



# Providing Vehicle OEMs Flexible Scale to Accelerate Adoption of Electric Drive Vehicles

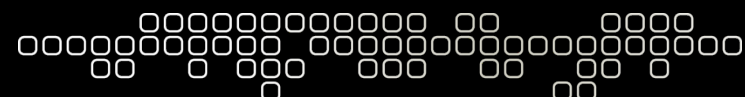
Principle Investigator: Jeremiah Shives  
Presenter: Dane Carter

## Remy Inc.

Date: May 15th, 2012

Project ID: ARRAVT025

This presentation does not contain any proprietary, confidential, or otherwise restricted information





## Timeline

Start: December 17th, 2009

End: December 16, 2013

Status: Approx. 45% complete

## Barriers and Risks

- Market Acceptance Timing
- Manufacturing Expansion
- Production Component Supply
- Application Integration

## Budget

Total: \$120,400,000

DOE Share: \$60,200,000

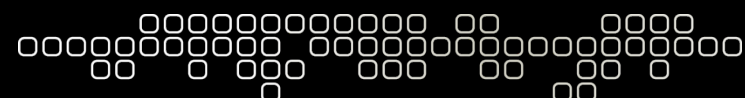
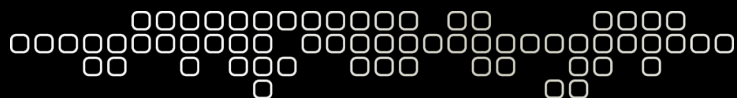
Contractor Share: \$60,200,000

## Partners (subawardee)

Phoenix International

(division of John Deere)

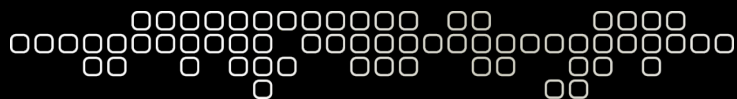
Project Lead: Kevin Larson





## Objectives

- Accelerate the adoption and use of electric drive vehicles in the market by developing a standardized platform of lower cost, higher performance hybrid electric motors and controls
- Invest in the expansion or refurbishment of U.S. based manufacturing facilities, as well as new product tooling and engineering, production and test equipment, and product commercialization



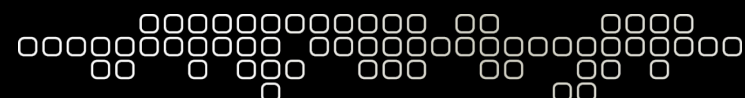
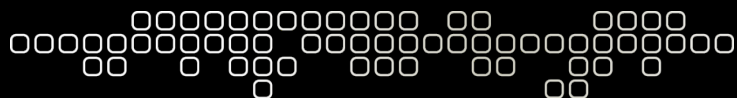


## **Technical Feasibility:**

- The new motor and inverter products proposed in the project are based on an extension of existing product and process technology.
- Remy has been producing rotating electrical products for over 100 years and hybrid electric drive motors since 2003.
- Phoenix has been producing electronic controls for over 20 years.

## **Ability to Complete Facility:**

- Manufacturing processes, including site expansions and supply chain management, are well-established at both Remy and Phoenix International.
- Phase I of the project began with the refurbishment of existing facilities to support initial production capacity.
- Phase II of the project includes the addition of capacity in a second existing facility to support high volume production.



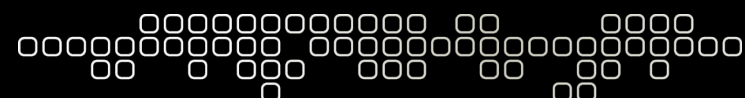
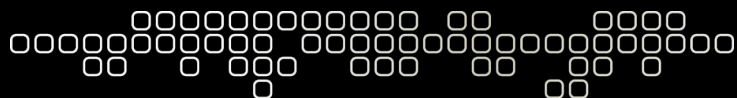


## **Ability to Deliver Commercial Ready Product:**

- For this project, many of the target customers are Remy's existing customers in both the automotive and heavy duty market where Remy has the leading share of rotating electrical products in North America.
- These customers have been very enthusiastic regarding Remy's new approach to reduce costs through creating a family of standardized electric drive motors, and have launched new product development efforts with Remy.

## **Ability to Estimate Costs:**

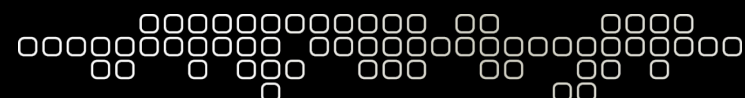
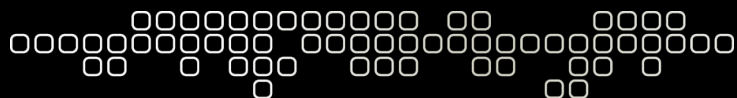
- Remy's facilities planning group continues to provide direction for the manufacturing site costs based on several previous plant relocations in the United States.
- Phoenix International has very current costs for site expansion and equipment having commissioned a new power electronics facility in January of 2009.
- New product designs are extensions of existing products.
- Material prices are reviewed by global purchasing and supplier quality teams at both companies.





## Ability to Recycle:

- Remy is the largest U.S. remanufacturer of starter and alternator products, recycling and refurbishing 4 to 5 million units per year in its two U.S. facilities in Virginia and Oklahoma.
- Planning for such recycling of hybrid motors is already underway in joint meetings between Remy, its customers, and its suppliers.
- Remy has standard workflow procedures in all of its manufacturing operations which define and control the segregation and recycling of various scrap raw materials used in its process, including byproduct materials and nonconforming products.
- Phoenix International's recycling plan is to leverage Remy's existing capability in the product recycling area.
- If re-manufacturing is called for, the inverter parts could be returned to Phoenix facilities for rebuild or Phoenix could supply the required subcomponents back to Remy to facilitate the remanufacturing.
- In cases where scrapping of the inverter is called for; the housing and bus bar metals are recyclable.



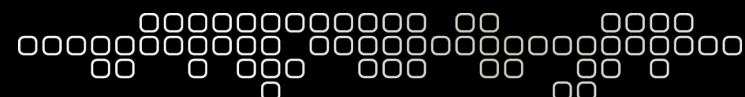
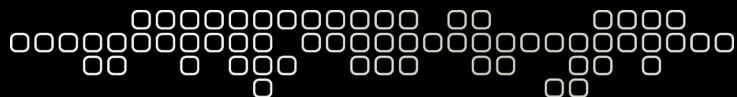


## Environmental Impact:

- Existing facilities are being utilized for all phases of the project so that no new construction will be required.
- Phase 1 production does not require any new environmental permits.



Phase 1 Manufacturing Facility

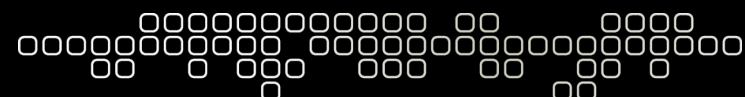




Key Milestones for 2011	
Validation Stage Motor Hardware Available	COMPLETE
Ready For Start Of Production	On-Track With Customers
Inverter 1 Rev 2 Hardware Available	COMPLETE
Inverter 2 Rev 2 Hardware Available	COMPLETE

**This project has helped to fund 199 direct jobs at Remy and our sub-awardees.**

**Another 955 jobs are estimated to have been funded at our suppliers and vendors.**





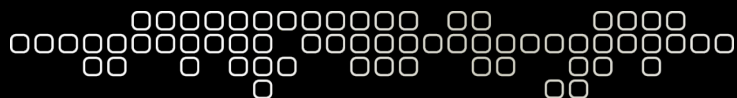


## Production Intent Design Motor Samples:

Multiple configurations of the HVH410 and HVH250 motors have been produced.

Configurations include:

- Oil Cooling
- Water Cooling
- 3 motor lengths
- Multiple Winding Patterns
- Customer Specific Assemblies



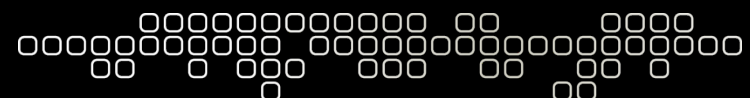
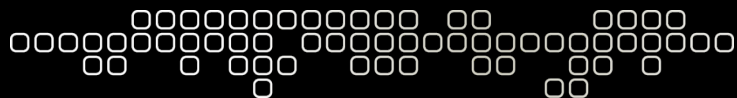


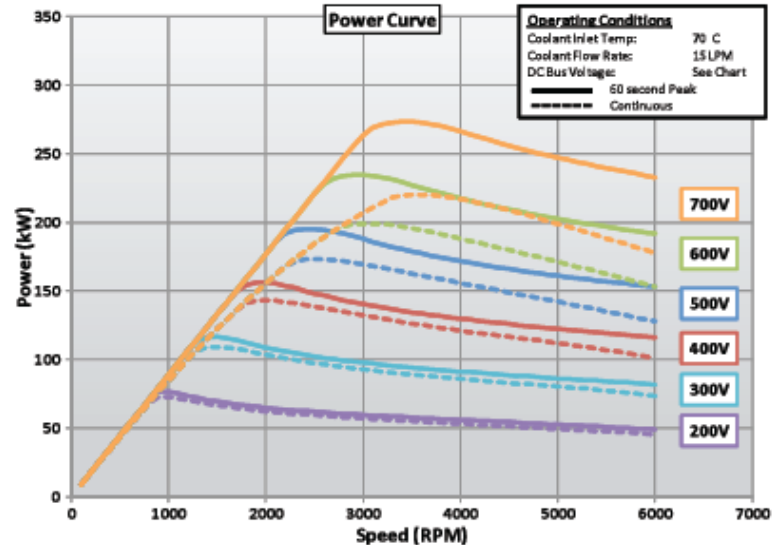
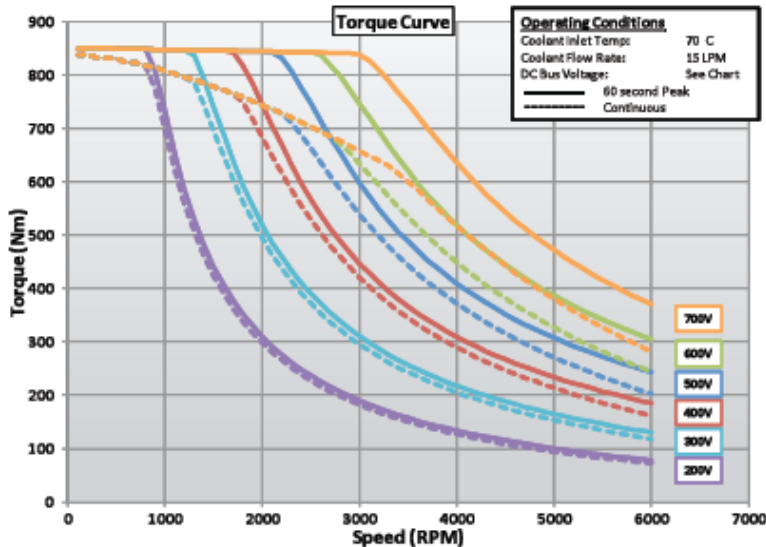
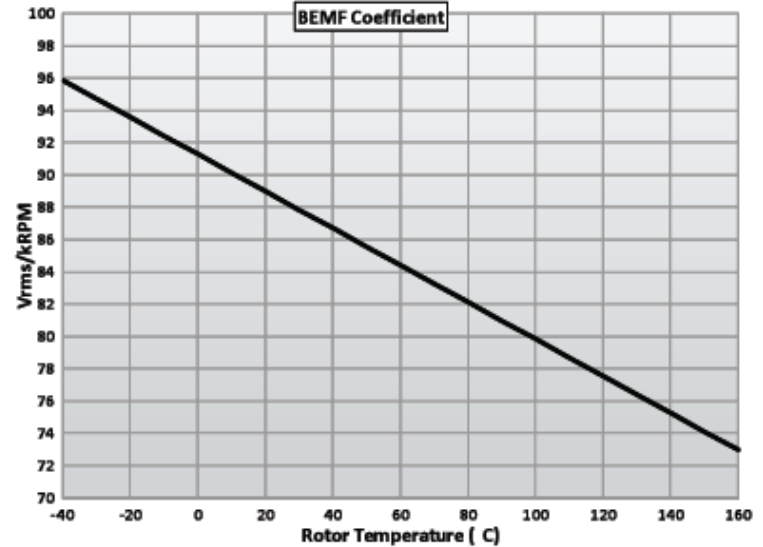
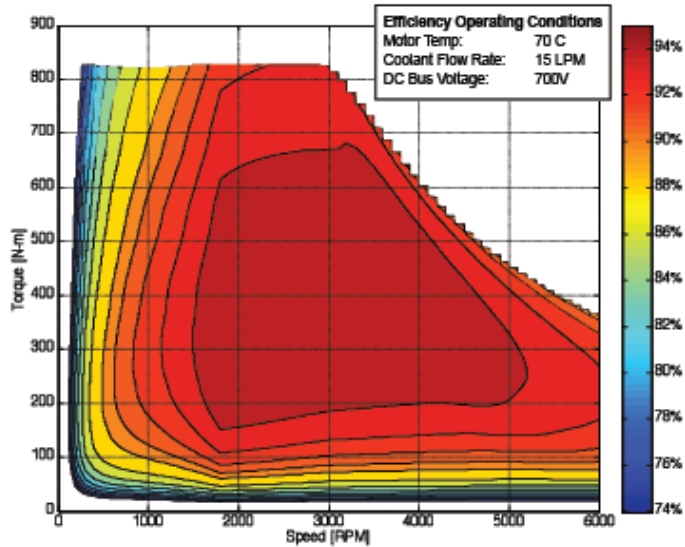
### Production Intent Design Samples:

- Sample motors have been tested to meet initial performance and durability targets.
- Validation to customer specific specifications has also been complete.



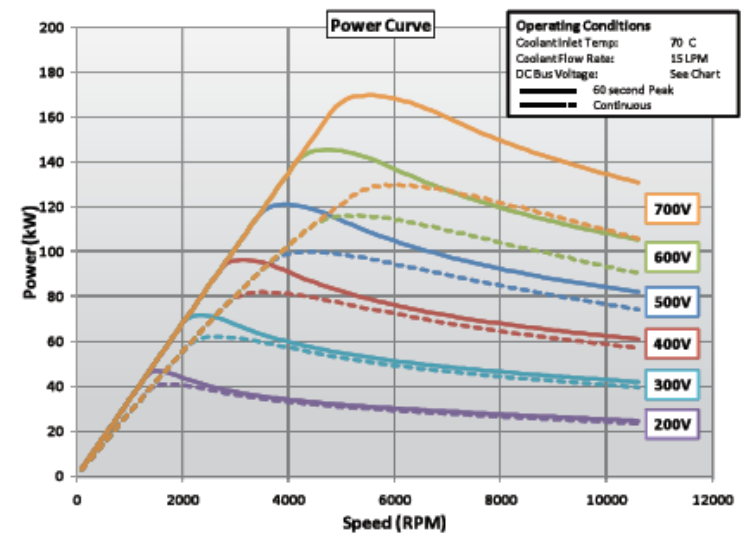
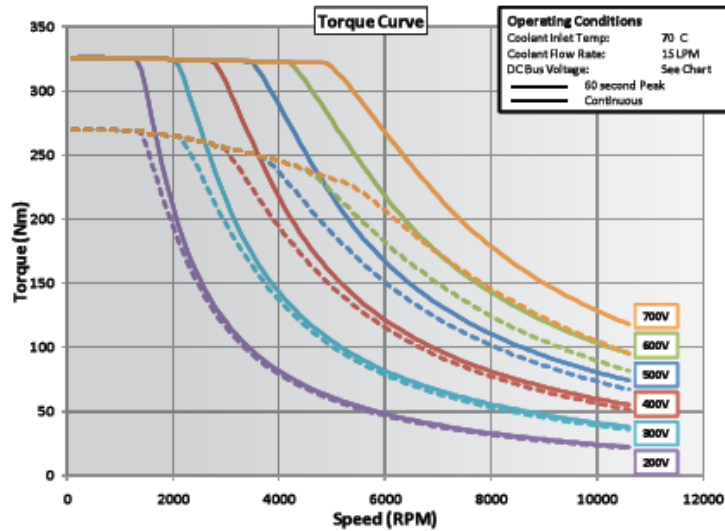
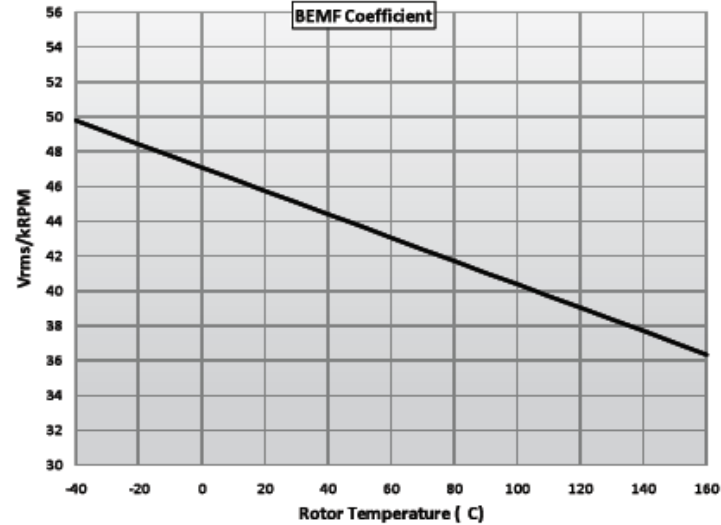
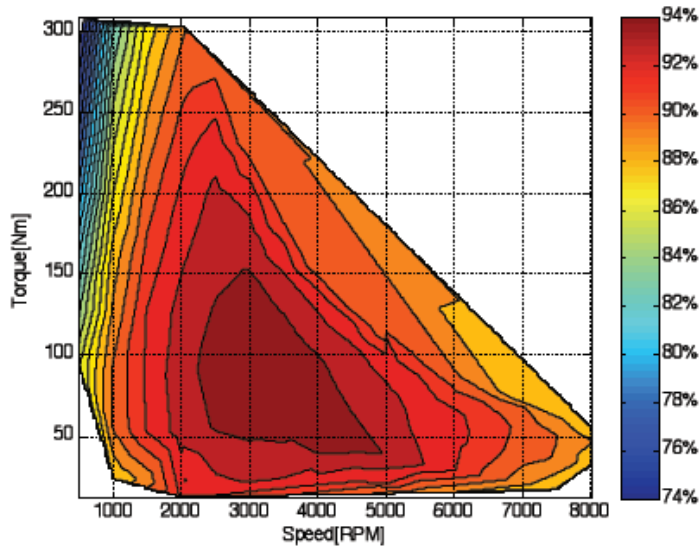
Motor Test Stands





Note: The torque and power ratings are based on typical operating conditions as noted on the performance graphs. There are several variables that may change the motor performance, including coolant flow rate, operating temperature, inverter settings and parameters, etc. For actual performance, the motor must be evaluated in its final system and application. All specifications are subject to change.





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### Inverter Samples:

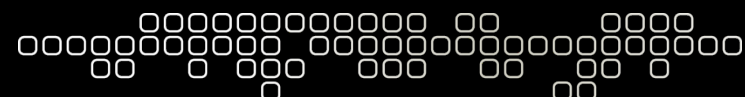
- PD300
  - Production release planned Aug 2012
- PD550
  - Product verification underway
  - Production release planned Oct 2012



PD300



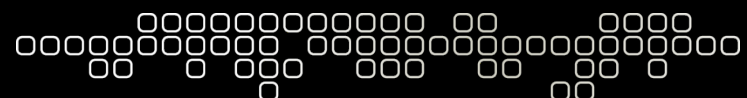
PD550 Dual





## Phoenix International:

- Remy has collaborated with Phoenix International as a subawardee to this grant.
- The inverters will be developed and put in production by Phoenix International at a location in Fargo, ND.
- The inverter sizes required will match the motor sizes needed in the marketplace.
- The motors and inverters are typically matched to various customer requirements such as peak power of the motor and available voltage of the DC source.
- Inverter development will follow the same typical steps as the motor development with the delivery of prototypes and production devices availability at the same time.
- This will provide the customer with a matched set of motor and inverter drive systems.

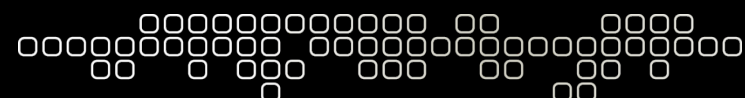
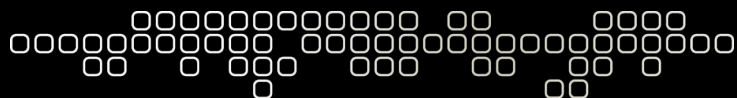


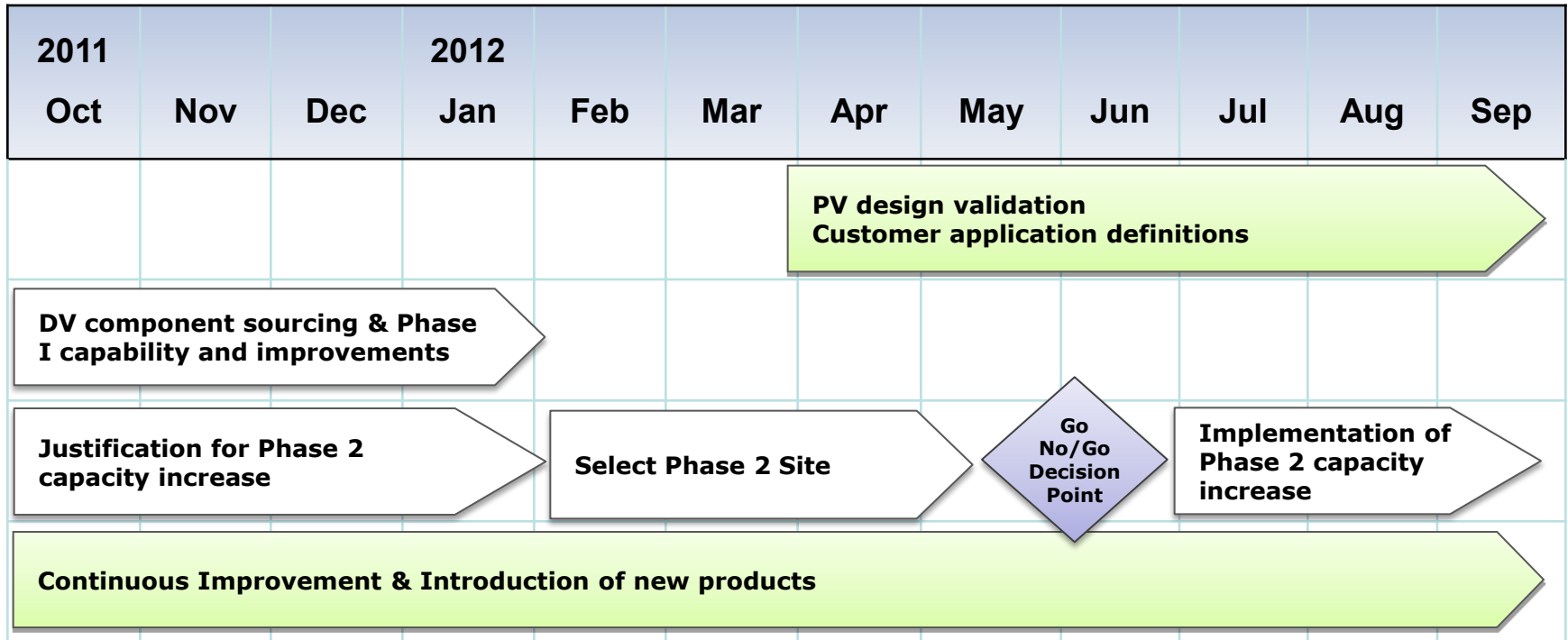
**2012:**

- Complete production stage hardware validation for base motor and inverter products
- Start production at Phase 1 production facility
- Continue to forecast market demand for additional production capacity
- Select Phase 2 site

**2013:**

- Expand motor production capacity to a Phase 2 facility based on market demand



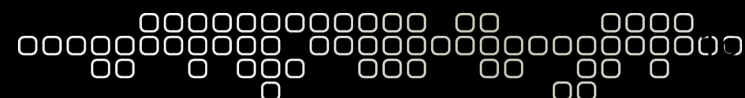


## 2012 Focus:

Phase 2 facility site selection in June. Complete validation of production design. Grow customer base.

## 2013 Focus:

Implementation of Phase 2. Customer production launches.







- Accelerating the adoption and use of electric drive vehicles in the market.
- Developing a standardized platform of lower cost, higher performance hybrid electric motors and controls.
- Building on the proven success of existing product and other technologies.
- Matching product features and production capacity to real market requirements.
- Delivering technical accomplishments on time.

