number of contract workers on the building site
- **100% of major motor line equipment ordered from American vendors**
- **80% of the major controller line equipment ordered from American vendors**

Future Work

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- **Take delivery and install manufacturing equipment**
  - May 2010
- **Run Production Part Approval Process (PPAP)**
  - May 2010
- **Develop our supplier base with alternate sources for critical components**
  - April 2010
- **Develop a growth curve for capacity to support additional business efficiently**
  - July 2010
- **Develop our next generation 135kW system**
  - Work with electronic component manufacturers to develop required technology

Summary

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- **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**
- **A second generation, 135kW system will be production ready as early as November of this year**
- **New facility and supplier relationships will give us the capability to increase volumes within a very short lead time, supporting new vehicle platforms**