

## Electric Vehicle Batteries: Moving from Research Towards Innovation

### Knowledge Transfer from Research to Innovation

System Integration

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Brussels



## Bosch E-Drive Activities

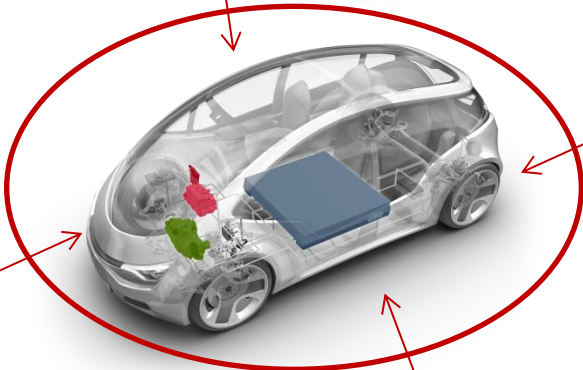
Drives for e-bikes



Battery: BBS



Electrical drives for passenger cars  
Hybrids, Plug-in & EV



Hydraulic hybrid system & electrical drives for commercial vehicles



Starters and generators for Start/Stop Systems



ABS, ESP, Break-Booster



Navigation systems

Chargers for EV / PHEV

Charging stations for electric vehicles



Software for infrastructure integration

Research and pre-development for future electrical vehicle concepts



System integration is more than putting components together in a vehicle

Gasoline Systems

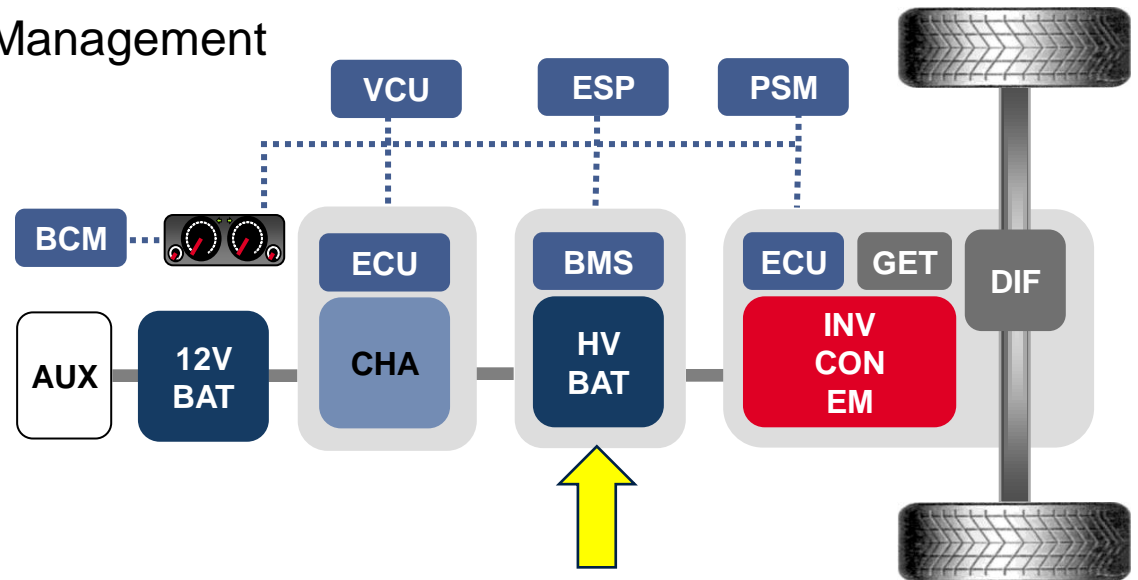


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## System Integration Powertrain

### Battery Integration Involves Several Interfaces

- Mechanical and Environmental
- Electrical Power and Recuperation
- Thermal Conditioning
- Communication and Management
- Safety Concept

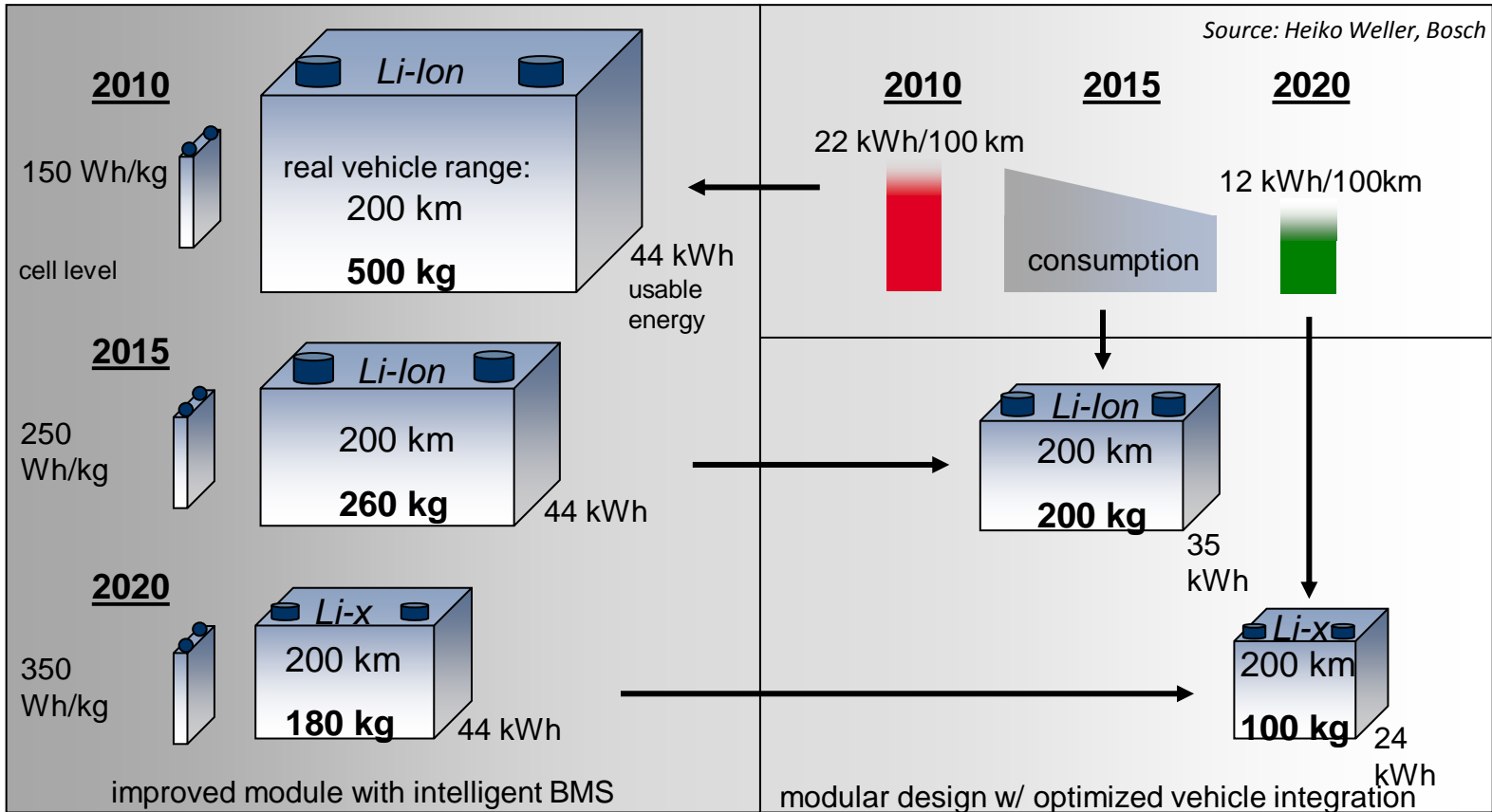


Integration of one component affects interfaces of others

# smart EV-VC: Battery and System Integration

## Optimize Battery


## PLUS Optimize Vehicle System




Optimization achieved through synergies between components and vehicle:  
Vision -> integrated components

## Future Intelligence in System Integration

### System optimization for Driving Range

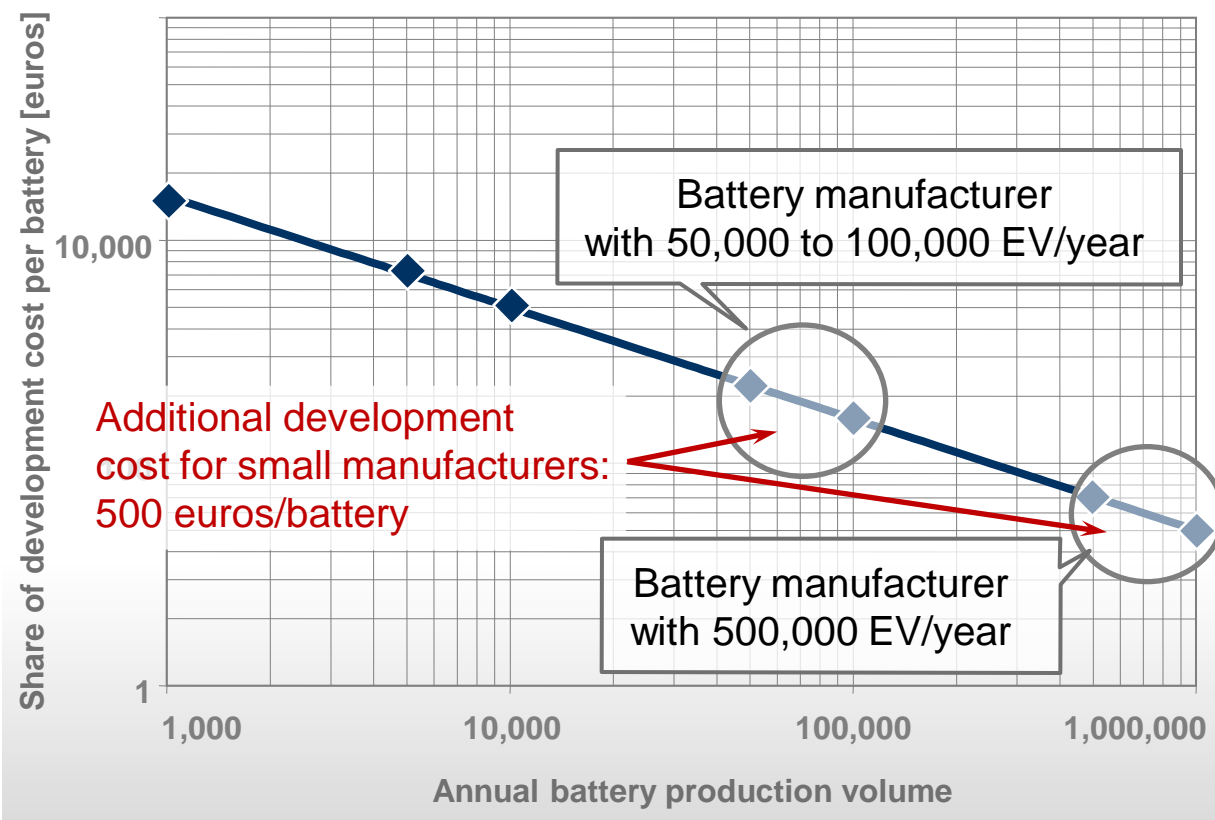
	Current	Future
 Batterie	<ul style="list-style-type: none"><li>• State of Charge</li><li>• Cell Balancing</li><li>• Range estimation</li></ul>	<ul style="list-style-type: none"><li>• Equivalent Circuit Model</li><li>• Active Cell Balancing</li><li>• Scalability of Battery Energy Content</li></ul>

### System optimization for Life-Time

	Current	Future
 Batterie	<ul style="list-style-type: none"><li>• Set-point fixing</li><li>• Balancing</li><li>• Thermal management</li></ul>	<ul style="list-style-type: none"><li>• Full capacity charging based on demand</li><li>• Uniform cell aging using battery management</li></ul>

Optimization achieved through synergies between components and SW

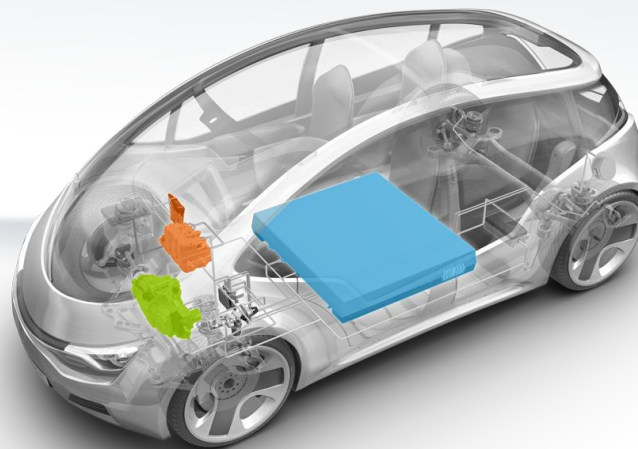
## Volume Bundling



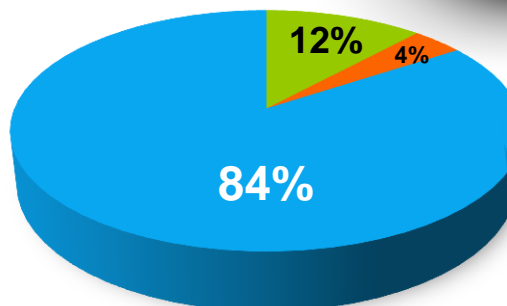
- Anticipated development effort for cells and packs approximately 1,500 man years
- As a result investment in development of approx. 150 m euros
- With depreciation over 10 years and 8 % financing cost, cost amounts to 25 m euros/year and manufacturer

## Summary

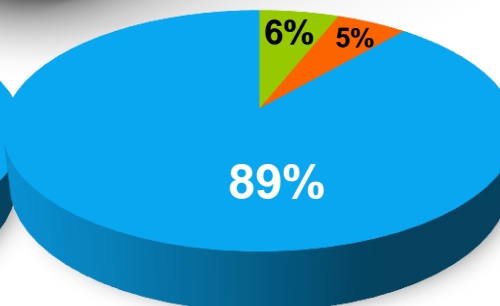
Li-ion battery



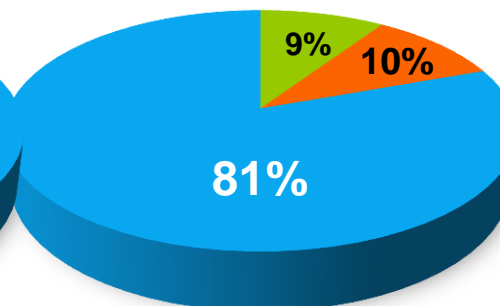
- Battery
- Power Electronics
- Electric Motor



**Weight**



**Volume**



**Cost**

Electric motor: 60 kW    Battery: 20 kWh

Integrated system must lead to weight, volume and cost reduction.



## Key Messages

- System integration adds additional value to components
  - Optimization must cover powertrain, communication and whole vehicle concept
  - System integration must cover safety aspects
    - for the user
    - for the service technicians
    - for rescue forces in case of accidents
- To maintain equivalent high safety levels as with today's conventional vehicles
- Support standardization of non competition relevant products for “platform” concept
  - Research is still needed in key areas:
    - solutions for product integration
    - reduced energy consumption of controls, as well as auxiliaries (heating/cooling)
    - pre-heating/cooling of passenger compartment and temperature sensitive components (like battery)
    - second life concepts, reliability and safety and recycling
    - standardized protocol of SOH for cells and modules
    - ensure safety level achievement incl. data communication



## Thank you for your attention!



### Gasoline Systems

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