Magna E-car SYSTEMS

Magna E-Car Systems Overview

2nd CHAdeMO North America Meeting

January 14th, 2011

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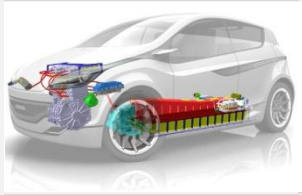
- **Magna and Magna E-Car Systems Overview**
- **Hybrid and Electric Vehicle Portfolio**
- **Magna E-Car's CHAdeMO Association Membership**

Experience | Company | Mission | Locations | Organization

Magna and Magna E-Car Systems Overview



Magna's Experience in Alternative Propulsion Systems

SPANNING 20 YEARS

1980
- VW Golf Electric Concept

1990
- Fiat Panda Elettra

2003
- Research Project: Hybrid-System-Development

2004
- LI-ION Battery-System (LIBS)

2005
- Hybrid-Powertrain Development

2006
- Foundation of an specific electronics group within Magna

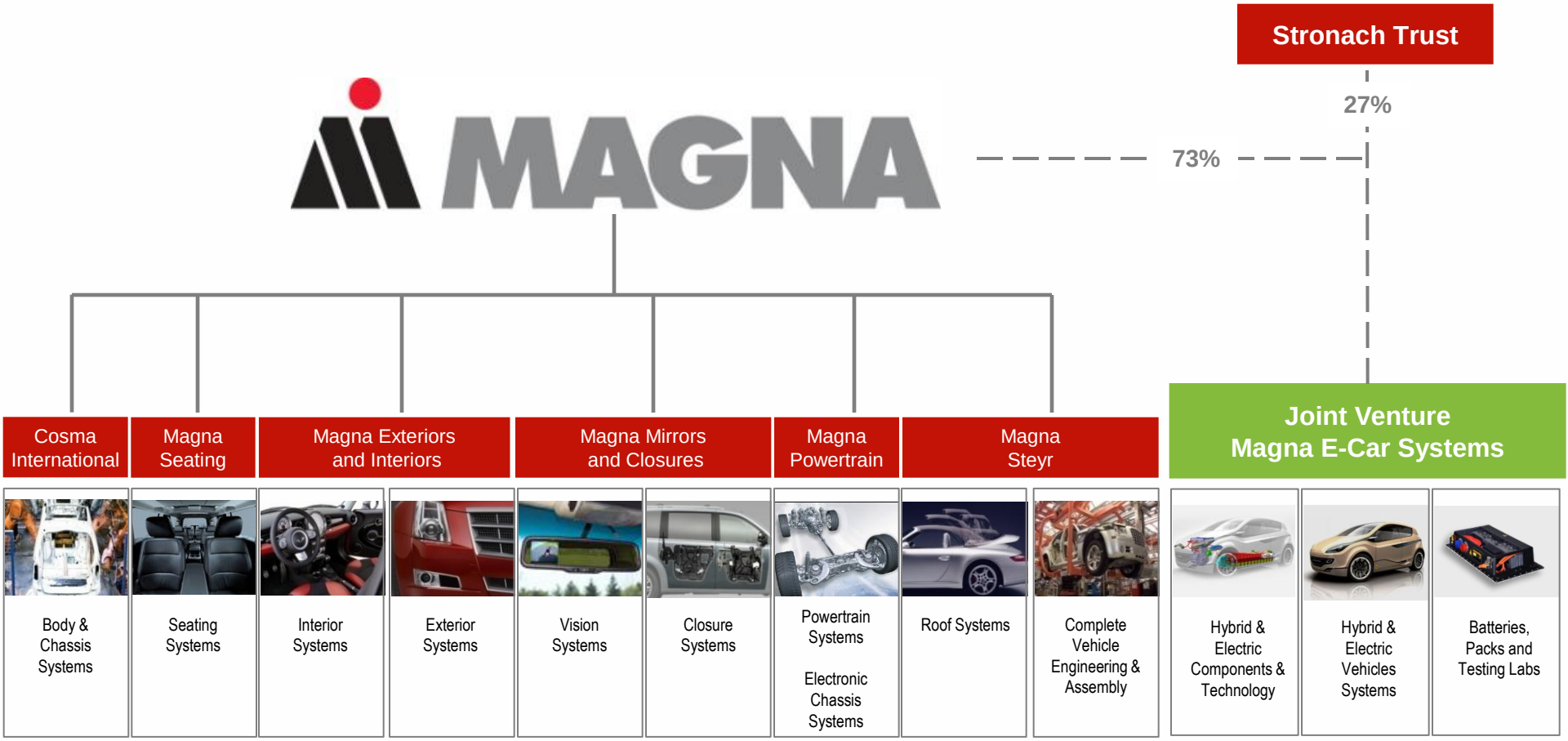
2007
- Hybrid SUV (HYSUV)

2008
- Foundation of Magna E-Car Systems
- Focus on EV components as e-motors, inverter, converter, charger
- Mini EV
- Mila EV
- Ford Focus E
- First EU serial contract for EV-Components - ERAD

2009
- SOP Heavy Duty Battery Pack

2010
- Energy Battery Serial Production
- Serial Development EV in Europe
- Transition of EV components from electronics-group to E-Car Systems

Magna International



- Magna E-Car Systems is a joint venture of Magna International (73%) & Stronach Trust (27%) headquartered in Auburn Hills, MI USA.

Magna E-Car Systems

Vision

To be the worldwide leading partner for Engineering, Integration and Production of Innovative Solutions for Future Mobility with regards to Hybrids and EV's

Mission

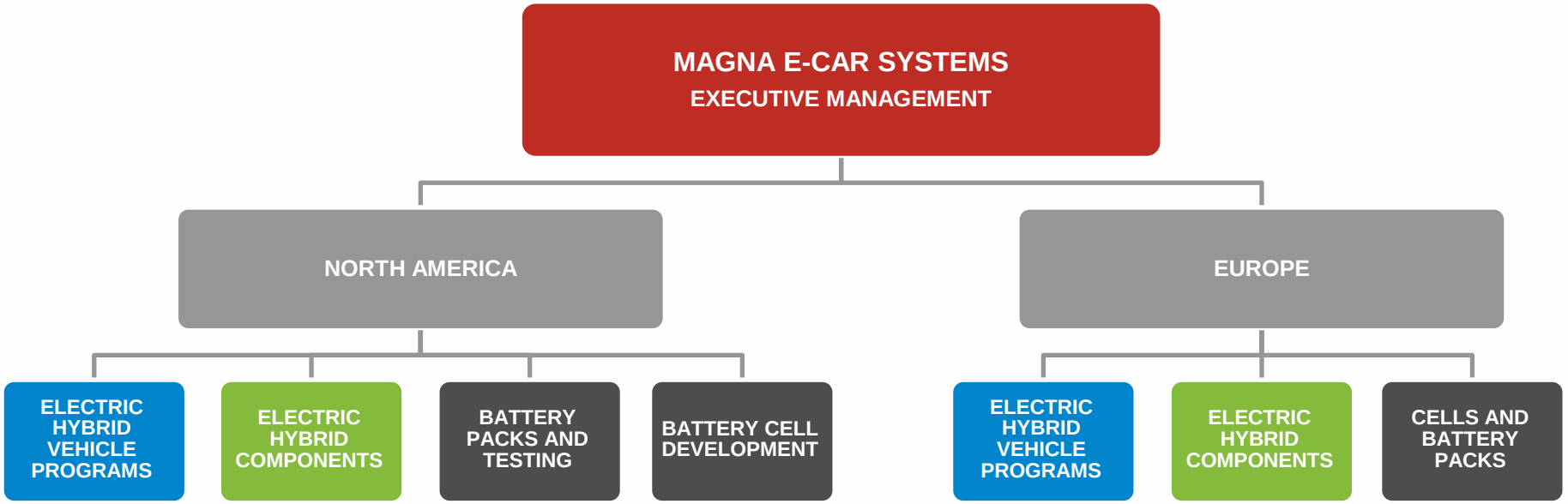
- General Contractor for Hybrid and EV activities within Magna
- One (Magna) face to the customer
- Create Innovative Solutions for Future Mobility
- Development and production of own products

Magna E-Car Systems Locations

NORTH AMERICA	EUROPE
Auburn Hills, Michigan	Graz, Austria
Aurora ,Canada	Oberwaltersdorf, Austria
Rochester Hills, Michigan	Sailauf, Germany
Grand Blanc, Michigan	Nürnberg, Germany

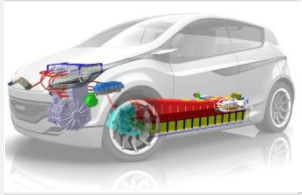
2 Headquarters | 6 Product Dev. & Eng. Centers | 2 Manufacturing Operations

Organization



Vehicle Programs | Components | Battery Packs & Testing | Battery Cell Development

Hybrid and Electric Vehicle Portfolio



E-Car Systems Components & Integration

Magna e car SYSTEMS

Vehicle Programs







E-Car Components

Component

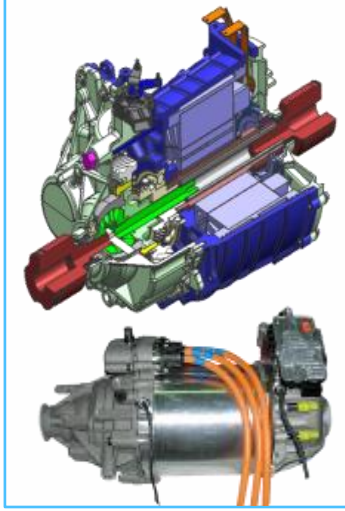
- Inverter
- Traction Motor
- Charger
- Vehicle Controller
- Battery Controller

Power Plant

- Traction Motor
- Inverter
- Controls

eDrive

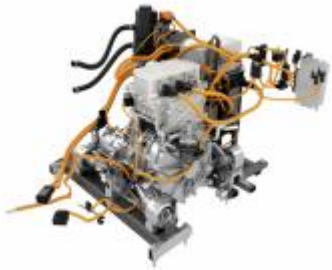
- Traction Motor
- Inverter
- Transaxle
- Shift Pos'n Switch



E-Car Systems

ePowertrain

- eDrive Integration
- Coolant ePump
- Torque Reactor
- Cradle



Vehicle Integration

- ePowertrain Integration
- Battery Systems
- HVAC System Components
- Vehicle Control
- Wiring harness
- Thermal Management

Electrify To Satisfy Our OEM Customers

Production Programs

2011 Ford Focus BEV

2011 Mercedes eVito Van

Volvo Truck

Component Portfolio

	Propulsion Systems		Energy Systems	
Current Products				
	Traction Motors Chassis Motor 20-150kW Torque Motor 15-70kW Hub Motor 30-70kW	**Traction Control Module** (Inverter and Motor Controller) Single Inverter 400A / 120kW 370A / 50kW 120A / 20kW Dual Inverter 370A / 50kW	**On-Board Charger** Charger Max. 6.6 kW Integrated Charger and DC/DC Converter	**Control Units** VCU - Vehicle Control Unit MCU -Motor Control Unit HVDU – High Voltage Distribution Unit BDU - Battery Disconnect Unit CSC - Cell Supervision Circuit BMU- Battery Management Unit

Component Development Timeline

2008	2009	2010	2011	2012	2013	2014	2015	2016
						Further optimized Hybrid & EV Components		
1st Gen. EV Components		**2nd Gen. EV Components**		**Serial Production of 1st Generation**		**Serial Production of 2nd Generation**		

Battery Pack Portfolio

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Current & Future Products

Truck/Bus HEV Battery Pack

Energy Content: 2 - 18 kWh
Power: up to 180kW
Battery Weight: 80 to 150 kg
Cooling: air or liquid
SOP: 2009
Next Generation: 2012

PHEV / EV Battery Pack

Energy Content: up to 36 kWh
Power: up to 200 kW
Battery Weight: approx. 10 kg/kWh
Cooling: air / liquid
SOP: Q4/2010
Flexible Modular Concept
Passenger Car and Commercial Applications

HEV Battery Pack

Energy Content: 0.8 – 3 kWh
Power: 10 – 60 kW
SOP: 2009
Next Generation: 2012

Battery Development Timeline

2006	2007	2008	2009	2010	2011	2012	2013	2014
					Optimized Power & Energy Battery Systems			
1st Generation Li-Ion Battery Systems	2nd Generation Li-Ion Battery Systems		Serial Production Truck/Bus HEV	Serial Production Energy Battery Systems				

Battery Testing Lab

Capabilities

Best cycling, thermal and data acquisition systems on the market

- Static Capacity
- Hybrid Pulse Power Characterization
- Self Charge
- Cold Cranking
- Thermal Performance
- Energy Efficiency
- Operating Set Point Stability
- Cycle Life
- Calendar Life
- Peak Power
- Constant Power Discharge
- Variable Power Discharge (FUDS & DST)
- Partial Discharge
- Stand
- Sustained Hill Climb
- Thermal Performance
- Fast Charge

Battery Testing Lab

Phase I

- 125 channels devoted to cell testing (26 consoles)
  - 48 Channels of 0 – 5V +/-100A
  - 16 Channels of 0 – 5V +/-150A
  - 28 Channels of 0 – 20V +/-300A
  - 33 Channels of 0 – 20V +/-500A
- 2 channels devoted to pack testing (1 AV900)
  - 1 Channel of 900V +/-600A / 2 Channel of 900V +/-300A
- 15 reach in thermal chambers
- 15 reach in ovens

Materials Testing Lab

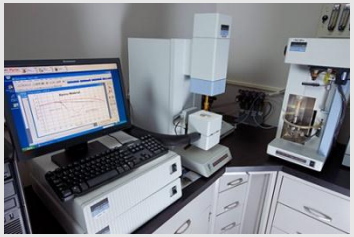
Capabilities

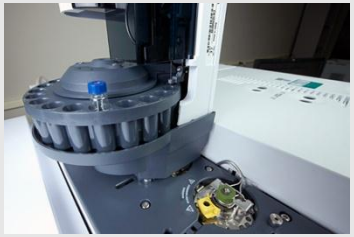
"World Class" materials lab making this operation a vertically integrated development facility

- Failure Analysis
- Alloy Analysis
- Metallographic Analysis
- Welding Evaluation
- Solder-Brazing Evaluation
- Polymer Analysis
- Plating-Coating Evaluation
- Trace Analysis
- Surface Analysis
- Lead Battery Materials Analysis
- Fibers-Films Evaluation
- Particle Size Analyzer
- Oxidation Studies
- Reaction Studies
- Thermal Properties
- Elemental Depth Profiling
- Lubricant Analysis
- Quality Control
- Process Variation Resolution
- Visual Documentation
- Specialty Testing
- Electrochemical Impedance Spectroscopy
- Custom Test Development

Material Testing Lab

- Magna Materials Testing Laboratory combines state of the art analytical technology with application specific engineering expertise to help quickly understand and resolve materials related issues
- The diversity of instruments available at Magna Labs allow for the ability to perform a complete failure or root cause analysis
- Magna Materials Testing Laboratory is well suited for routine testing of materials needing to be validated before being integrated into the end use





Rochester Hills Technical Center

Capabilities

- Engineering
- Fuel economy and emissions simulation
- Electronics and control systems design and development
- Systems integration modeling
- Testing and validation equipment

- Development and Testing
  - (5) Motor Dynamometer Cells 25kW – 300kW
  - (2) Drive Module Durability Dynamometers
- Development and Labs
  - Motor Dynamometers
  - High Power Labs
  - General Electronics Labs
  - Thermal / Environmental Chambers
  - EMC Lab
  - Vehicle Integration

Rochester Hills, MI

- 175 Personnel
  - 155 Engineers
  - 10 ME/EE Technicians
  - 10 Office/Administrative

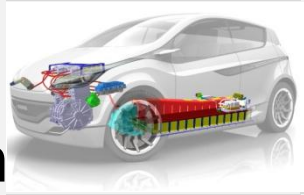
Thermal / Environmental Chambers

High Power Electronics

Motor Dynamometer Cells

Reasons | Impact | Installation

Magna E-Car's CHAdeMO Association Membership



Magna E-Car interest in CHAdeMO Association

- **Magna E-Car sees significant growth in the global electric and hybrid electric vehicle market over the next 10 years. Critical to this growth is an infrastructure that can support the vehicles AND an interface that allows any customer to charge in any location.**
- **Customer acceptance is critical after "early adopters", and key to that acceptance is an easy to use, universal, and common charge interface that provides the ability to charge quickly and at different rates on the same vehicle.**
- **Magna E-Car is a global system and component supplier committed to bringing our customers options to meet their needs now and into the future. We are taking an active role in bringing our system level capabilities to help develop standards which will benefit the global market.**

Installation – Grand Unveiling 2nd Qtr 2011

Rochester Hills Technical Center

Questions & Answers