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

Project Overview

Electrifying Vehicles

- **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

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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**

Ongoing Objectives

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

Product Technical Approach- Motor

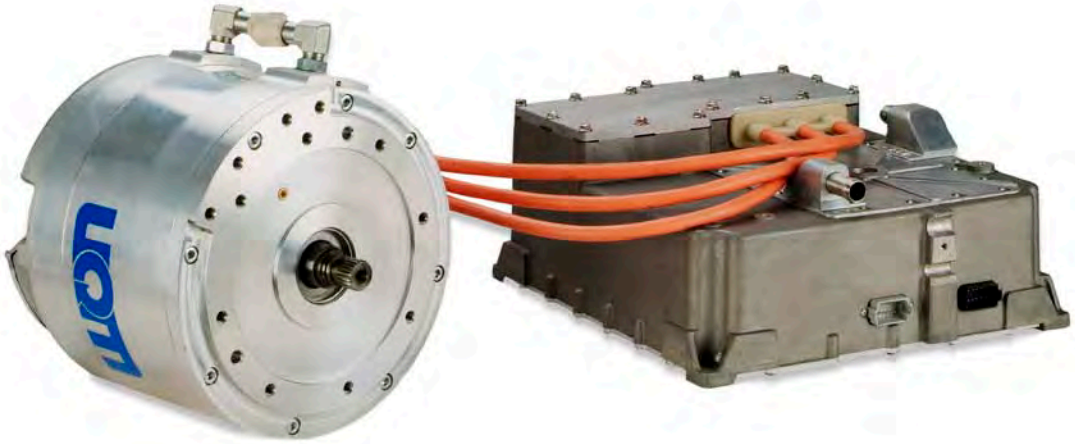
Electrifying Vehicles

- 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

Electrifying Vehicles

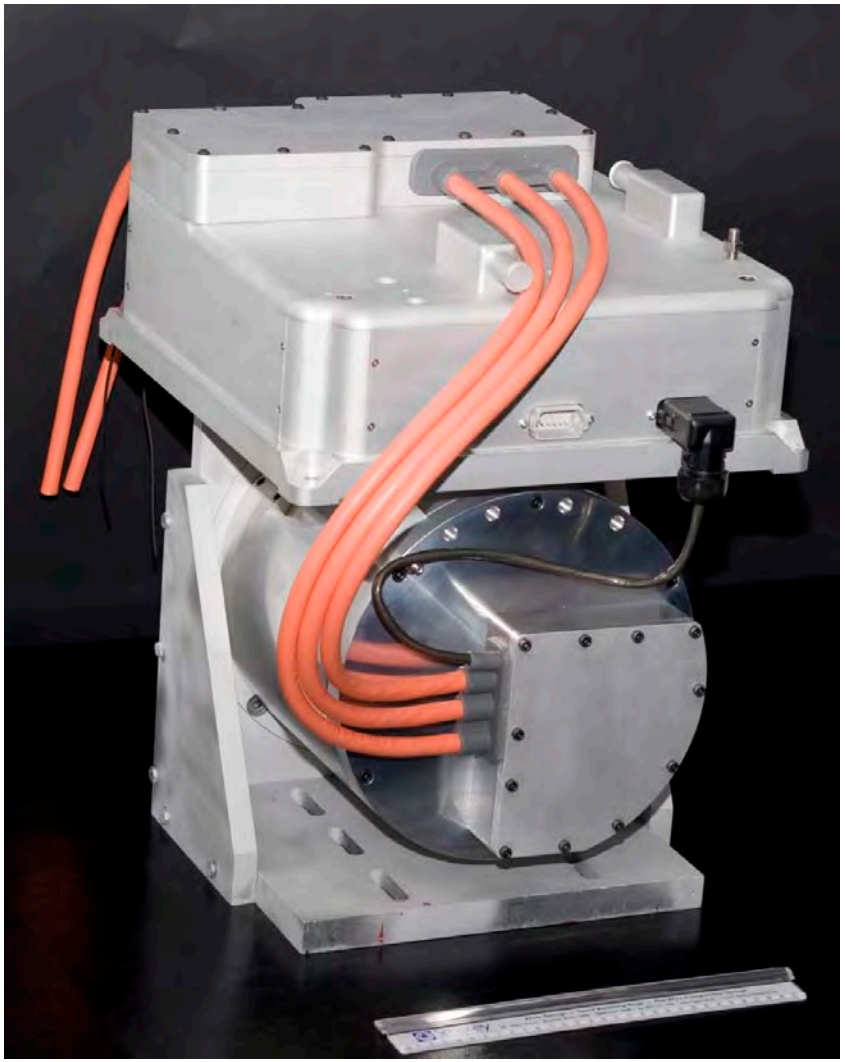
- Integrated EMI filter
- Modular design
- Integrated safety features
- Low cost cast housings and covers
- Layered design for improved manufacturability



Approach- Building a Reliable System

Electrifying Vehicles

- **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

Electrifying Vehicles

- **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

Electrifying Vehicles

- 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

Approach -Expanding Manufacturing Space

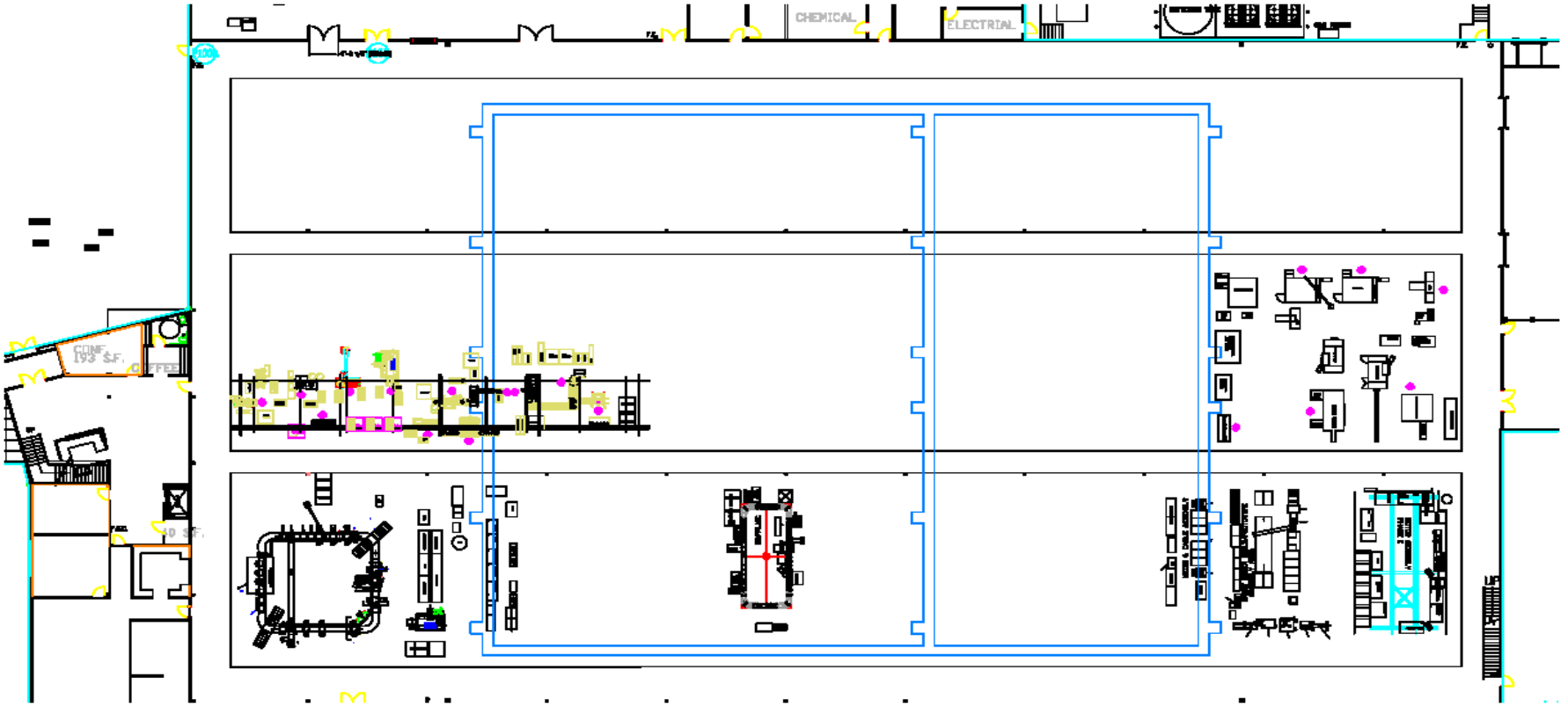
Electrifying Vehicles

- **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

Electrifying Vehicles

+ **Current new facility layout with 100kW production lines in place**



Major Accomplishments

Electrifying Vehicles

- 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

Electrifying Vehicles

- **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

Electrifying Vehicles

- **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

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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**
  - 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**