



# Magna Steyr Discussion on xEV Battery Pack Designs

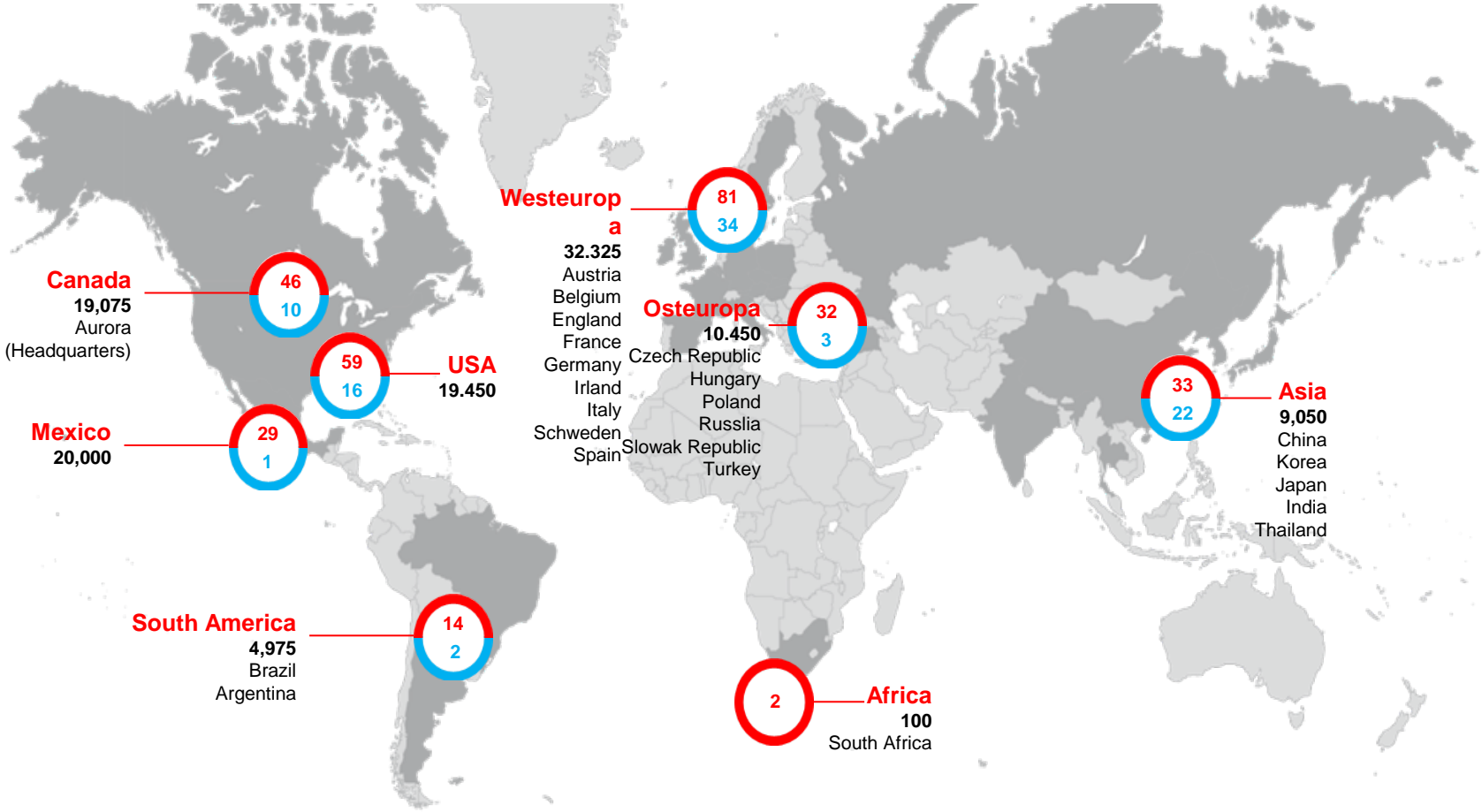
November 12, 2012

- Magna Steyr Fuel and Battery System Introduction
- Four main areas of xEV Li-ion Battery design consideration:
  - Li-ion Cell
  - Mechanical/structural
  - Electrical
  - Thermal
- RESS Safety – A Systems Perspective

# Worldwide Presence MAGNA Int.



(Status Q3 2012)



**Westeurop**

**a**

32.325

Austria

Belgium

England

France

Germany

Ireland

Italy

Schweden

Spain

**Osteuropa**

10.450

Czech Republic

Hungary

Poland

Russia

Slovak Republic

Turkey

**Asia**

9,050

China

Korea

Japan

India

Thailand

**Africa**

100

South Africa

● ~ 115,000 employees | 26 countries

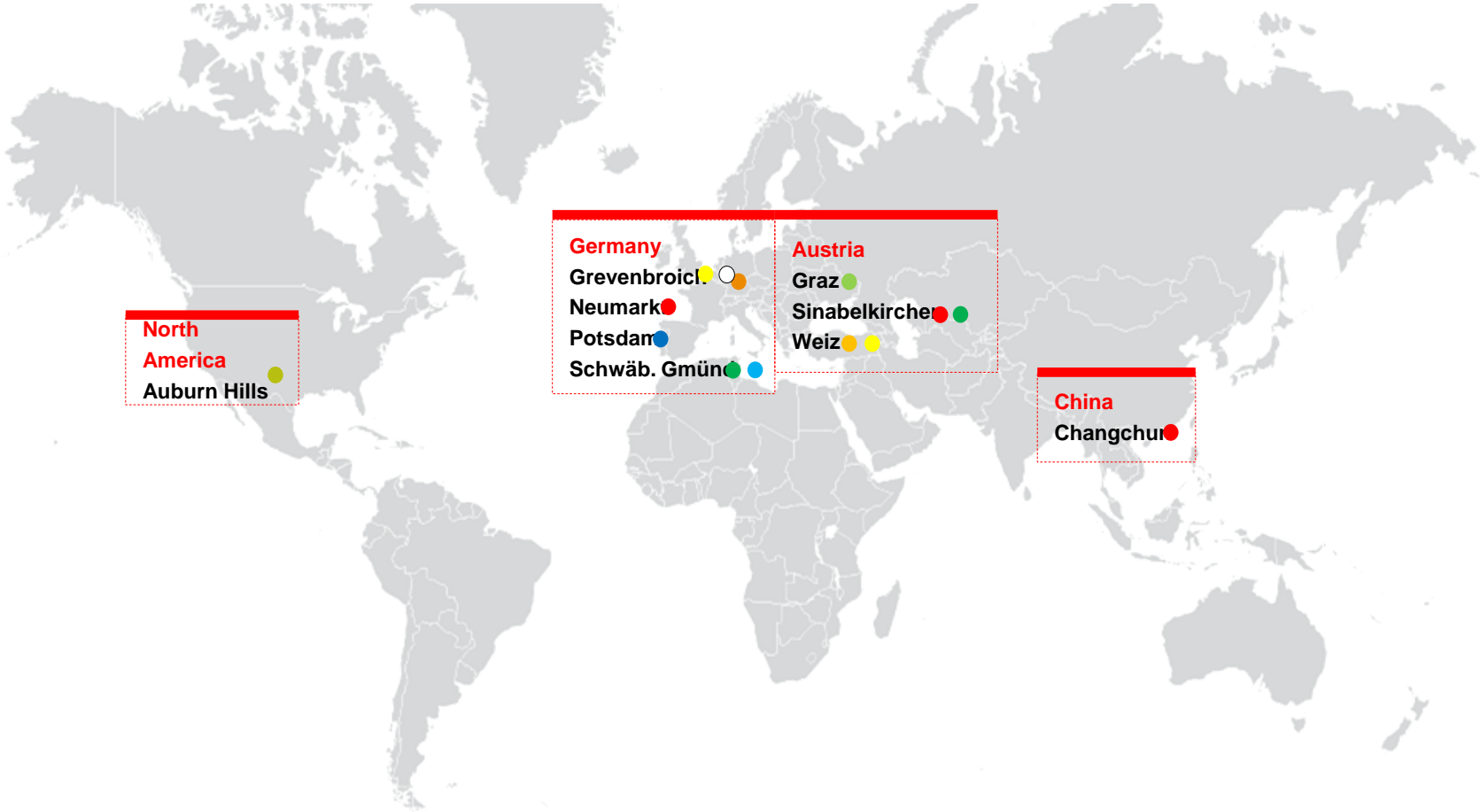
● 296 manufacturing operations ● 88 product development / engineering / sales centers

\$28.7 billions (Sales 2011)

# Fuel & Battery Systems – Worldwide Presence



(Status Q3 2012)



1.500 employees | 7 locations in Europe  
 1 location in Asia  
 1 location in North America

- Battery Systems
- Plastic Fuel Tanks
- Steel Fuel Tanks
- Aluminum Fuel Tanks
- Filler Pipes (plastic and steel)
- Fuel and Oil Caps
- Water-Carrying Components
- Steel Compressed-Air Tanks

# We offer ...



## Engineering

Engineering services including complete vehicle engineering

## Vehicle Contract Manufacturing

Flexible solutions from niche to volume production

## Fuel & Battery Systems

Innovative fuel & battery systems

## Roof Systems

Entire range of roof systems

# Innovative Battery Systems

- **Battery pack development & production**  
based on state-of-the-art lithium-ion cell technology
- **Cell, module and battery pack testing**
- **Material testing**
- **Truck/Bus HEV Battery Packs**
- **HEV Battery Packs**
- **PHEV / REX Battery Packs**
- **EV Battery Packs**

- Excellence in automotive engineering and production
- Deep knowledge of international safety standards
- Integrated thermal and electronic management
- Customizable solutions due to modular design
- Leading Li-ion battery provider for commercial vehicle segment



# Battery Pack Portfolio

Current & Future Products



**Truck/Bus HEV  
Battery Pack**

**Energy Content:** 2 - 18 kWh  
**Power:** up to 180kW  
**Nom. Voltage:** 360V / 650V  
**Battery Weight:** 60 to 150 kg  
**Cooling:** air or liquid  
**SOP:** 2009  
**Next Generation:** 2011



**EV  
Battery Pack**

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



**PHEV / REX  
Battery Pack**

**Energy Content PHEV:** 6-16 kWh  
**Power:** 50-120 kW  
**Battery Weight:** < 10 kg/kWh  
**Cooling:** air / liquid  
**SOP PHEV:** 2013



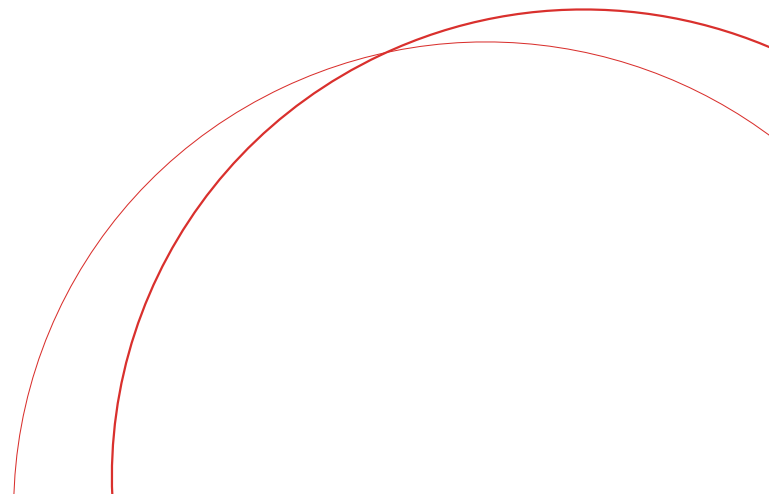
**HEV Battery Pack**

**Energy Content:** 0,2 -3 kWh  
**Power:** 15 -60 kW  
**Battery Weight:** 10 -40 kg  
**Cooling:** air / liquid  
**SOP:** 2014 (2<sup>nd</sup> Gen.)

## Battery Development Timeline

2006	2007	2008	2009	2010	2011	2012	2013	2014
1 <sup>st</sup> Generation Li-Ion Battery Systems	2 <sup>nd</sup> Generation Li-Ion Battery Systems		Serial Production Truck/Bus HEV Gen 1	Serial Production EV Battery Systems	Serial Production Truck/Bus HEV Gen 2		Serial Production PHEV Battery Systems	Serial Production HEV Battery Systems

# xEV Battery Design Considerations





- Cell type
  - Cylindrical
  - Prismatic
  - Pouch (Laminate)
- Chemistry
  - LFP, NMC, NCA
- Safety Features
  - Vents
  - Current Interrupt Devices
  - Safety Separator



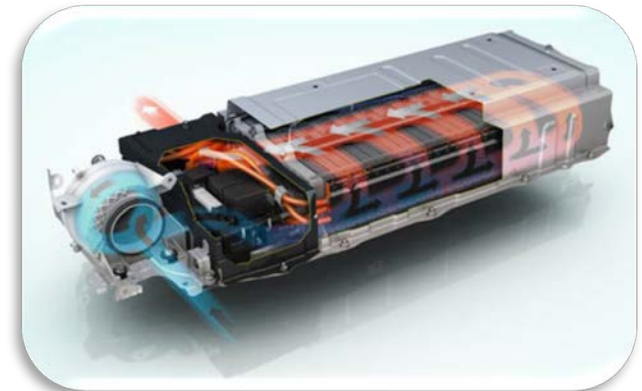
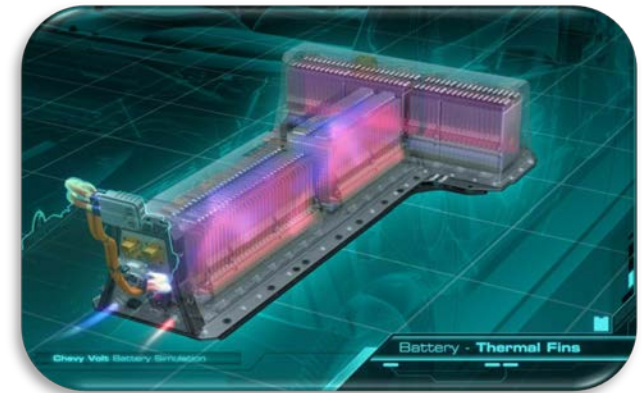
- Single or multiple packs
- Pack mounting location
  - Inside vehicle cabin
  - Exterior to cabin
- Permanent or Removable
  - Battery Swapping
- Module type and concept
  - Different module types for different cells



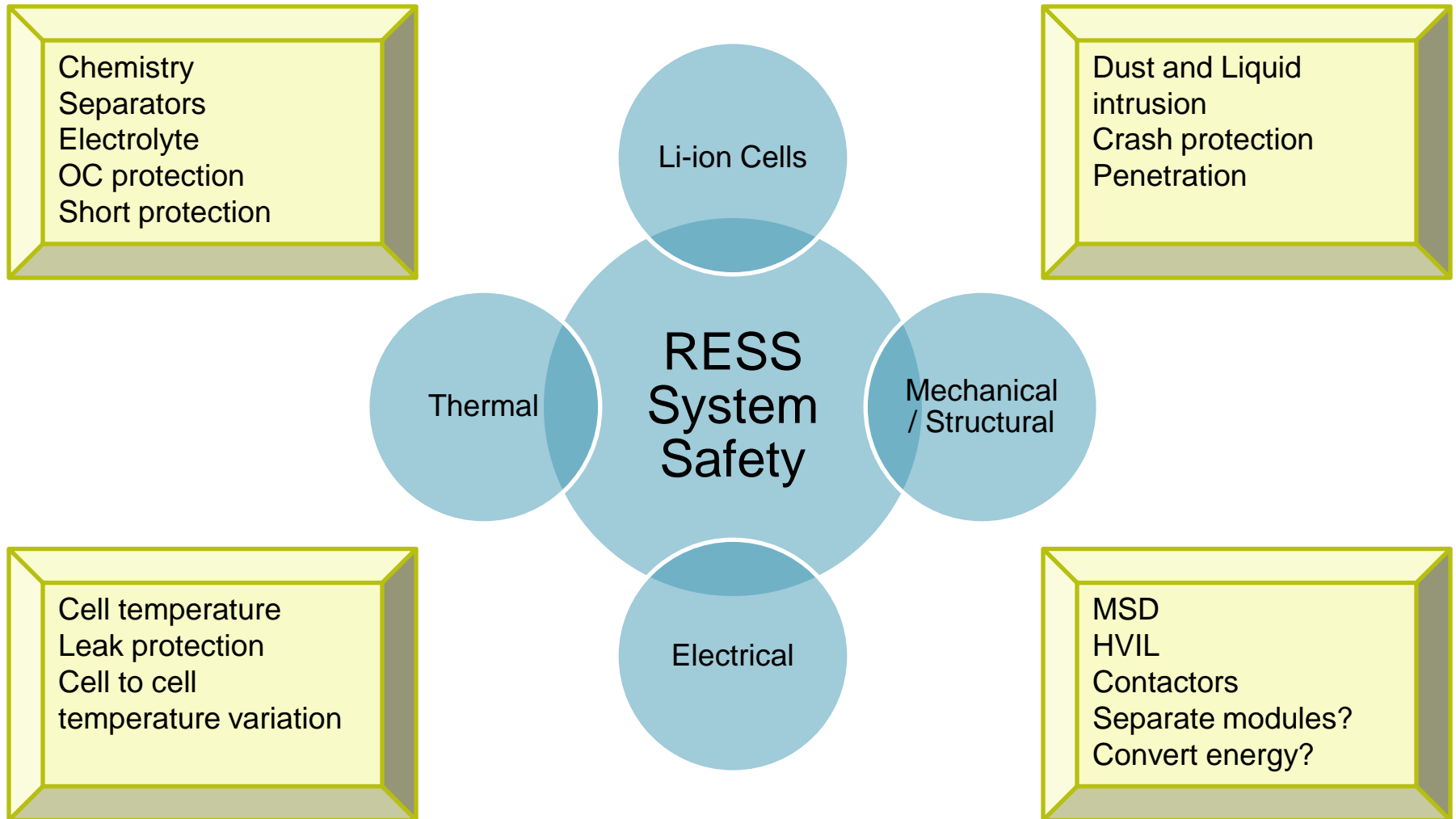
- BMS
  - Centralized
  - Distributed
  - Modular
- Cell Balancing
  - Active
  - Passive
- Safety systems
  - High Voltage Interlock Loop
  - Manual Service Disconnect
- HV Switches, Contactors and Fuses
- Charging
  - Fast Charge
  - Standard Charging



- Liquid / Air
- Active / Passive
- Closed / Open system
- Cooling / Heating
- Phase Change materials



# RESS Safety – A Systems Perspective





**The future is ours to make.**