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e-Mobility, a Key Technology for Targeting the 2020 EU Mandate



***-MOBILITY
2020***

Uni- Prof. Dr. Enrique J. Dede
University València
R&D Director, GH Group

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& Communications**

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Uni- Prof. Dr. Enrique J. Dede
University Valencia
R&D Director, GH Group

Societal Megatrends for the next Future



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Environment

CO2 emission reduction



Mobility

Increased mobility needs



Connected World

Connected Digital Society

Driving Forces for a Smart Green World

Energy Resources

70% of global oil and gas reserves in just a few counties



Habitability

Increased Population
27 Megacities by 2025



Energy needs

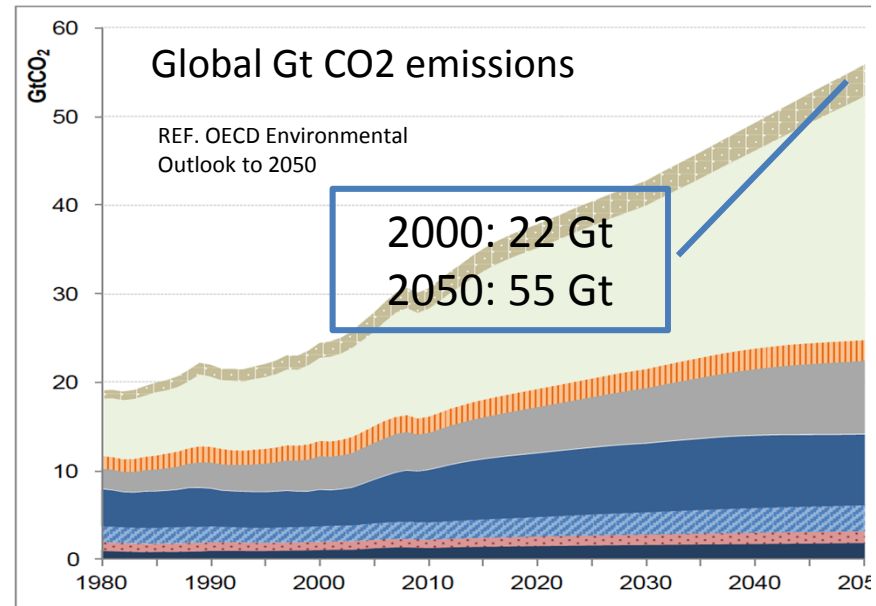
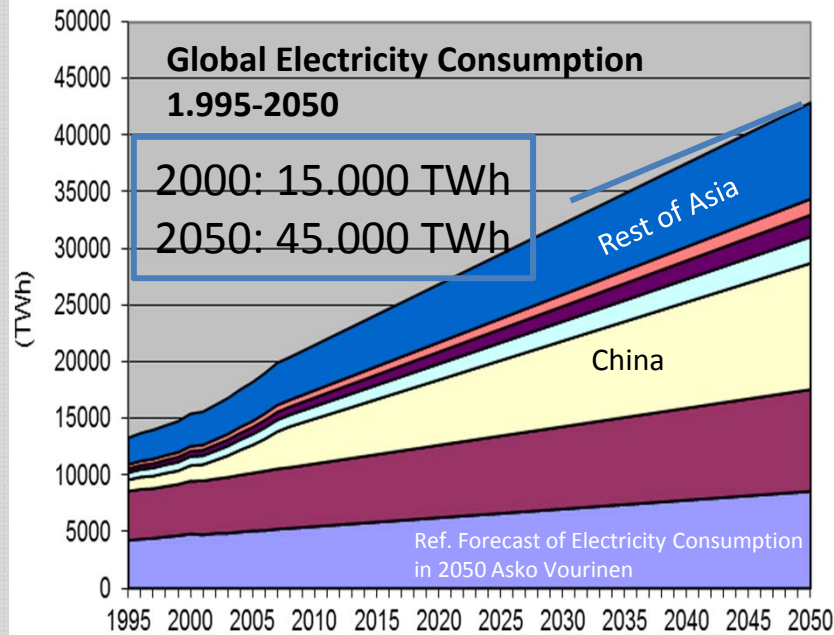
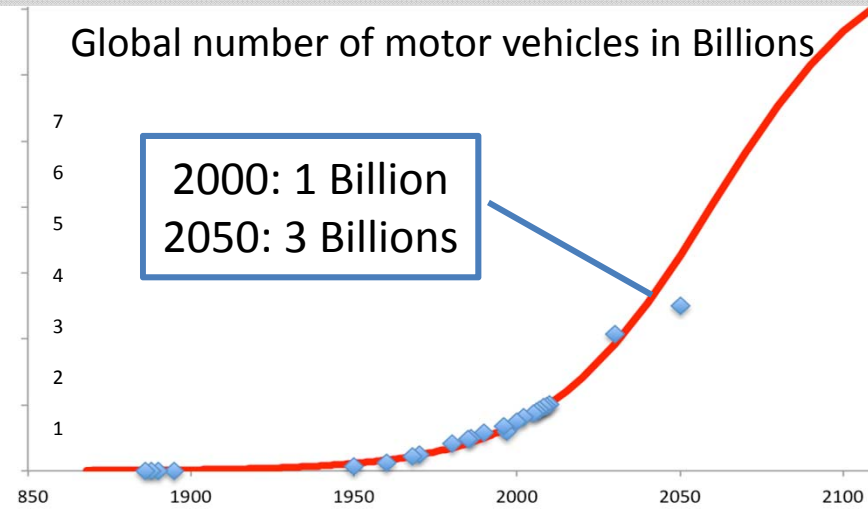
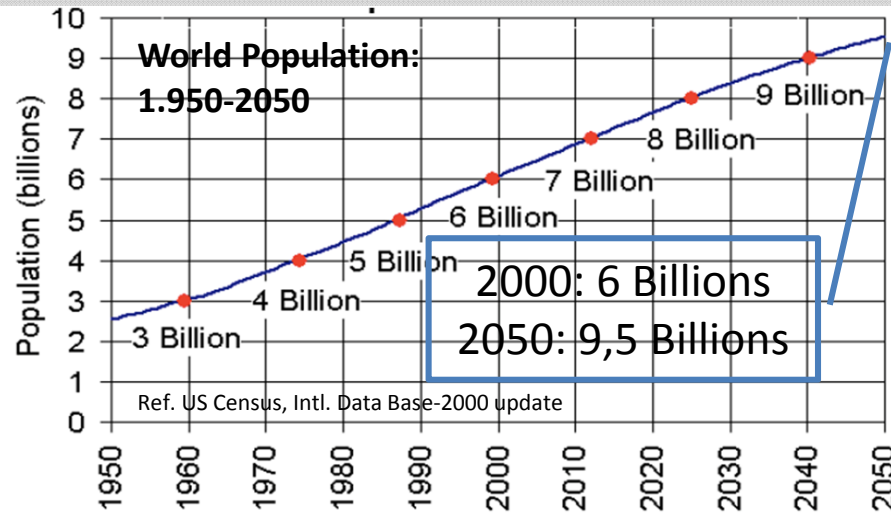
Growing electrification of society



Societal Megatrends for the next Future



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EU 2020 Targets and Goals



Efficiency

Intelligent use of the energy →

Smart infrastructure

↑ New Business Opportunities
& Energy Dependence Reduction

Competitiveness

Reducing Energy Bill
Increase Renewable Energy by 20%
Boost R&D & markets for EU global leadership
Create new business opportunities



Energy supply

Energy flow

Efficiency

Loss reduction at component, sub-system and system level

Security of Energy Supply

Reduce EU's energy dependence
Reduce investments in energy dependence
Improve energy balance

Sustainability

Reduce Green House Emissions & Other Particles
Limit Environmental Degradation
More Comfortable Cities



Source :
G.Miladinova,
DG Energy
EU Commission

↑ Energy Efficiency

↓ Green House Emissions

e- Mobility 2020

Contributions to reach the EU2020 objectives



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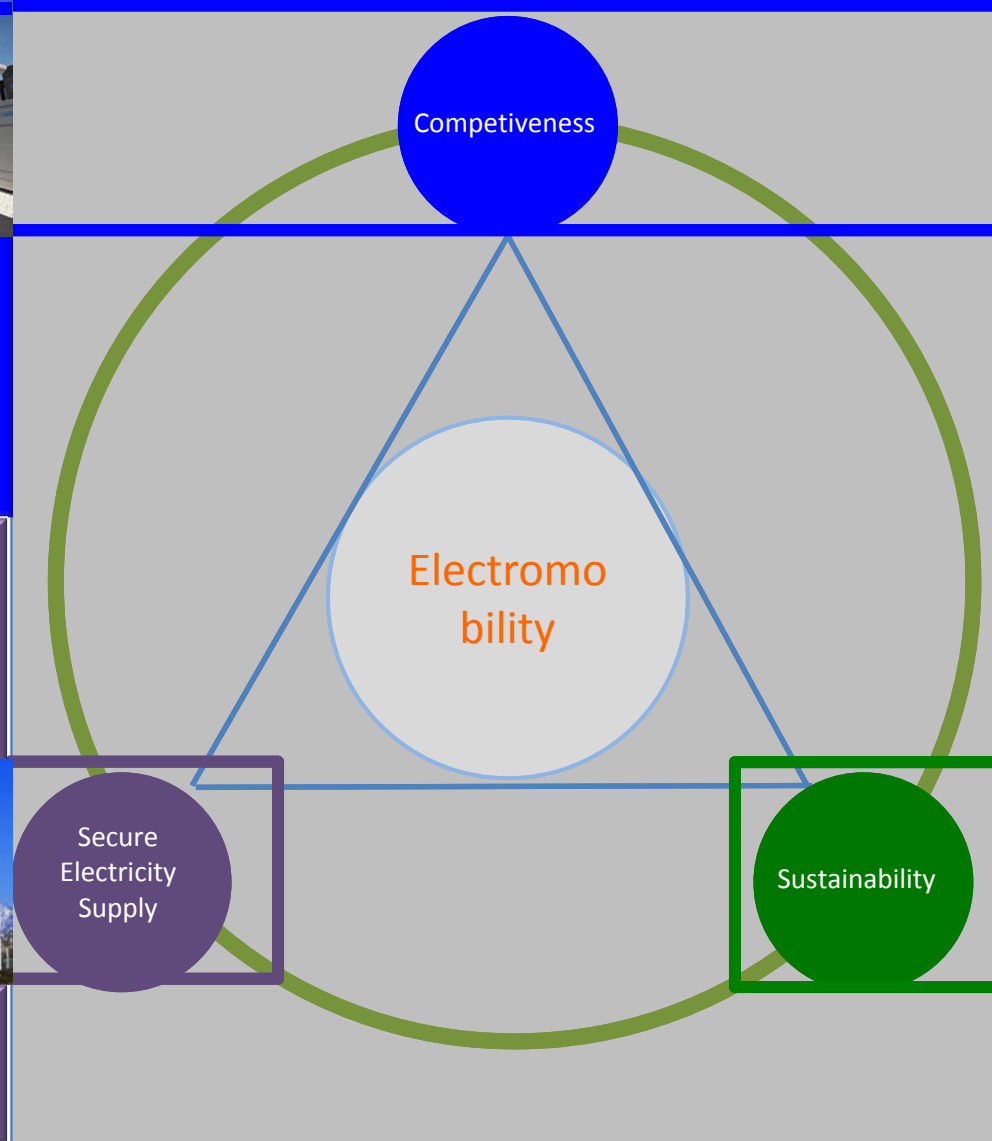


E-Mobility allows to create new business opportunities in traction systems, infrastructure, new materials.....

E- Mobility allows the integration of EVs into Smart Grids for assuring secure electricity supply



E-Mobility allows the use renewable energy for charging EV's



E-Mobility allows to reduce the EU's energy dependence

E-Mobility allows to reduce the energy bill

E-Mobility allows lower overall well to wheel CO2 emissions than ICE vehicles as well as other contaminants



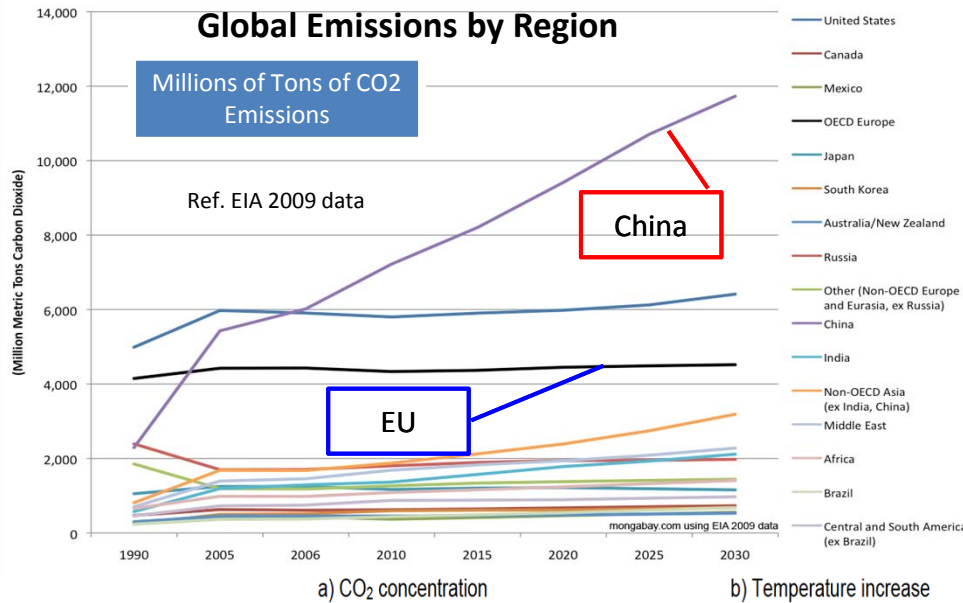
E- Mobility allows more efficient traction systems than ICE's

Sustainability

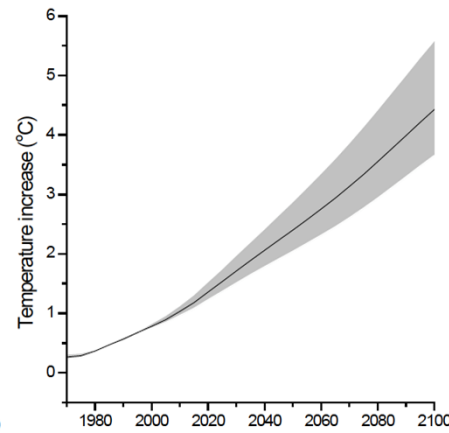
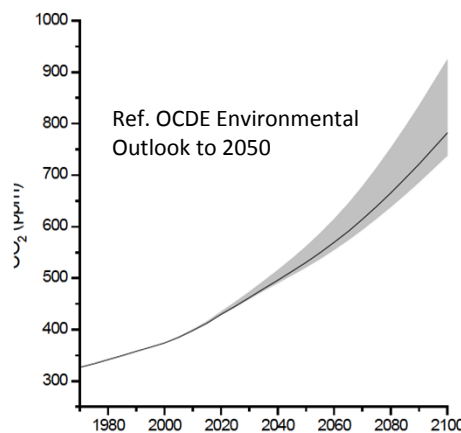
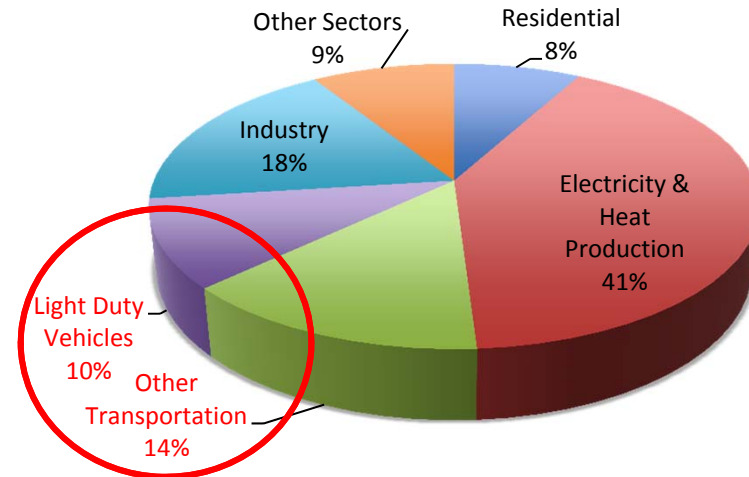
Reduce Green-House Emissions by 20%



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Global Carbon Emissions by Sector



Long-run CO₂ concentrations and temperature increase

Key Impacts of increasing global temperature

- ✓ Decreasing water availability in mid-latitudes
- ✓ Up to 30% of species at increasing risk of extinction
- ✓ Cereal productivity decrease in some regions
- ✓ Increased damage from floods and storms
- ✓ Increase burden from malnutrition, cardio-respiratory and infectious diseases

Sustainability

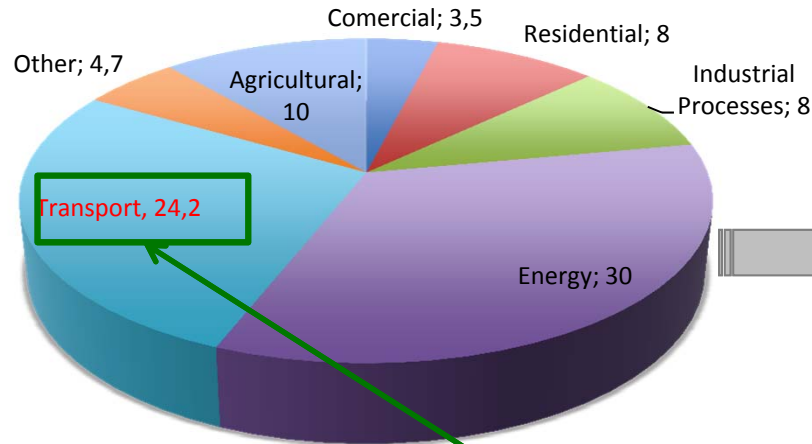
Reduce Green-House Emissions by 20%



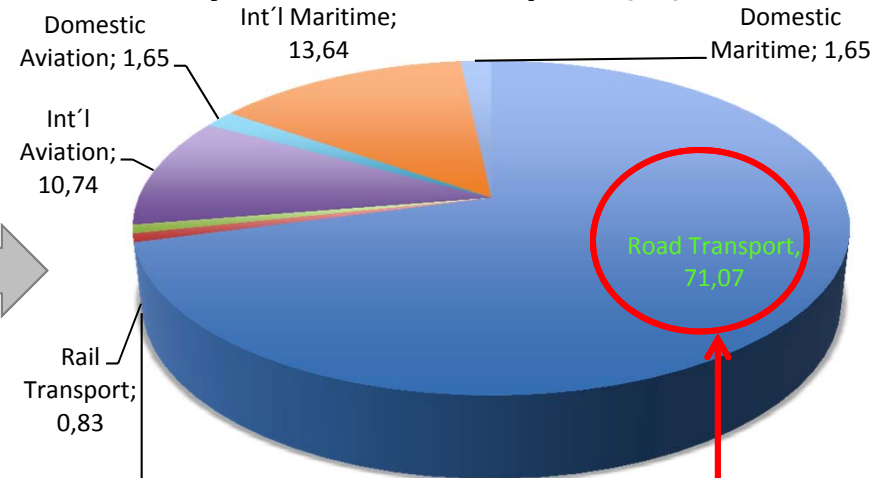
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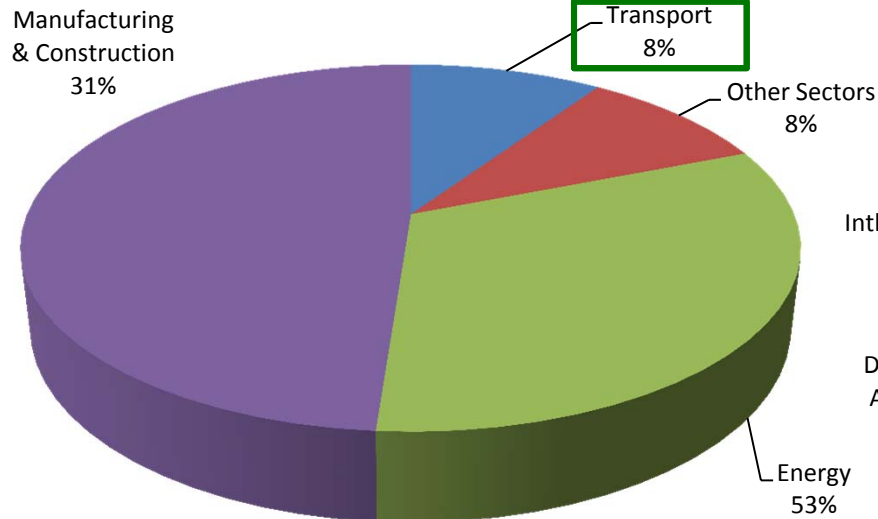
EU27 Greenhouse Gas Emissions by Sector (%)



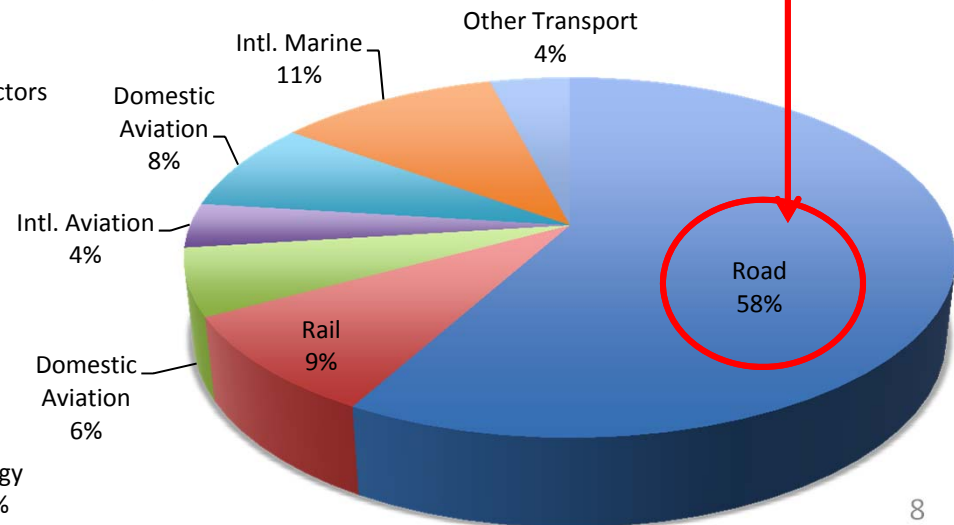
EU27 Greenhouse Gas Emissions by Mode of Transport (%)



CO2 Emissions in China (2007)



CO2 Transport Emissions in China (2007)



Sustainability

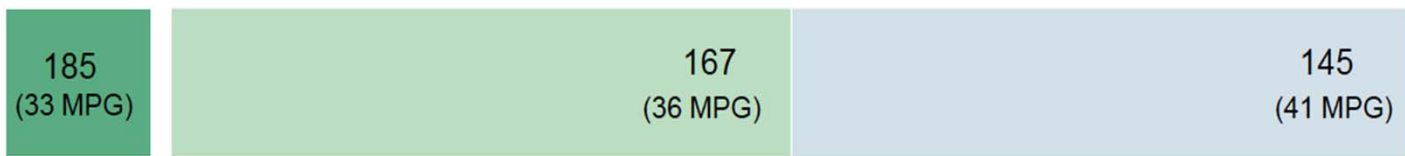
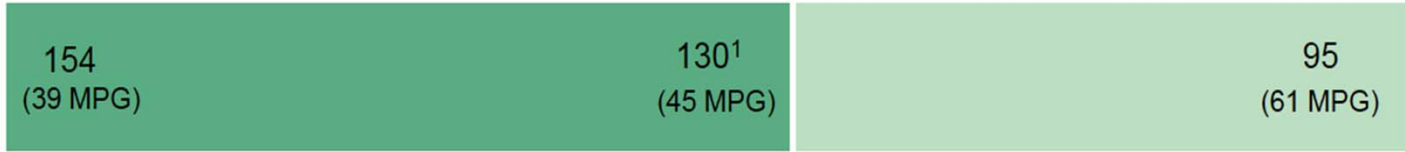
Reduce Green-House Emissions by 20%



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CO₂ g / km -
NEDC Cycle
(MPG - CAFE Cycle)



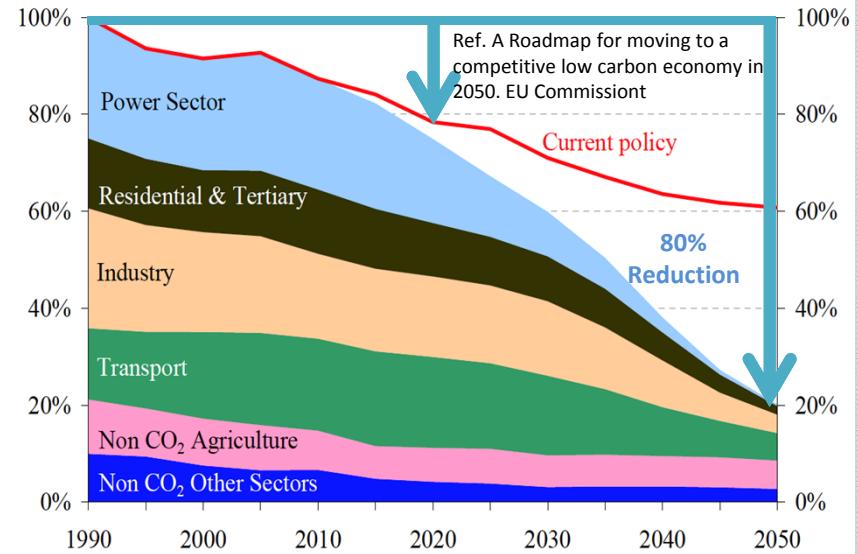
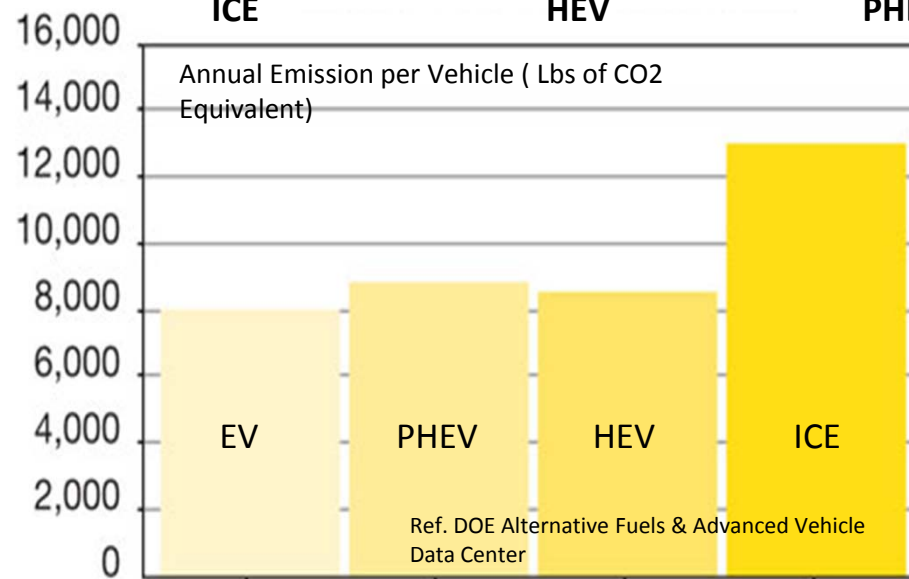
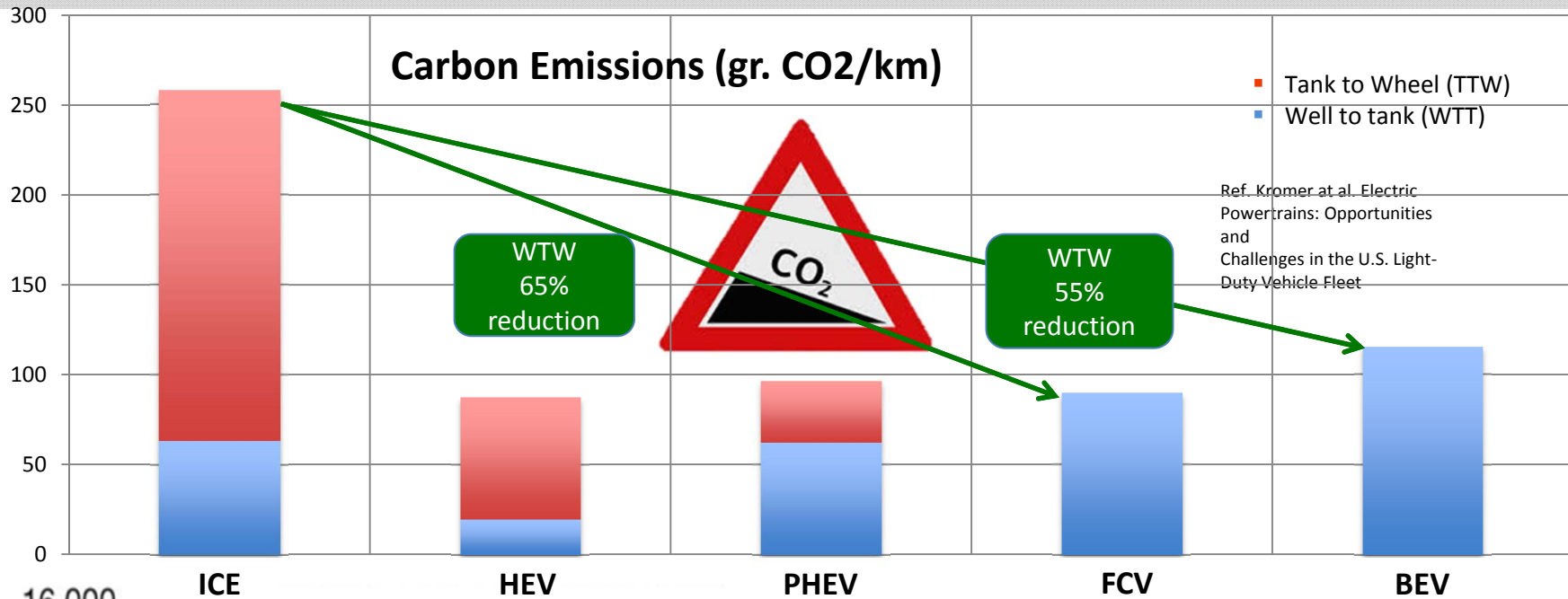
■ Enacted (through legislation)
 ■ Proposed
 ■ Estimates based on current trend

Sustainability

Reduce Green-House Emissions by 20%



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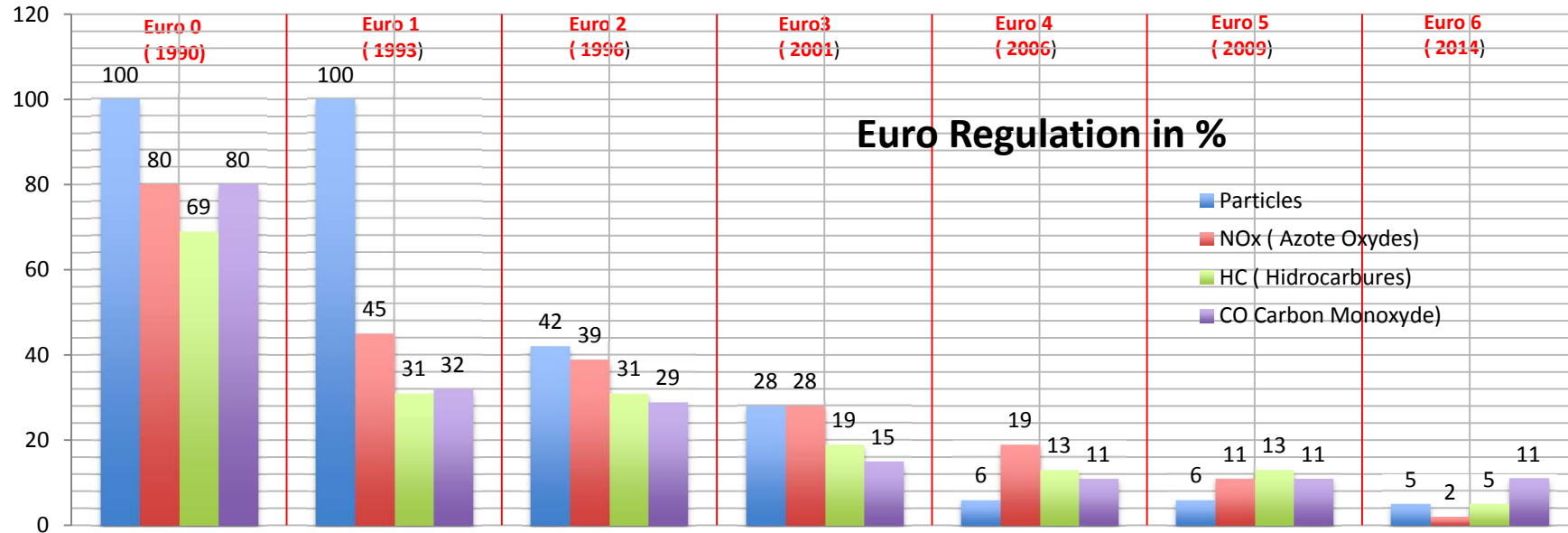


Sustainability

Reduce Green-House Emissions by 20%



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Carbon monoxide (CO), mg/km³

Nitrogen oxides (NO_x), mg/km²



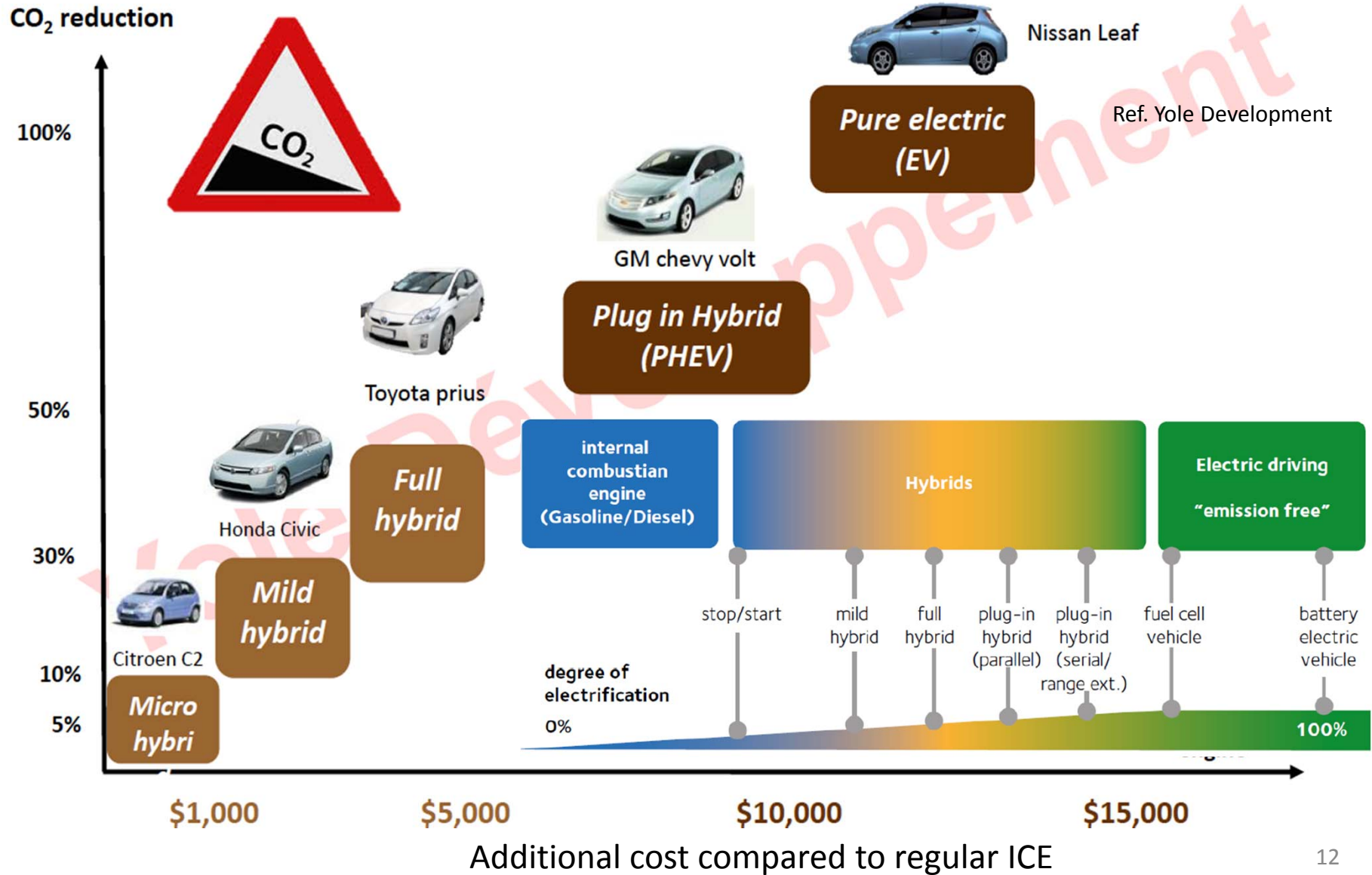
Ref. Recharging China's electric vehicle Aspiration. McKinsey & Company

Sustainability

Reduce Green-House Emissions by 20%



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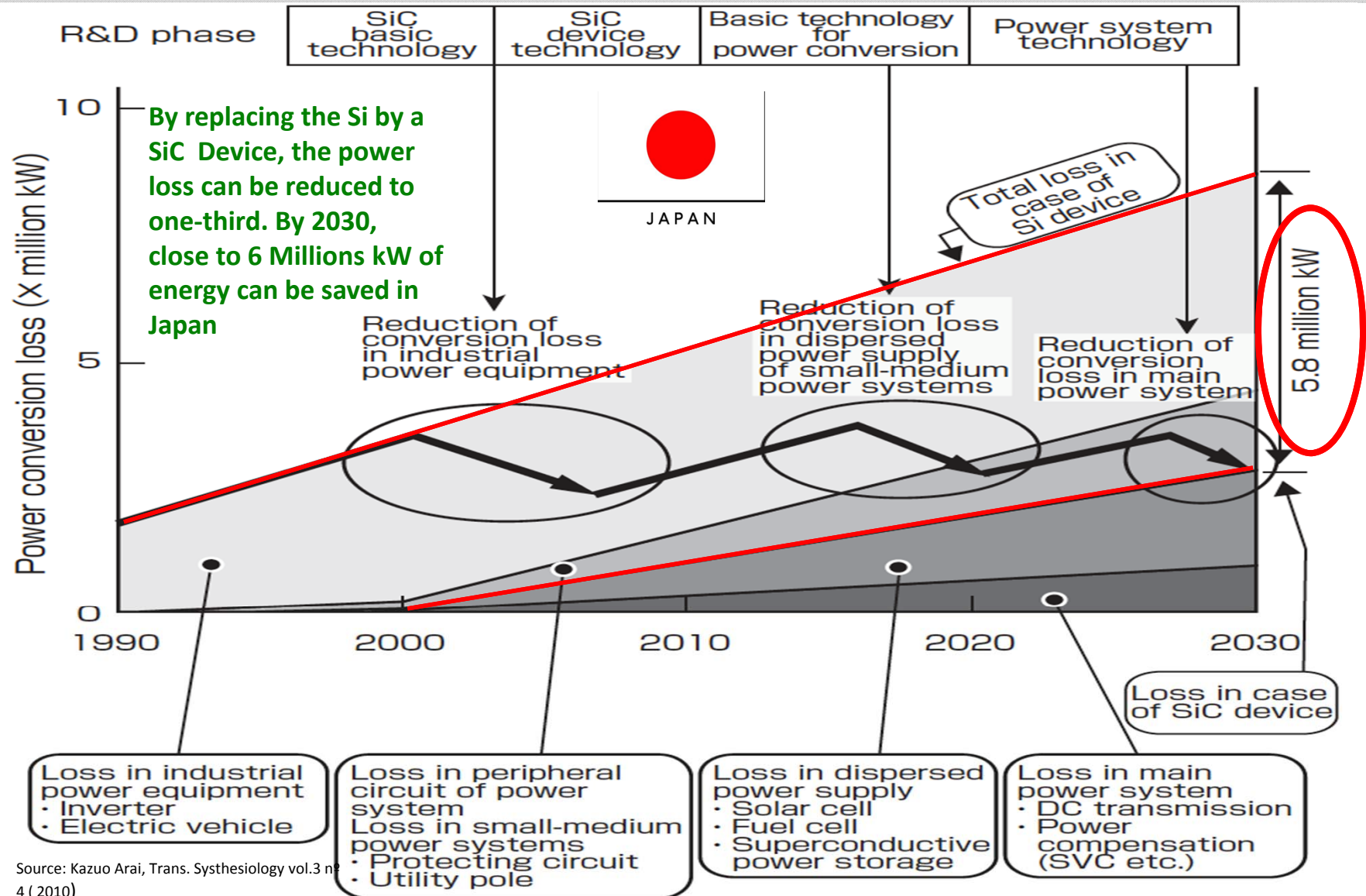


Security of Energy Supply

Increase Efficiency by 20%



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Source: Kazuo Arai, Trans. Systhesiology vol.3 n. 4 (2010)

Security of Energy Supply

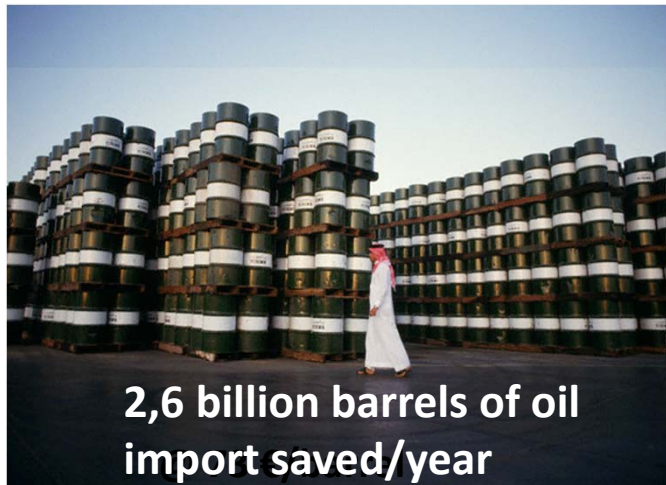
Increase Efficiency by 20%



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Meeting the 20% Energy Efficiency Target



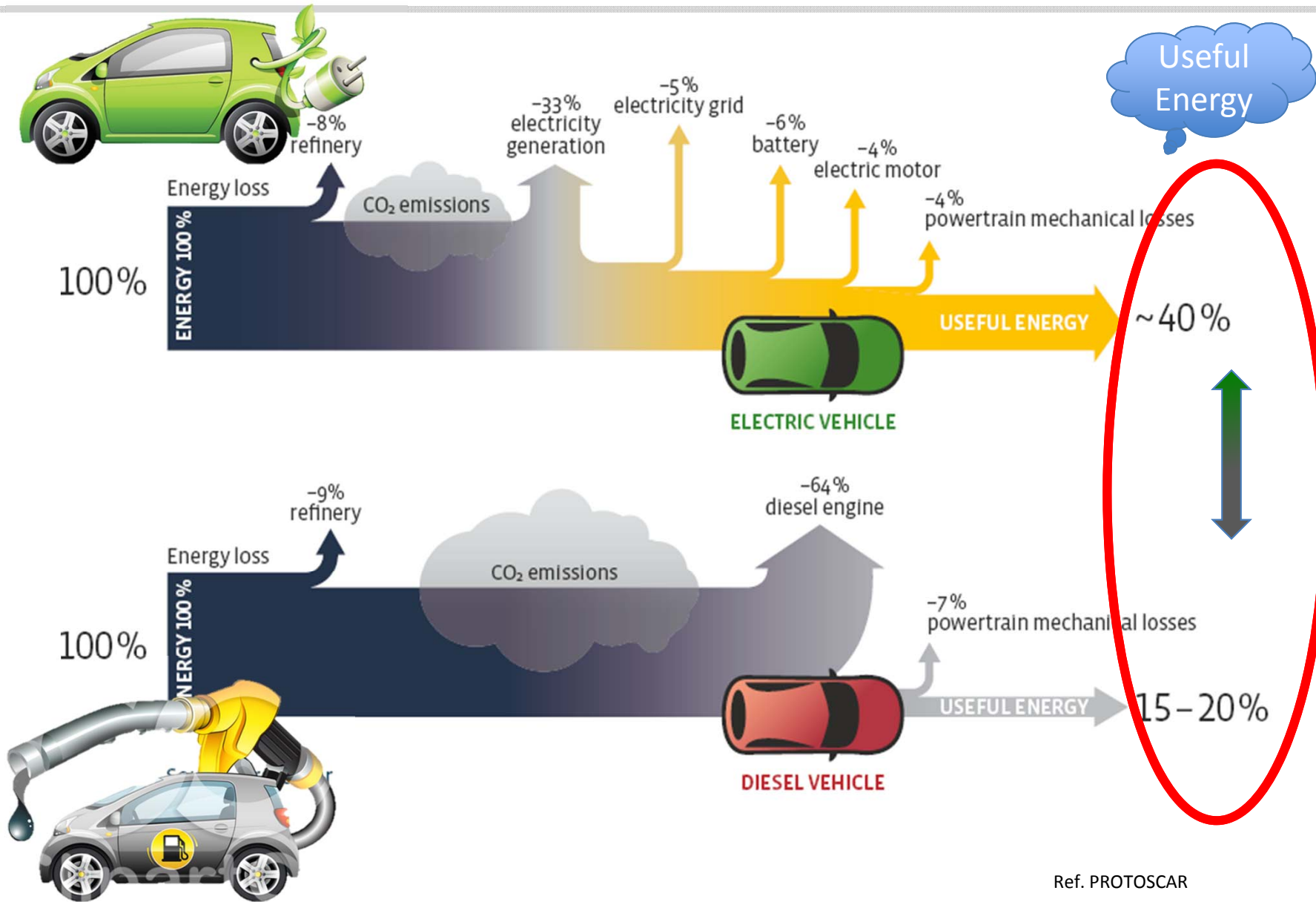
Source :
G.Miladinova, DG Energy,
EU Commission

Security of Energy Supply

Increase Efficiency by 20%



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Ref. PROTOCAR

Security of Energy Supply:

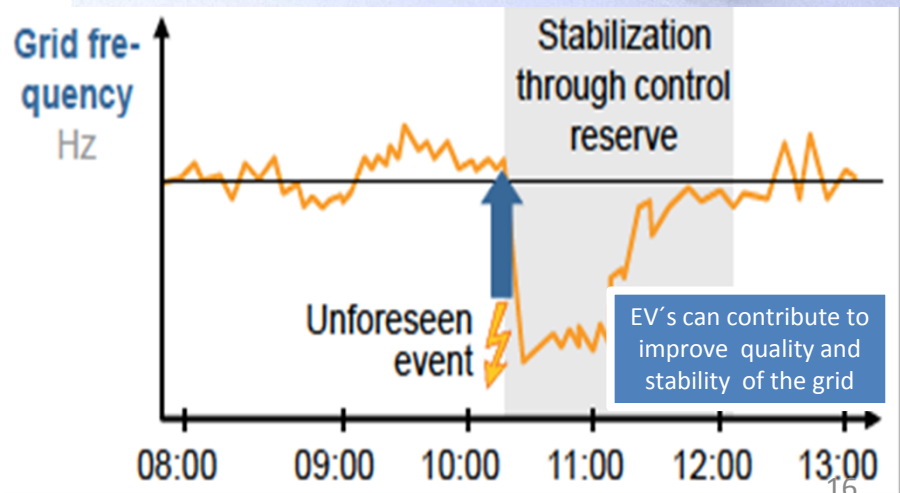
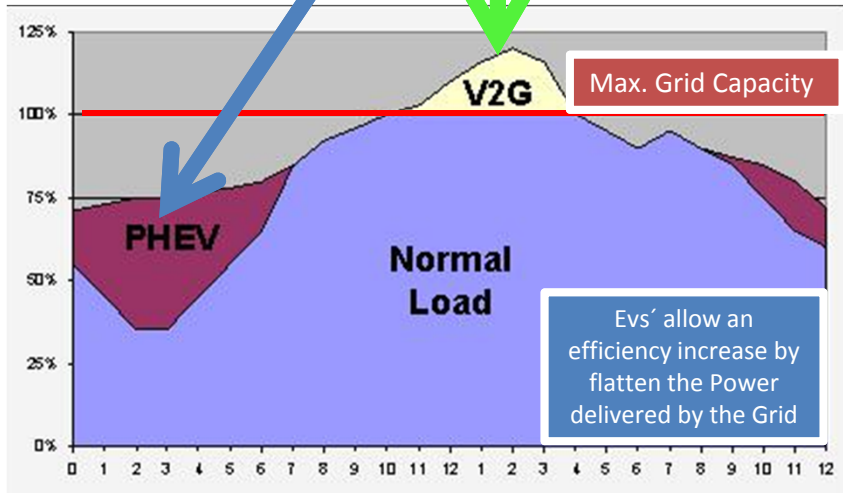
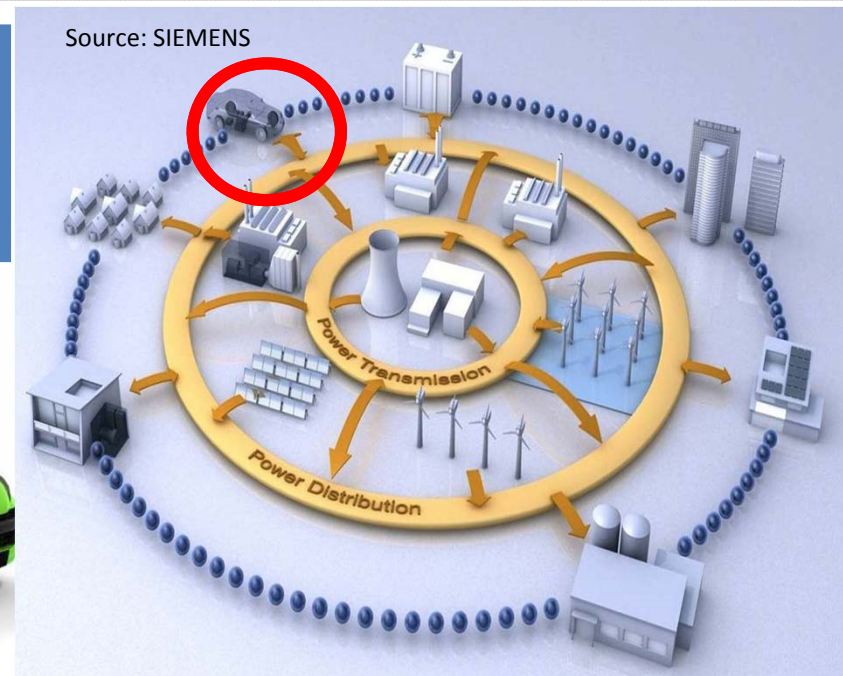
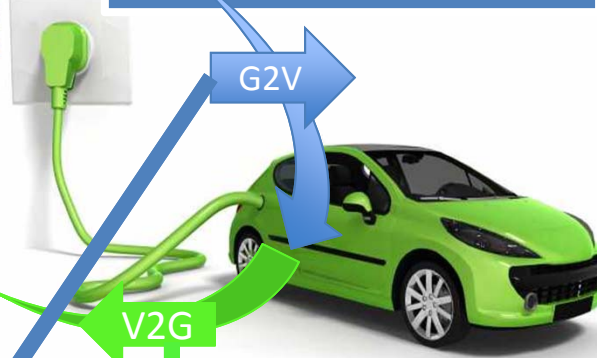
Integration with Smart Grids



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V2G concept allows user of EV's, to sell back to the electric utility excess energy storage from the battery of the car



Competiveness

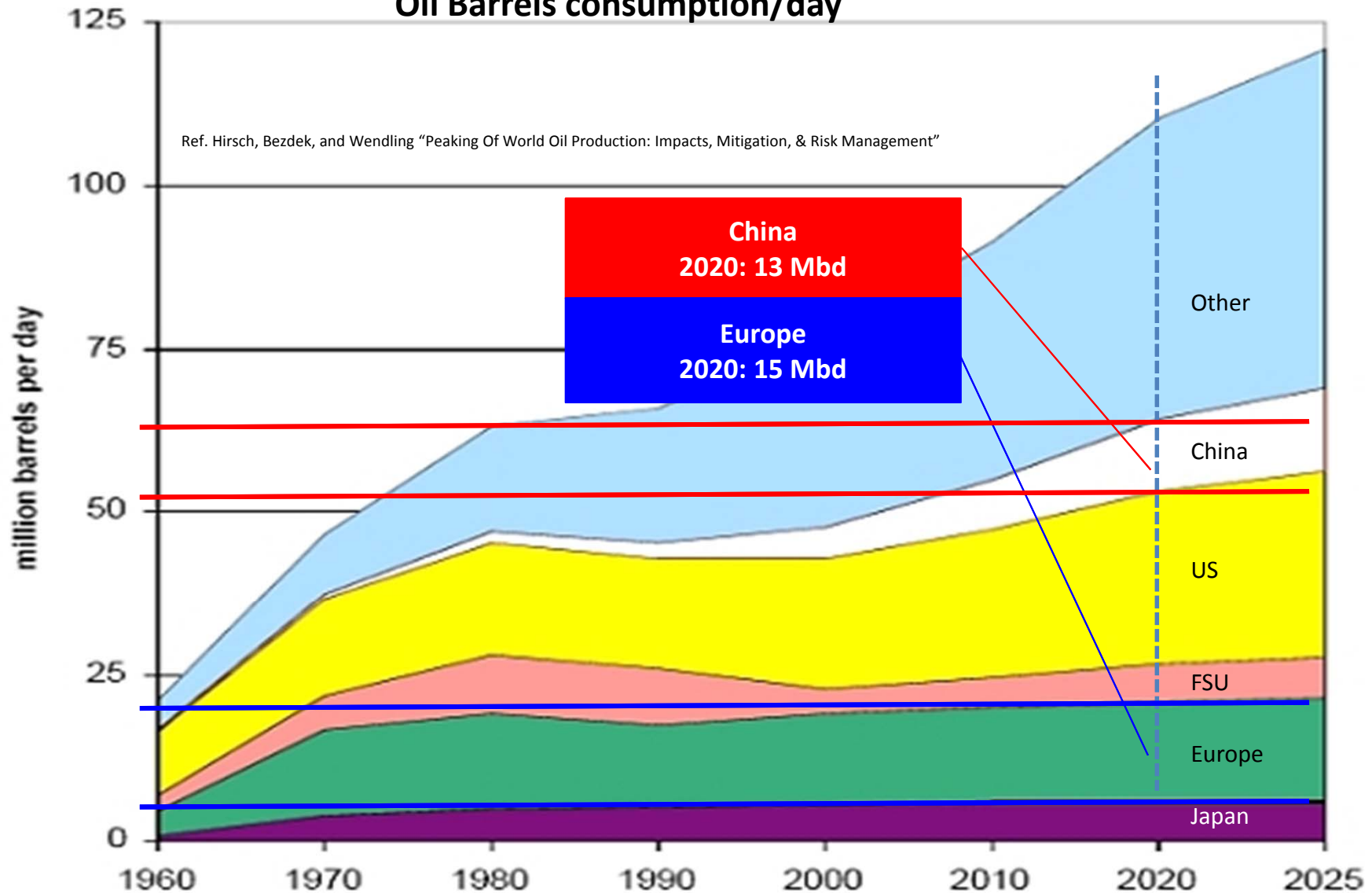
New Business Opportunities & Reduction on Energy Dependence



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Oil Barrels consumption/day



Competiveness

New Business Opportunities & Reduction on Energy Dependence



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Electricity production share in the next decades

37.000 TWh

Renewables 2008: 600 TWh

Solar: 2%
Biomass: 47%
Wind: 28%
Geothermal: 13%

2,6% p.a.

21.000 TWh

3%

15%

13%

22%

5%

42%

Fossil
Energies

14%

13%

13%

21%

3%

36%

**Renewables
2030: 5.200 TWh**

Solar: 28%
Biomass: 13%
Wind: 48%
Geothermal: 3%

Source: Dr. Michael Weinhold-
SIEMENS

Share of fuel 1990-2030
(% shares of world energy use)

	1990	2030
Renewables*	0.4	6.3
Nuclear	5.6	6.0
Hydroelectric	6.0	6.8
Coal	27.3	27.7
Natural gas	21.8	25.9
Oil	38.9	27.2

Ref. Oil Dictatorships Require High Oil Prices: Can They Hold?

2008

2030



Today, roughly 70% of all electrical energy is estimated to be processed by power electronics and its application space spans automotive, renewables generation and integration, electric-grid infrastructure upgrades (i.e. smart grid), and energy efficiency

Competiveness

New Business Opportunities & Reduction on Energy Dependence



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Sun2Grid
and/or
Wind2Grid

15% by 2025



20% by 2020



20% by 2020



25% by 2025



Source: Bladow, TÜV SÜD, LBST

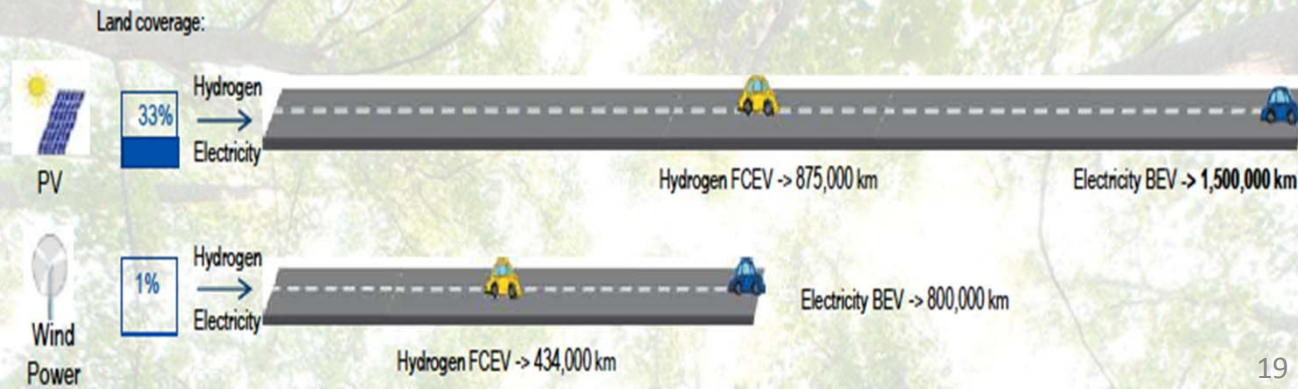
10m² roof
needed for
driving
10.000
km/year

Reduce Petrol Bill &
Reduce EU's Energy
Dependence
by using Renewables



Source: Bladow, TÜV SÜD, LBST

One hectare of land can power a vehicle:



Competiveness

New Business Opportunities & Reduction on Energy Dependence



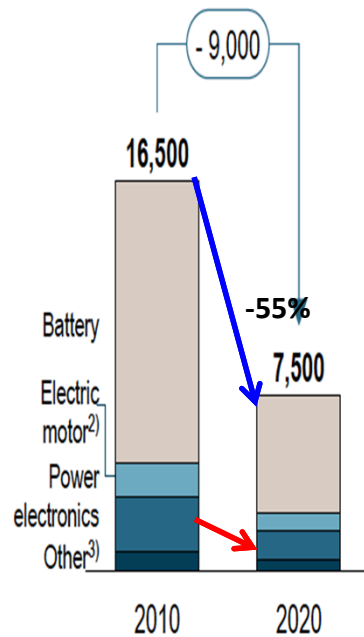
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Power Train Costs Estimations

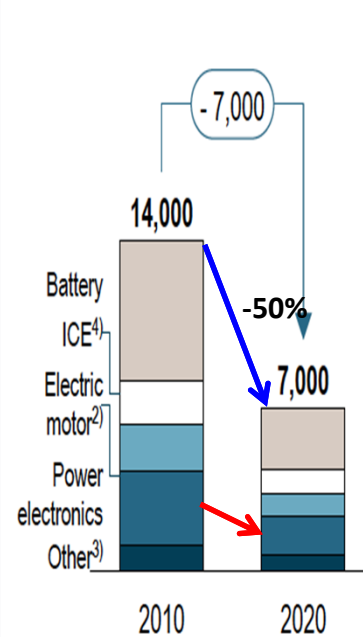
EV

Powertrain costs



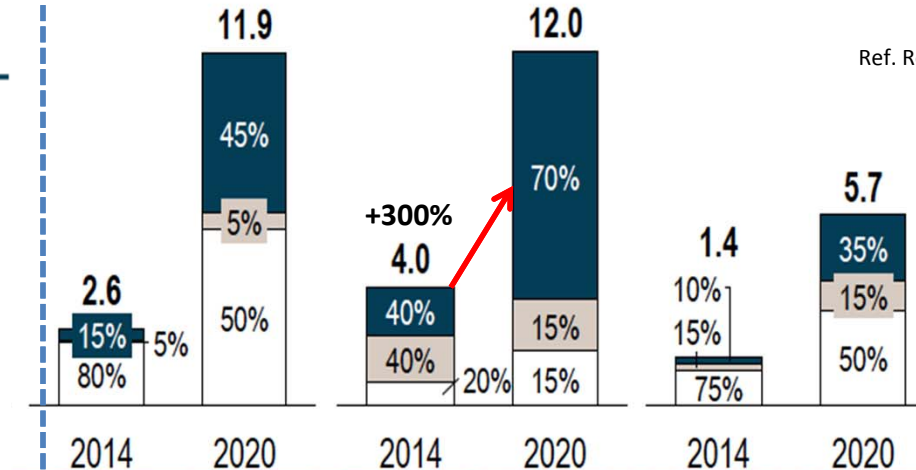
PHEV⁽¹⁾

Powertrain costs



Power Train Market Potential

Ref. Roland Berger



Actual Players



New Players

Source: Roland Berger

Captive
 Accessible HEV
 Accessible EV/PHEV

EESC_Brussels_20100630.pptx | 24

Shifts in the automotive Value Chain brought by EVs

R&D Large Increase

Energy Storage Systems: up to 60% of EV value and a key differentiator (range, size ...)

Power Electronics with high Communication capabilities

Electric Motors: with high ICT content

Ref. Impact of ICT R&D on the Large-scale Deployment of the Electric Vehicle AEA Technology plc

Competiveness

New Business Opportunities & Reduction on Energy Dependence

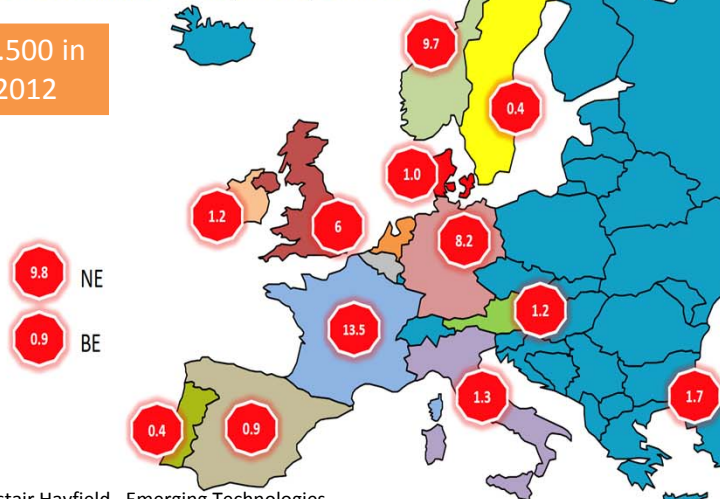


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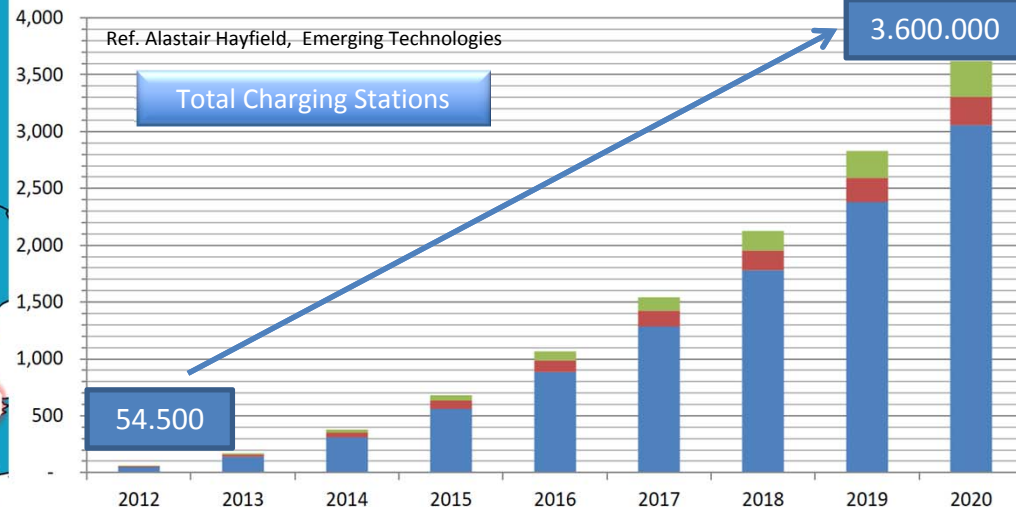
2012 – Total Charging Station Deployments
(Thousands of Stations – Public, Private, Semi-Public)

54.500 in
2012

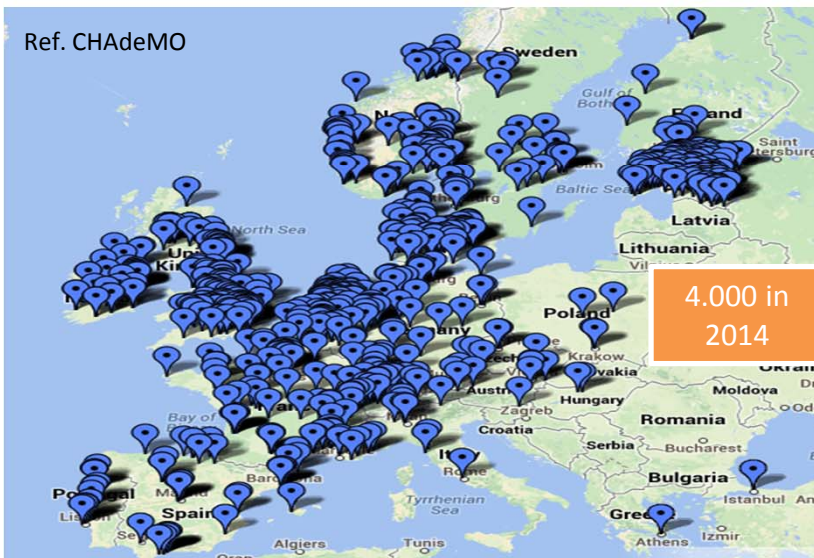


Ref. Alastair Hayfield, Emerging Technologies

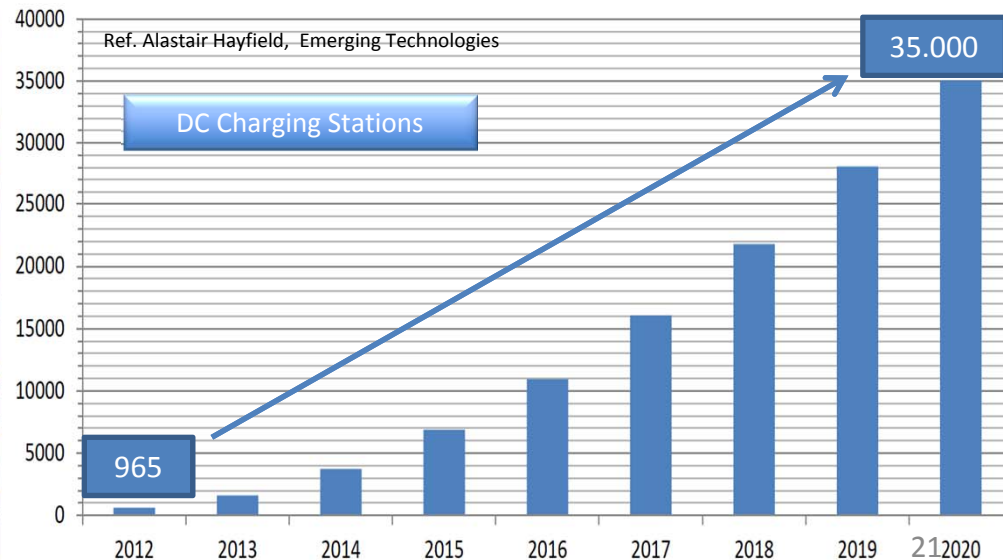
Cumulative Public, Private, Semi-Public Charging Station Deployments – EMEA – 000s of Stations



Ref. CHAdeMO



4.000 in
2014



e-Mobility 2020

Key Issues for the deployment of EV's



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EV Price
comparable to ICE

- ✓ Lower Battery costs
- ✓ EV Series Production

EV Range
comparable to ICE

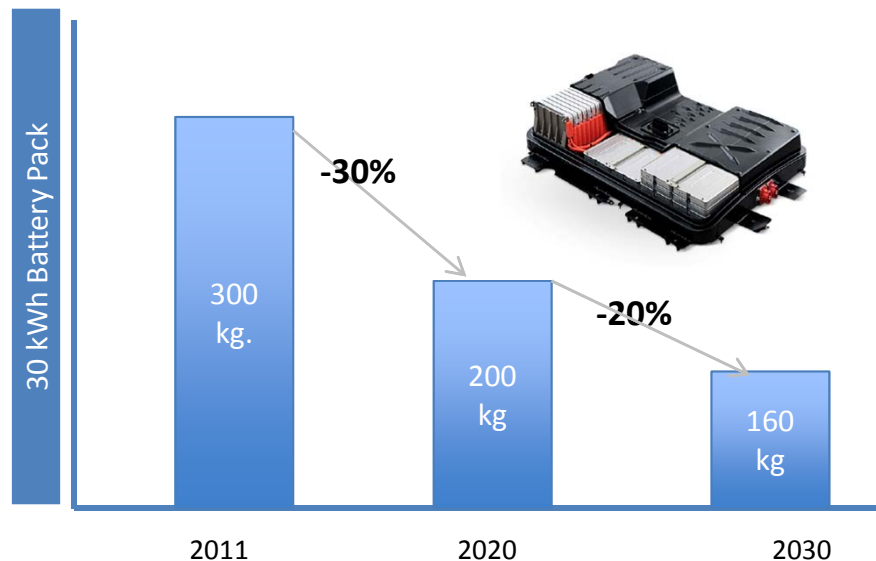
- ✓ More kWh/litre
- ✓ Extended Range

EV Infrastructure
comparable to ICE

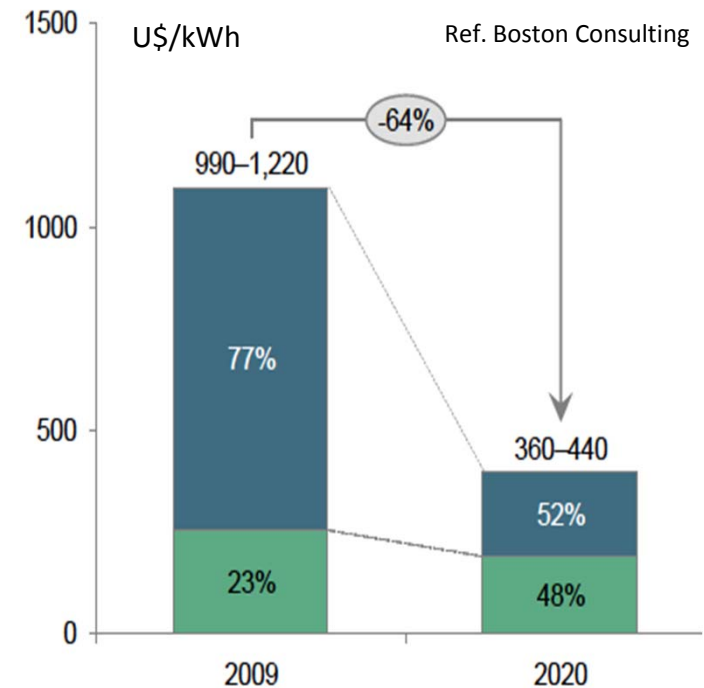
- ✓ More Charging Infrastructure needed

Battery Size

Ref. Boston Consulting



Pack cost per kWh



e-Mobility 2020

Key Issues for the deployment of EV's

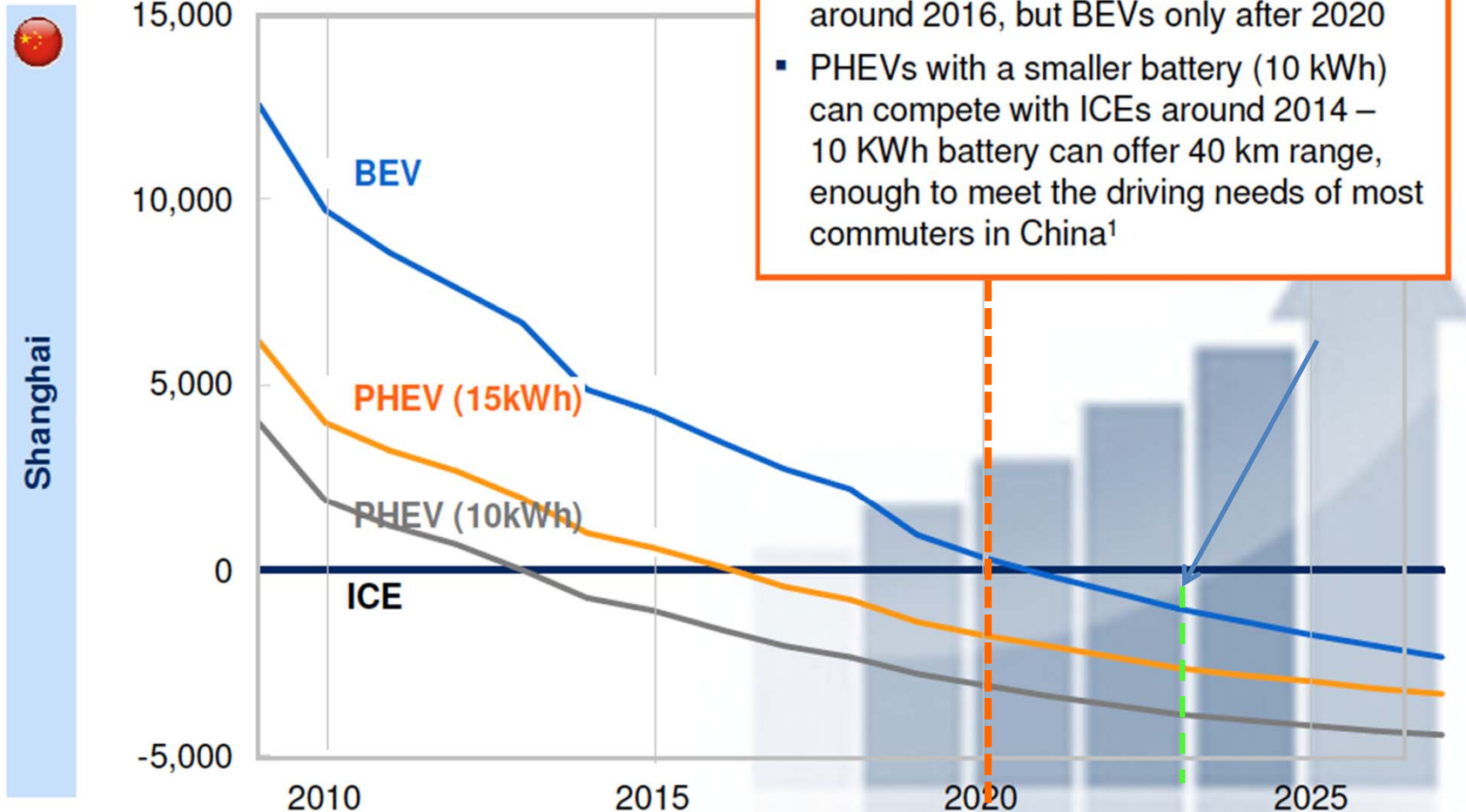


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Average TCO disadvantage of EV vs. ICE

Chinese RMB p.a., segment C

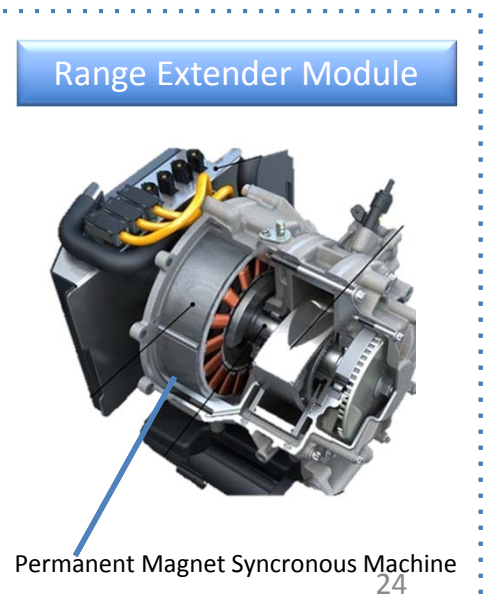
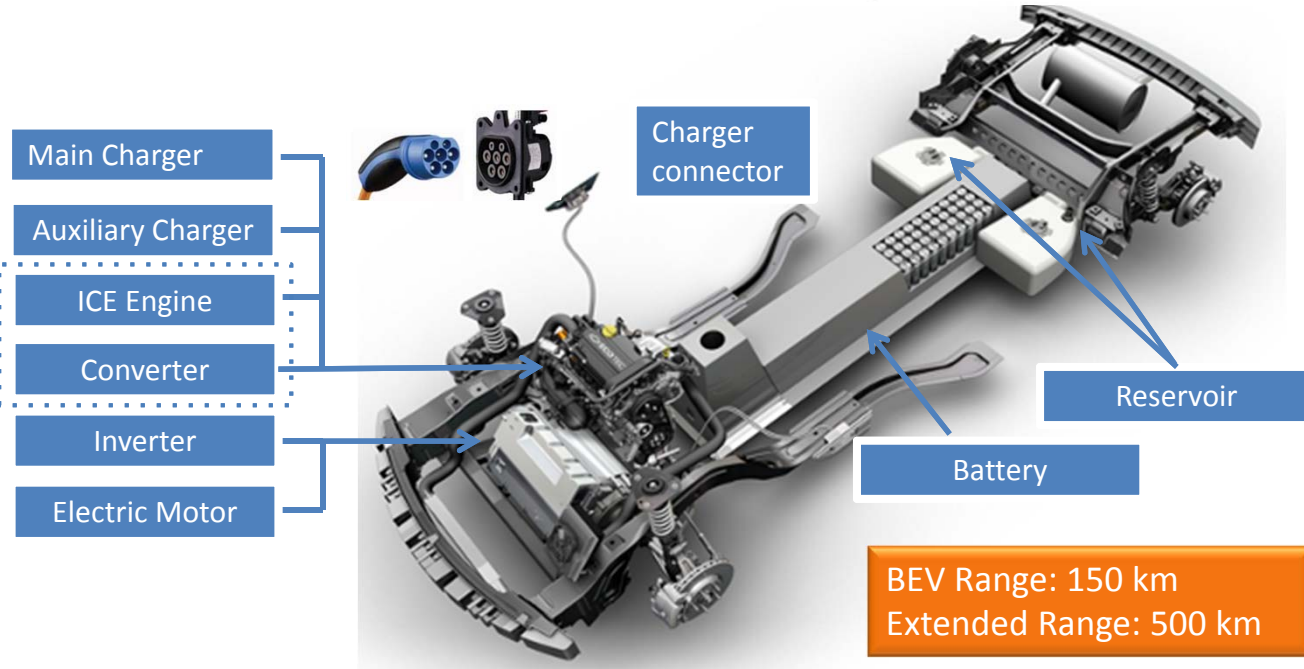
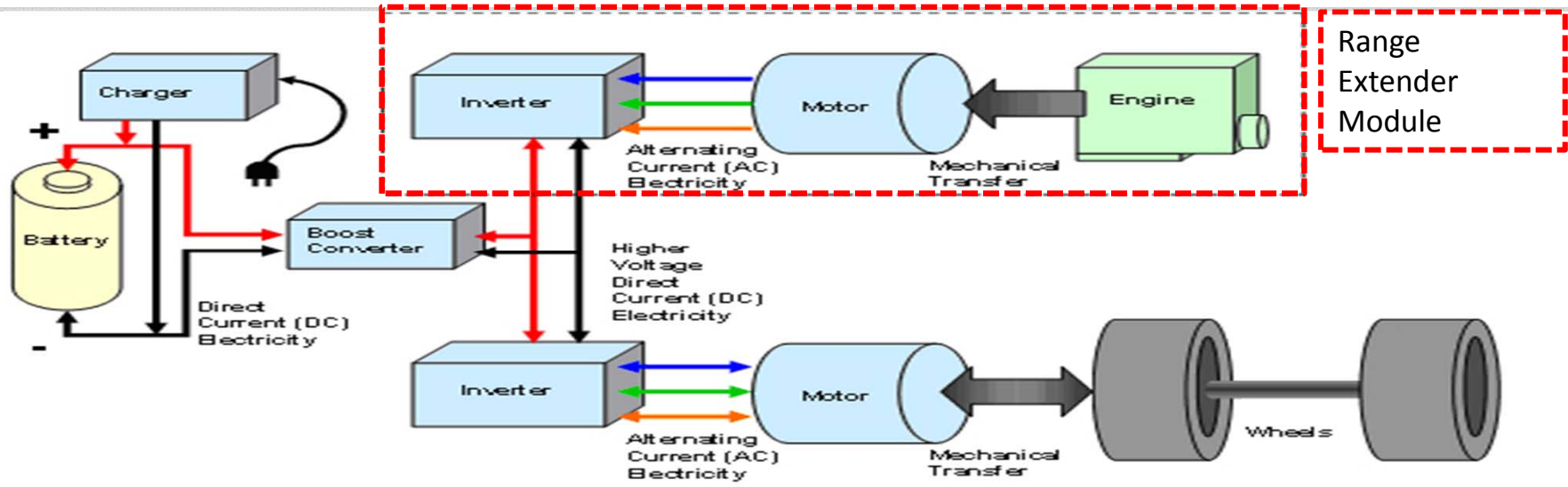


e-Mobility 2020

Key Issues for the deployment of EV's



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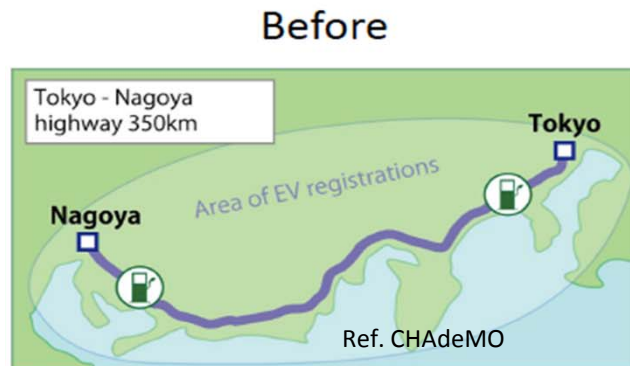


e-Mobility 2020

Key Issues for the deployment of EV's



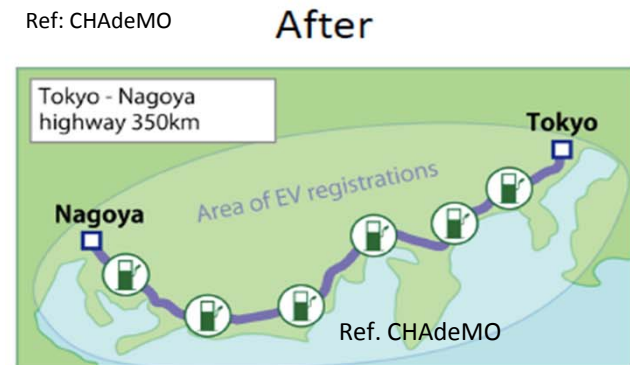
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CHAdeMO units: **2**

19% of EV drivers using a highway

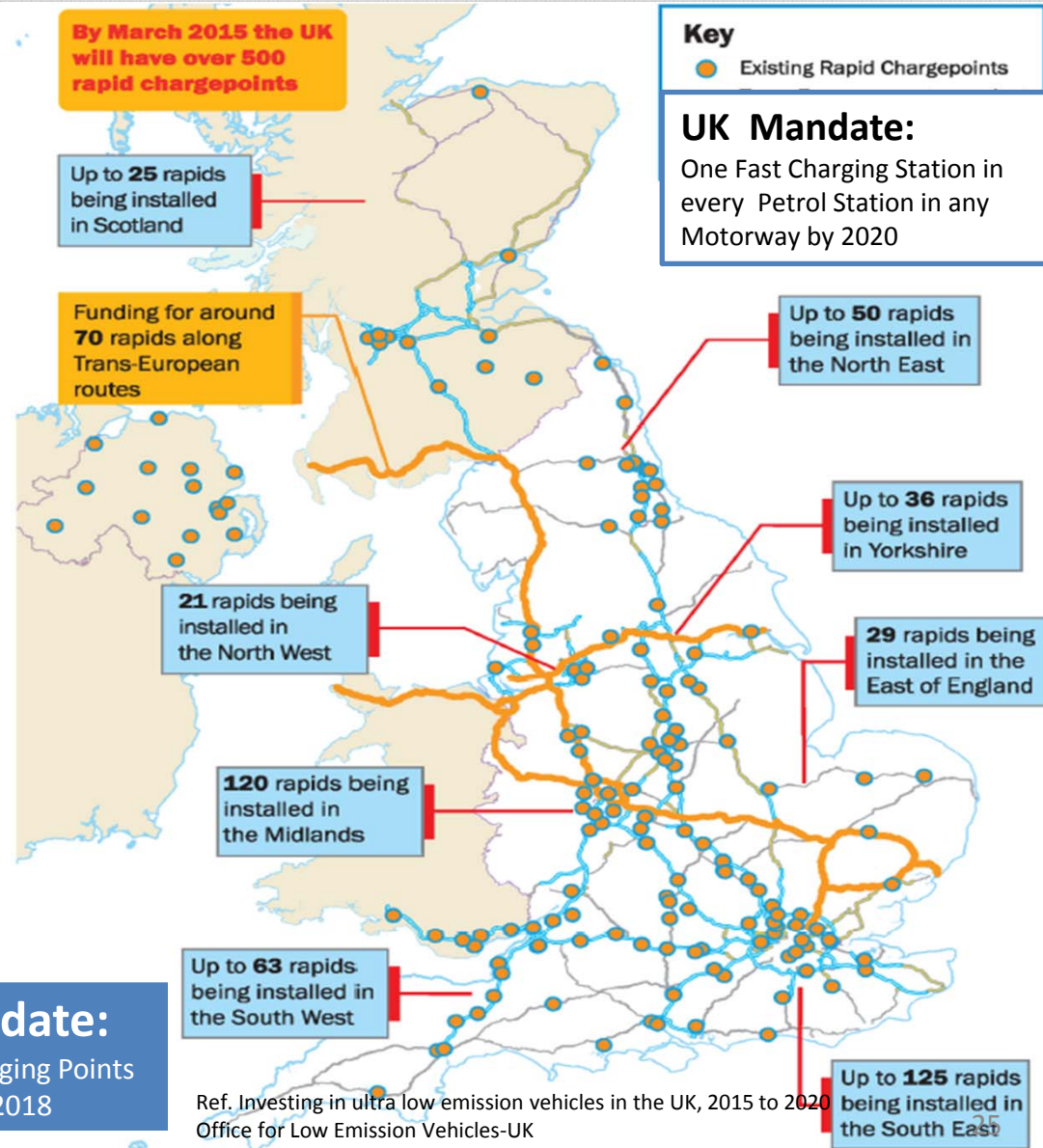
Ref: CHAdeMO



CHAdeMO units: **6**

46% of EV drivers using a highway

EU Mandate:
800.000 Charging Points in the EU by 2018



e-Mobility 2020

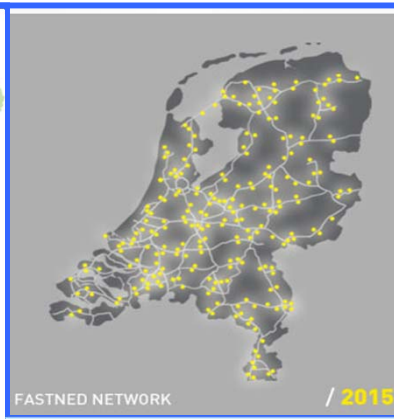
Key Issues for the deployment of EV's



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Ireland



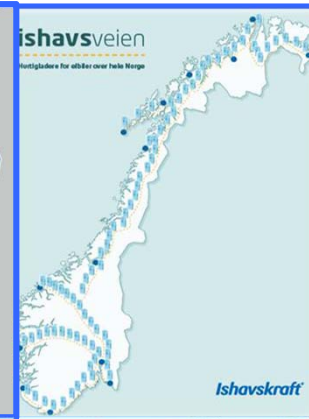
Holland



Denmark



Germany

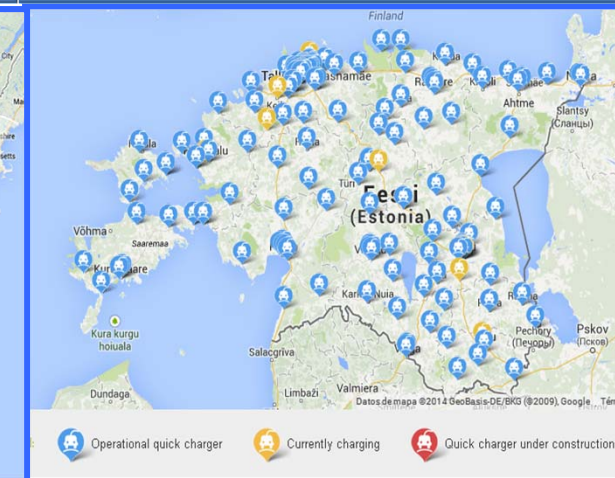
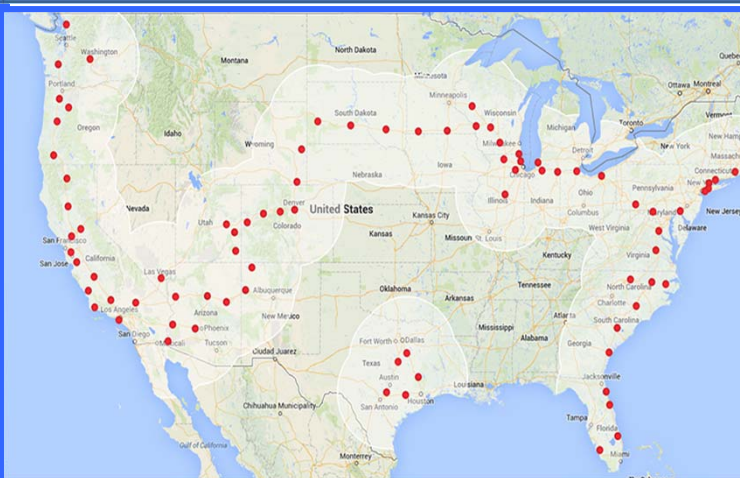


Norway

France

USA

Estonia



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Infrastructure for the Deployment of EV's



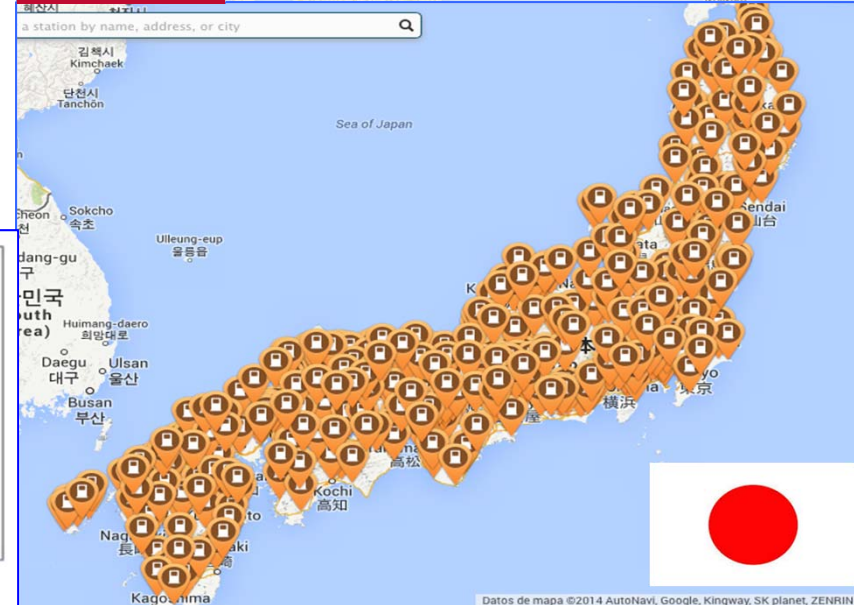
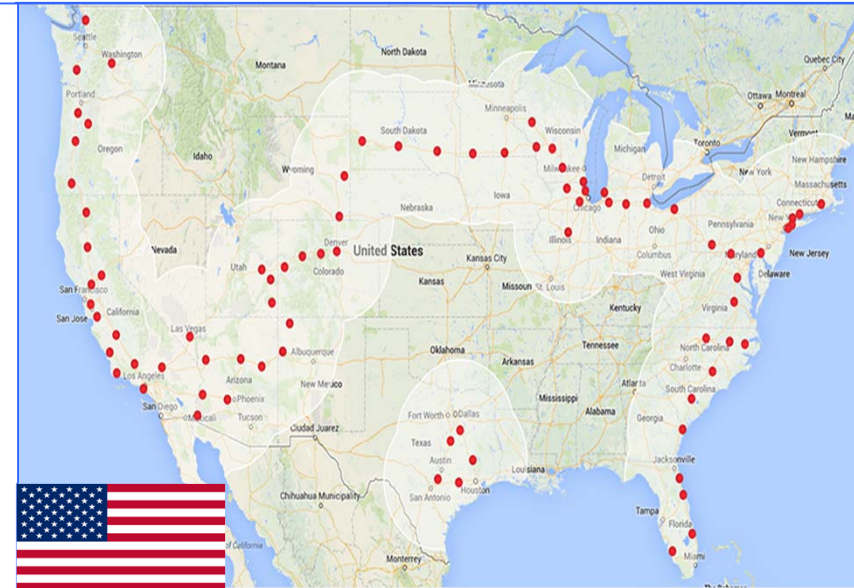
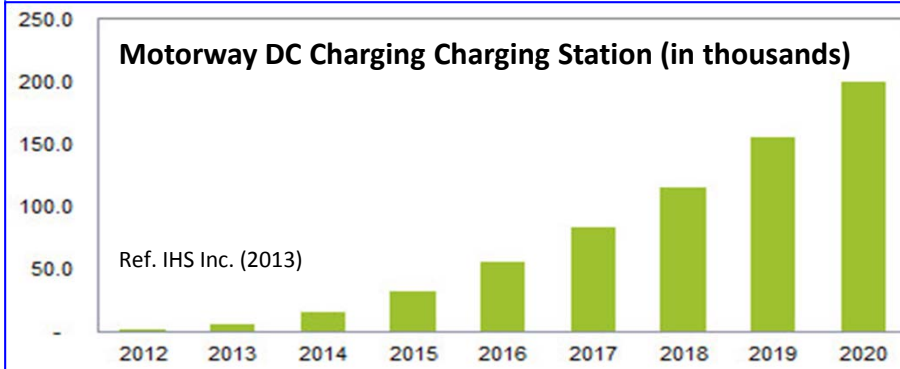
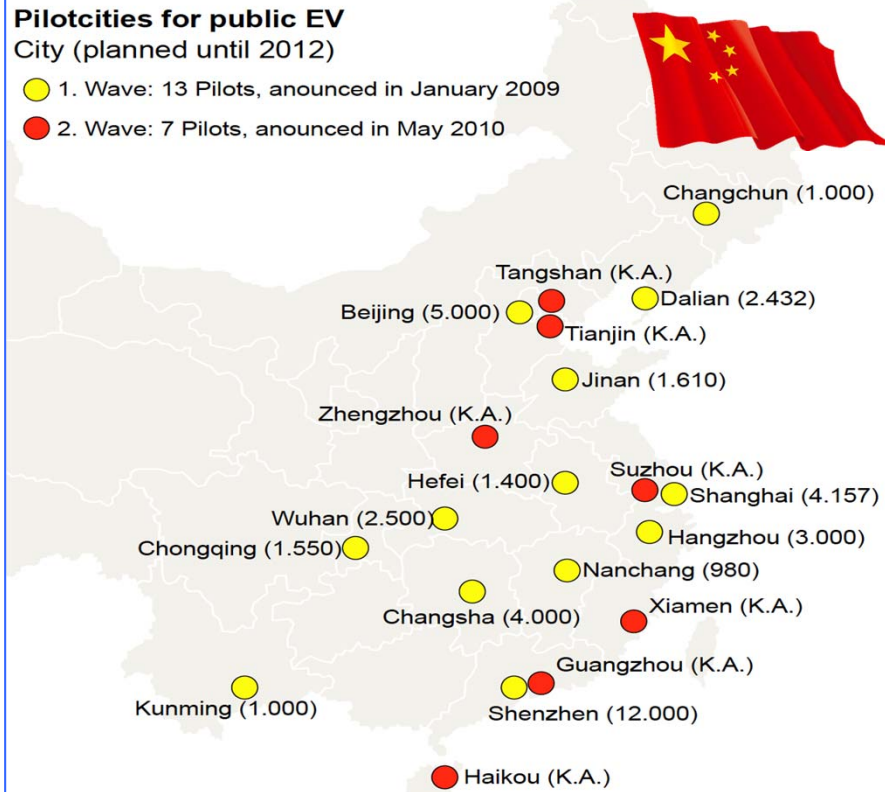
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Pilotcities for public EV

City (planned until 2012)

- 1. Wave: 13 Pilots, announced in January 2009
- 2. Wave: 7 Pilots, announced in May 2010



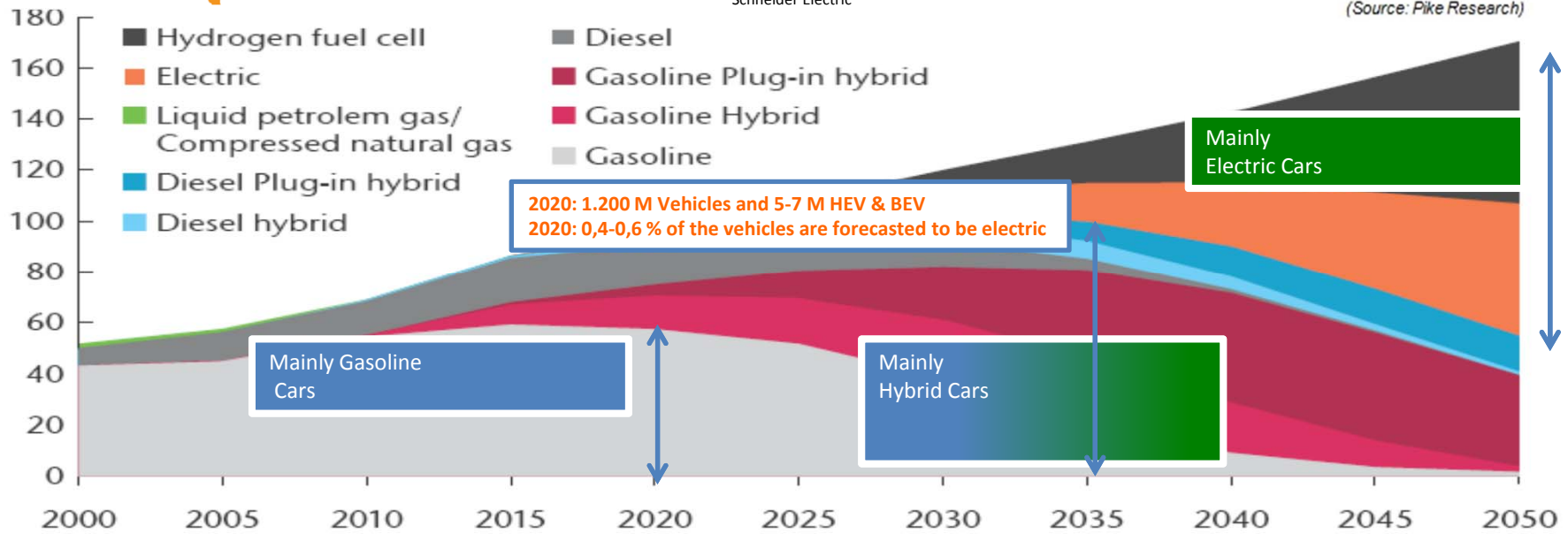
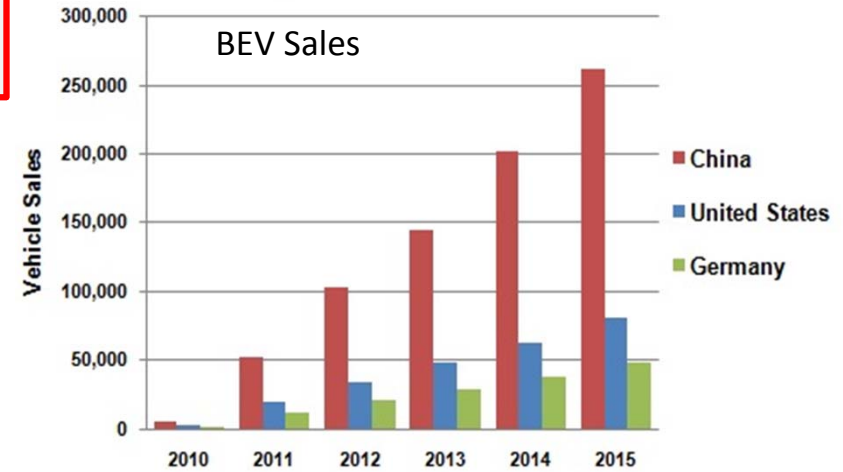
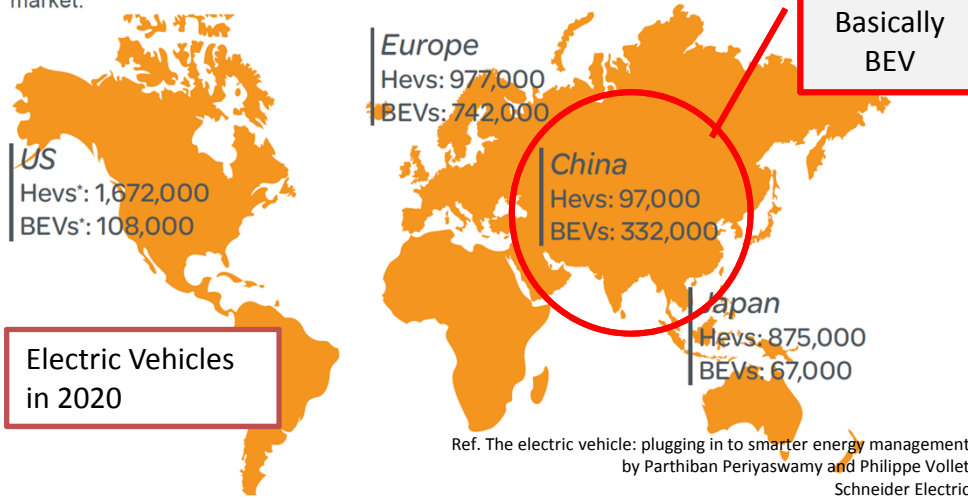
Datos de mapa ©2014 AutoNavi, Google, Kingway, SK planet, ZENRIN

e-Mobility 2020

Market Forecasts



market.



2012: Mainly ICE cars

2035: Mainly PHEV

2050: Mainly BEV

e- Mobility 2020

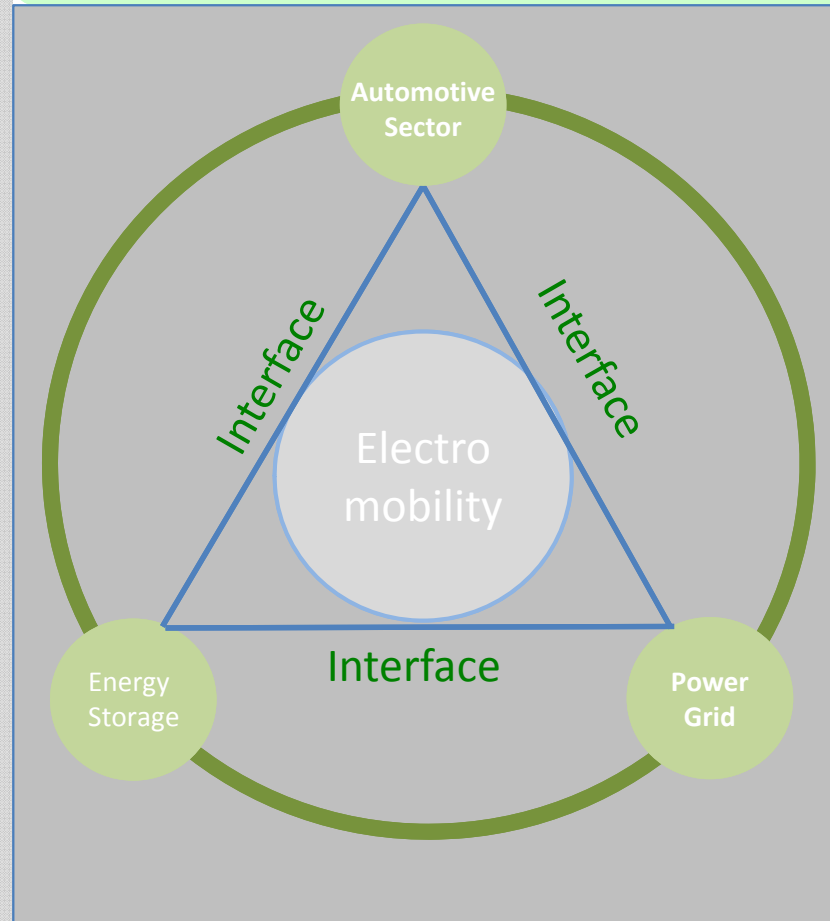
Actors involved for the Deployment of Electric Vehicles



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Advanced Power
Processing Systems



Advanced ICT
Technologies



IC Technologies



Infrastructure
(Grid Integration)



Systems
(Chargers)



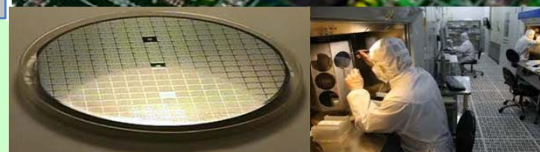
Sub-Systems
(Power Converters)



Components



Microelectronics



Materials

e-Mobility Charging Systems

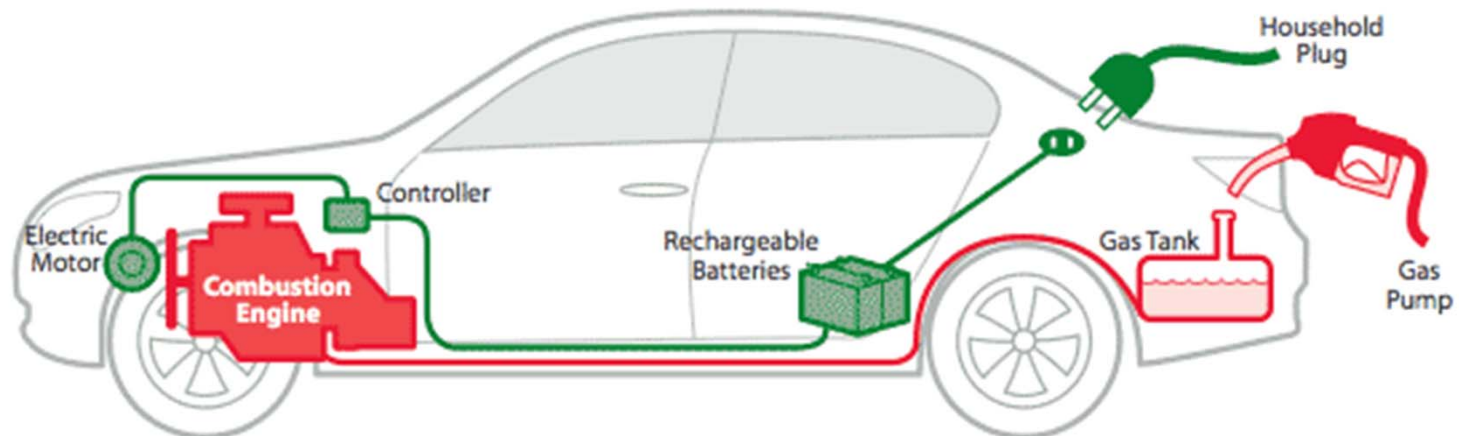
Basic Concepts



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	Utility Company	OPEC
ENERGY SUPPLIER		
RANGE	150 km	800 km
RECHARGING TIME	30 min...8 hours	2 min
€/100 km	1..1,5 €/100 km	10 €/100 km
grCO2/km	0 grCO2/km	150 grCO2/km

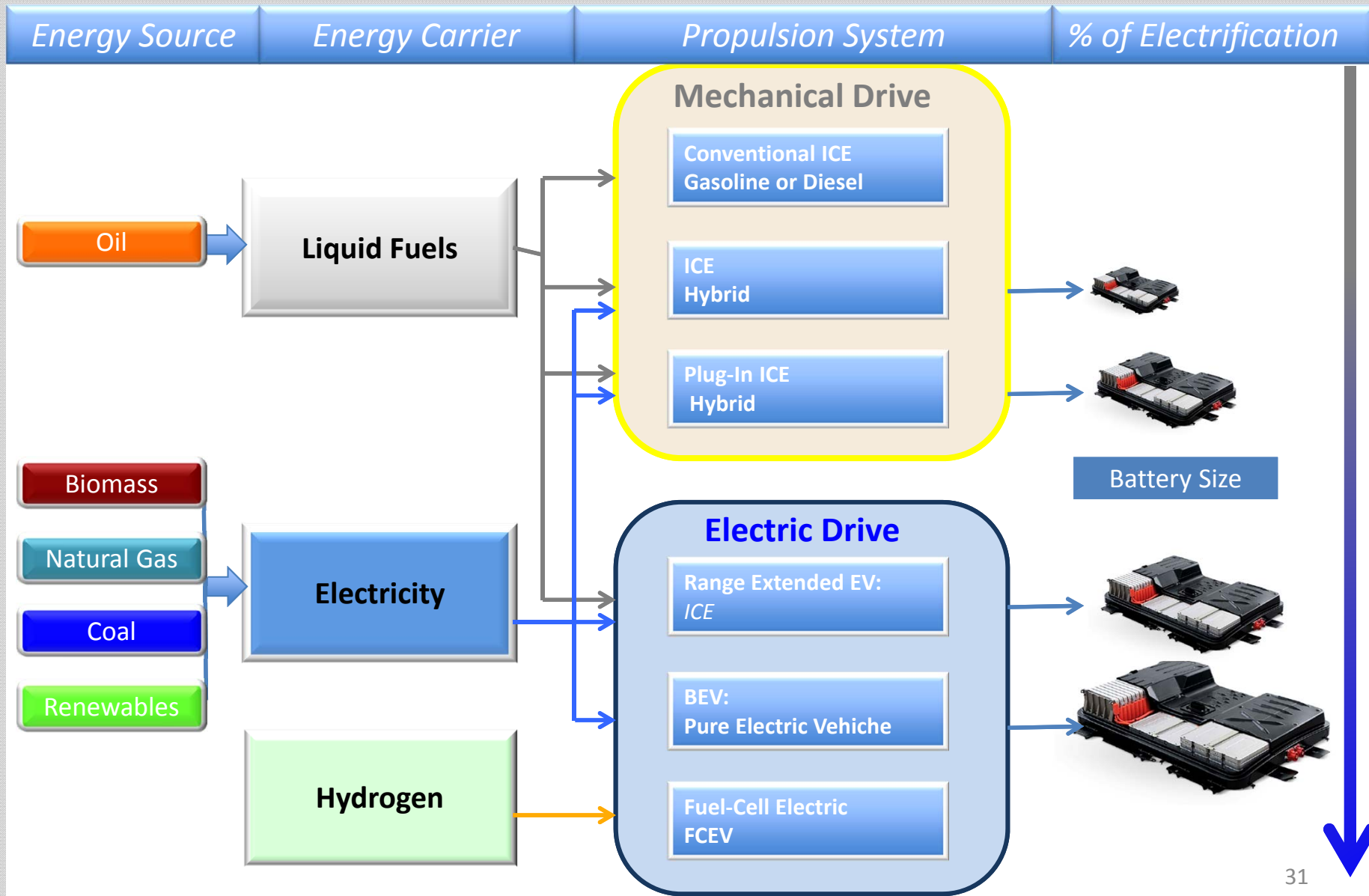


e-Mobility Charging Systems

Mechanical & Electrical Drive



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ID VALÈNCIA

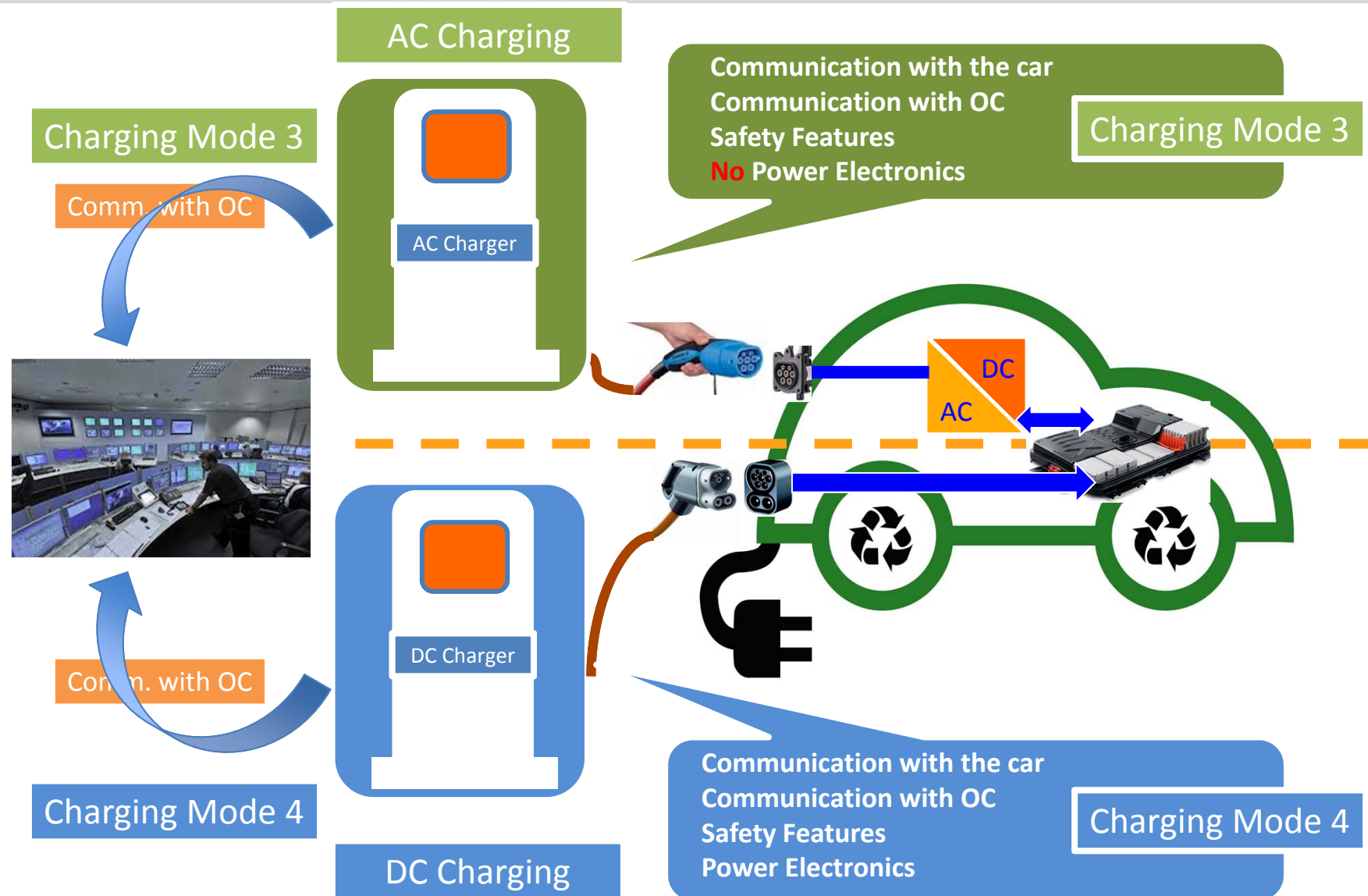


e-Mobility Charging Systems

Charger Fundamentals



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e-Mobility Charging Systems

Charger applicable Standards



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Communication to OC

Charge eMosphere – SIEMENS

The intelligence behind electromobility

ChargePoint
by Coulomb Technologies

Ocpp
Open Charge Point Protocol

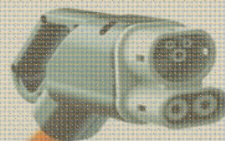
MOBIE
ELECTRIC MOBILITY



Safety & Charging Topology

Charging
Communication

Connector



IEC 62.196-2/3



ISO/IEC 15.118

IEC 61.851-1

CHAdeMO

DIN 70.121

IEC 61.851-24

IEC 61.851-21-
2

IEC 61.851-23

IEC 61.851-22

EV Charger

Power
Electronics

IC Tecnology

Electrical Safety
Regulations

Communication
SW

e-Mobility Charging Systems

Most Relevant Standards for e-Mobility Charging

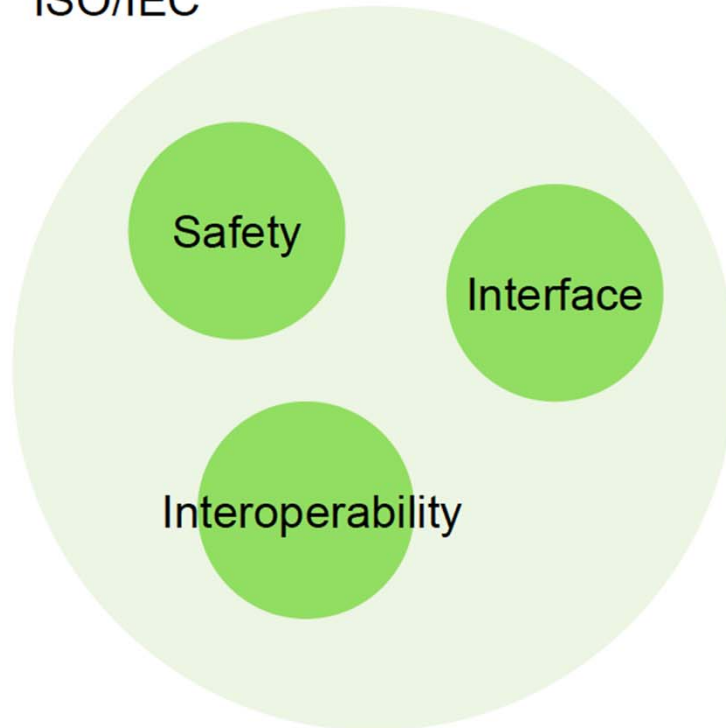


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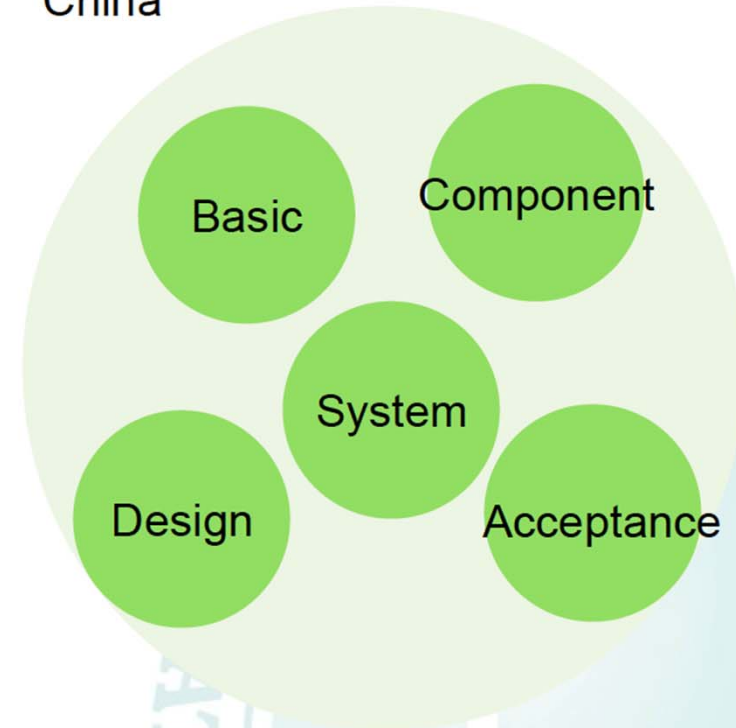


Comparison of the standard structure between ISO/IEC and China

ISO/IEC



China



e-Mobility Charging Systems

Most Relevant Standards for e-Mobility Charging



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◆ IEC 61.851: Electric Vehicle Conductive Charging Systems



- Part 1: General Requirements
- Part 21: Electric Vehicle Requirements
- Part 22: AC Charging Station
- Part 23: DC Charging

◆ IEC 62.196: Plugs, Socket Outlets and Vehicle Couplers



- Part 1: General Requirements
- Part 2: Dimensional Interchange ability requirements
- Part 3: DC Charging Connector

◆ IEC 15.118: Vehicle to Grid Comm.. Interface



- Part 1: Definitions and Use cases
- Part 2: V2G Protocol
- Part 3: Physical Layer (PLC)



◆ GB/T 18487: Electric Vehicle Conductive Charging Systems



- GB/T 18487.1: General Requirements
- GB/T 18487.2: EV Requirements for conductive connection to an AC/DC supply
- GB/T 18487.3 AC/DC EV charging station

◆ GB/T 20234: Plugs, Socket Outlets and Vehicle Couplers.....



- GB/T 20234.1: General Requirements
- GB/T 20234.2: AC Charging Coupler
- GB/T 20234.3: DC Charging Station

◆ GB/T 27930: Comm. Protocols between off-board conductive charger & BMS for EV



e-Mobility Charging Systems

Charging Modes acc. IEC 61.851-1



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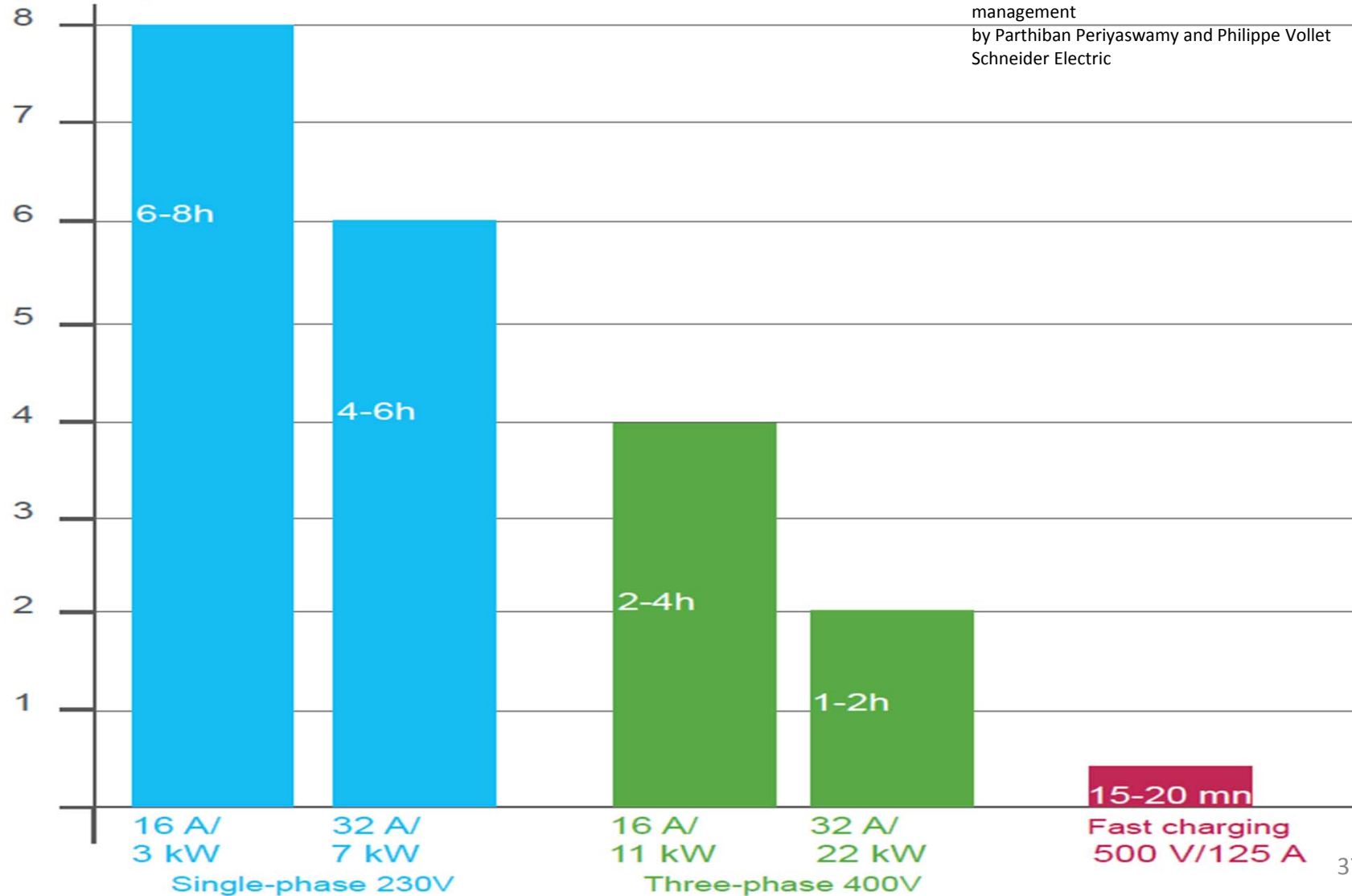
	<p>16 A. 230 or 400 VAC 3.7 or 7,2 kW</p> <p>Charging Time 3...8 hours</p>			<p>Mode1 AC Charging</p> <p>Home</p>
	<p>32 A. 230 or 400 VAC 11 or 22 kW</p> <p>Charging Time 2...8 hours</p>			<p>Mode2 AC Charging</p> <p>Home</p>
	<p>63 A. 230 or 400 VAC 22 or 43 kW</p> <p>Charging Time 30 min...2 hours</p>			<p>Mode3 AC Charging</p> <p>Home Comercial</p>
	<p>125 ADC/ 400 VDC 50 kW</p> <p>Charging Time 15...20 min</p>			<p>Mode4 DC Charging</p> <p>Motorway</p>

e-Mobility Charging Systems

Charging times



Time for full charge
(hours)



Ref. The electric vehicle: plugging in to smarter energy management
by Parthiban Periyaswamy and Philippe Vollet
Schneider Electric

e-Mobility Charging Systems

DC Chargers Typical Requirements



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DC Off- Board Charger Requirements

Output Voltage Range: 50..500 VDC
Output Current: 125 ADC
Output Power: 50 kW

Rated power at a temperature
range: -5°C to + 40°C.

Output Current Ripple < 6A_{pp}
OEM Requirement < 2A_{pp}
(Voltage Ripple < 100 mV at 400 VDC)

Isolation Monitoring Device
with Self Test Capability

Compliance with IEC 61.000-3-12.
THDI < 12% for direct connection
to the LV Grid (recommended

Interoperability

Efficiency > 95%
PF: > 0,95

IP33 or higher for indoor
IP44 or higher for outdoor
IP 54 Recommended

Compliance with the limits for Group 1
(Classes A & B) of CISPR 11

Vandalism protection
(IEC 61851-1 Ed. 2.0 11.11.2)

High Cost Pressure: 80-140 €/kW

High Price Pressure: 350-600 €/kW



Converter Features

Charger Features

e-Mobility Charging Systems

DC Charger Qualification



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Construction

UL 2202, ADA requirements

GB/T 18.487.3

Mechanical Safety

UL 2202

Electrical Safety

UL 2231-2

GB/T 18.487.3

Connector

IEC 62.196.3

GB/T 20.234.3

Conducted, Radiated Emissions & Immunity

FCC, Part 15, Subpart B

Qualification Requirements for the

US Market

China Market



Construction

IEC 61.851-23

Conformity Declaration

CE Mark

Electrical Safety

IEC 61.851-23

Connector

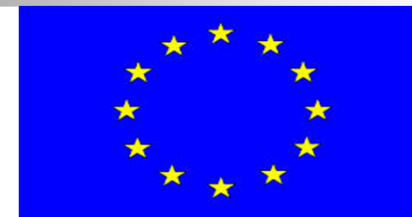
IEC 62.196.3

Conducted, Radiated Emissions & Immunity

IEC61.851-21-1

Qualification Requirements for the

EU Market



e-Mobility Charging Systems

IEC 62.196-2:Connectors for AC Charging



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	IEC 62.196-2			GB /T 20234.2
Car side				
Infrastruc. side				
Voltage	230 V	500 V	500 V	250/400 V
Phases	1Φ	1 or 3Φ	1 or 3Φ	1Φ, 3Φ reserved
Current	32A	16,32, 63 or 70 A	16 or 32 A	16/32 A
Power	Up to 7,2 kW	Up to 43 kW	Up to 22 kW	Up to 7,2 kW
	Type 1	Type 2	Type 3	













e-Mobility Charging Systems

IEC 62.196-3:Connectors for DC Charging



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	Yazaki	COMBO	SAE J 1772	GB /T 20234.3
Car side				
Infrastr. side				
				
Voltage	Unom=400 VDC Umax =500 VDC	Unom= 400 VDC Umax= 850 VDC	Unom=400 VDC Umax =500 VDC	Unom= 400 VDC Umax= 750 VDC
Current	125 ADC	200 ADC	125 ADC	250 A
Power	50 kW	80 kW	50 kW	100 kW





e-Mobility Charging Systems

EV/ DC Charger Communication



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JAPAN	CHINA	EUROPE	USA
			
Connector IEC 62196-3 (Draft)	Connector GB/T 20243/Part 3	Connector IEC 62196-3 (Draft)	Connector SAE J1772 IEC 62196-3 (Draft)
Protocol: CHAdeMO Spec. IEC-61851-24 (Draft)	Protocol: GB/T 27930	Protocol: IEC-61851-24 (Draft) IEC-15118-2; -3 (Draft) DIN Spec 70121	Protocol: IEC-61851-24 (Draft) IEC-15118-2;-3 (Draft) DIN Spec 70121
CAN (2 terminals) 5 Control Terminals 2 Power Terminals	CAN (2 terminals) 5 Control Terminals 2 Power Terminals	PLC (2 terminals) CP, PP, PE 2 Power Terminals	PLC (2 terminals) CP, PP, PE 2 Power Terminals
SOLUTION IN USE	NATIONAL STANDARD FOR APPROVAL	THE COMBINED CHARGER CONNECTOR SOLUTION IN USE	

e-Mobility Charging Systems

Combined Charging System



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e-Mobility Charging Systems

Multi-standard Chargers



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PEUGEOT



CITROËN



MITSUBISHI



TOYOTA

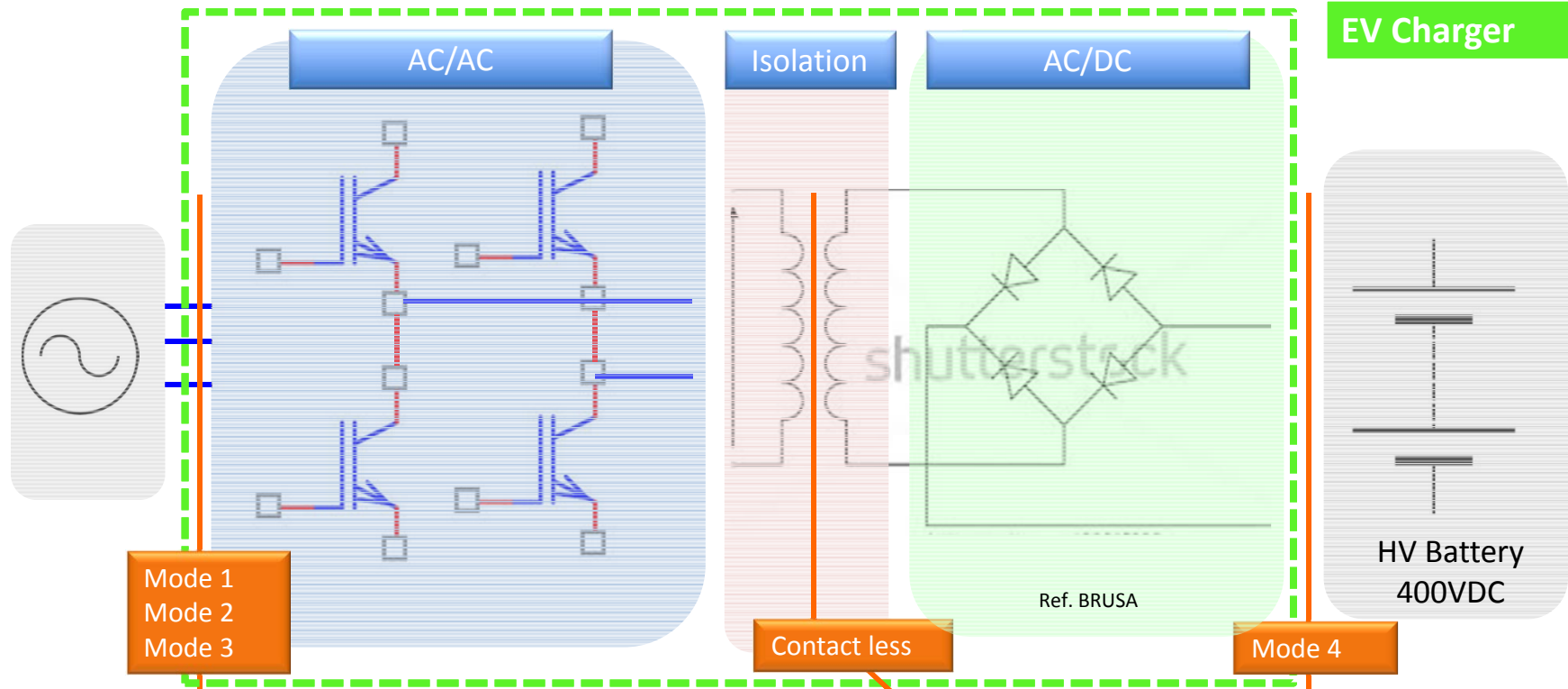


Power Electronics for Charging Electric Vehicles

Charging Electric Vehicles Fundamentals



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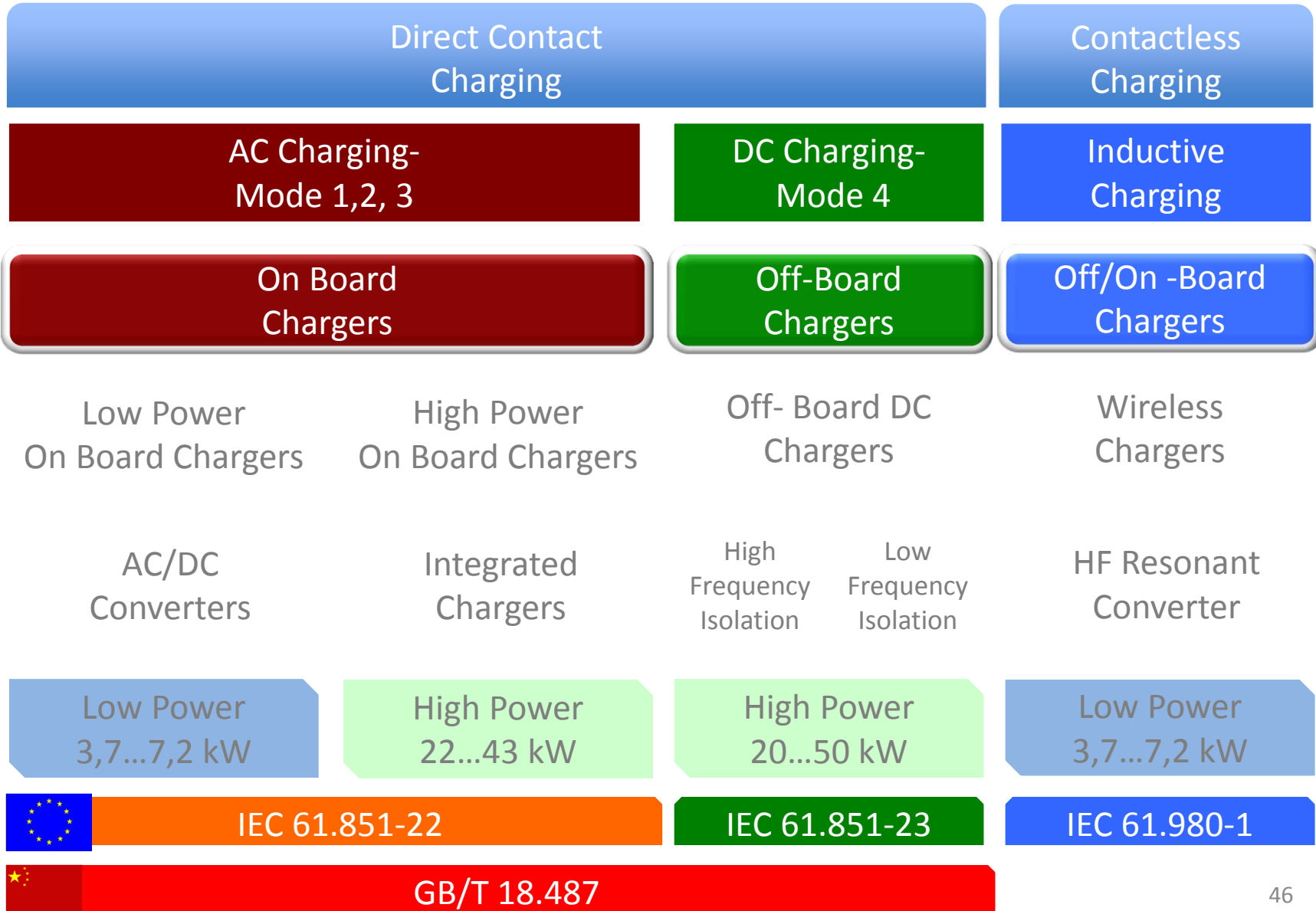
Conductive AC Charging	Connection	Inductive Charging	Conductive DC Charging
Low & High Power AC Charging	Charging Type	Low Power HF Charging	Quick Charging
LP: 8-10 Hours HP: 20-30 min	Charging Time	8-10 Hours	20-30 min.
On- Board DC Charger	Equipment	Off- Board Inverter & On Board rectifier	Off- Board DC Charger

Power Electronics for Charging Electric Vehicles

Electric Vehicles Charger Types



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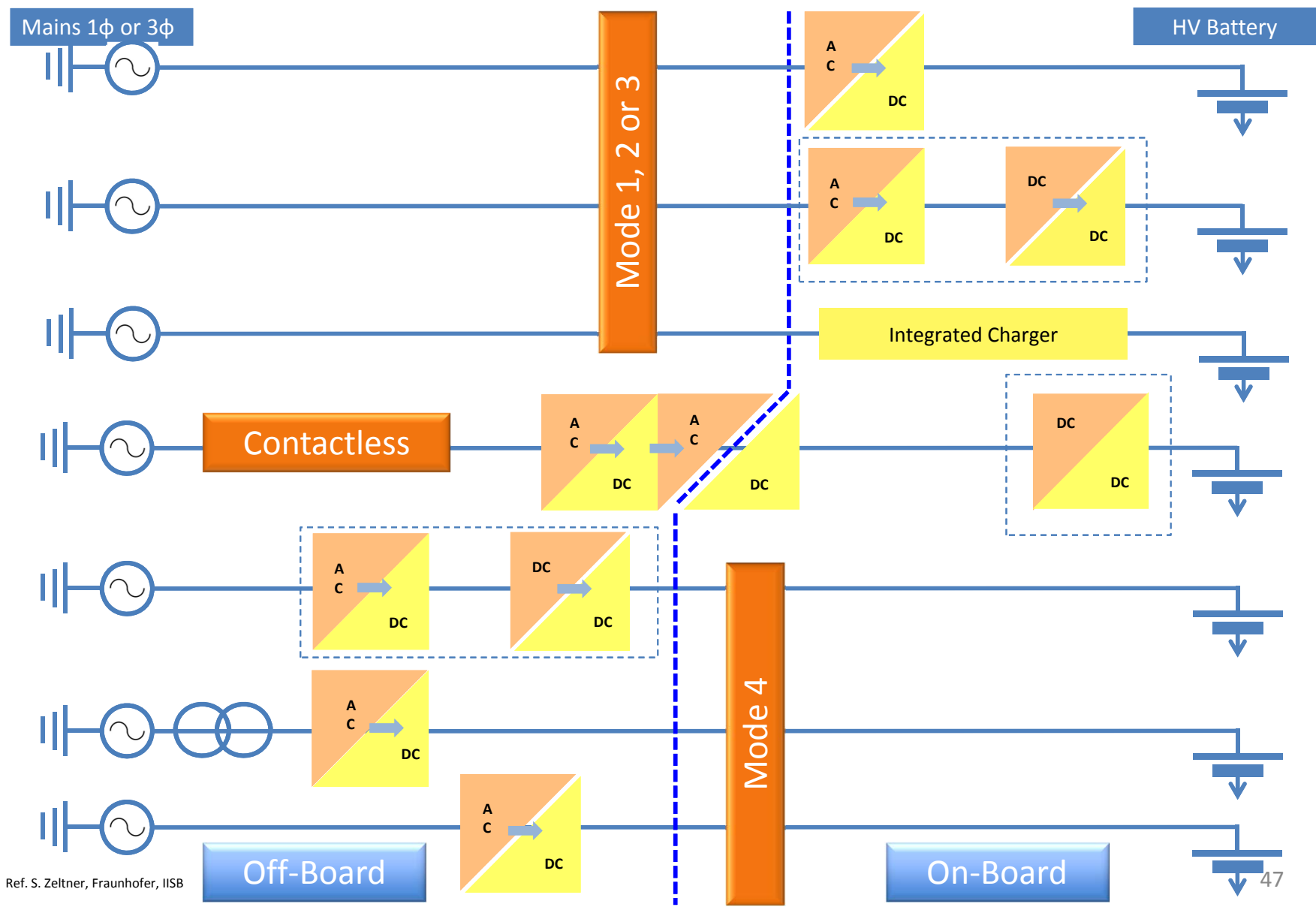


Power Electronics for Charging Electric Vehicles

Electric Vehicles Charger Power Topologies



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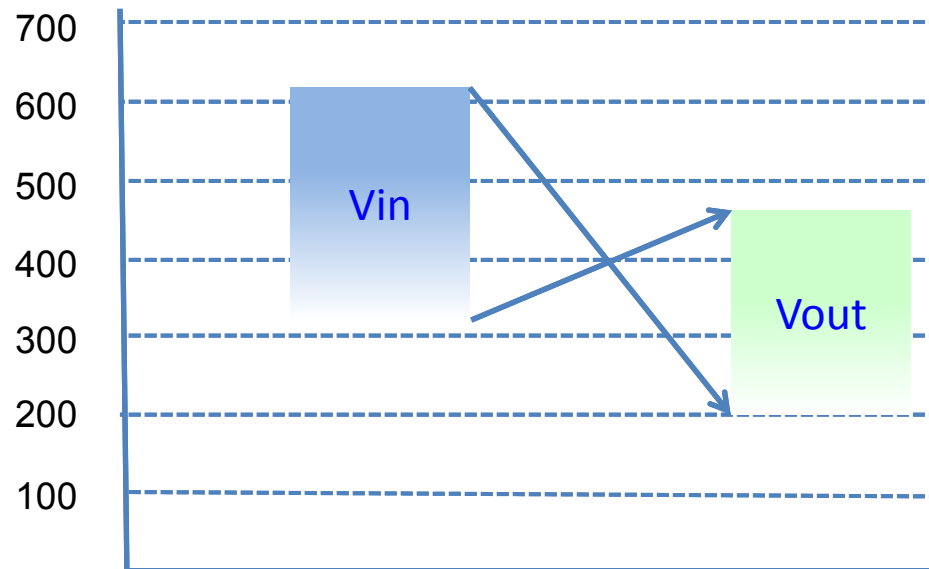
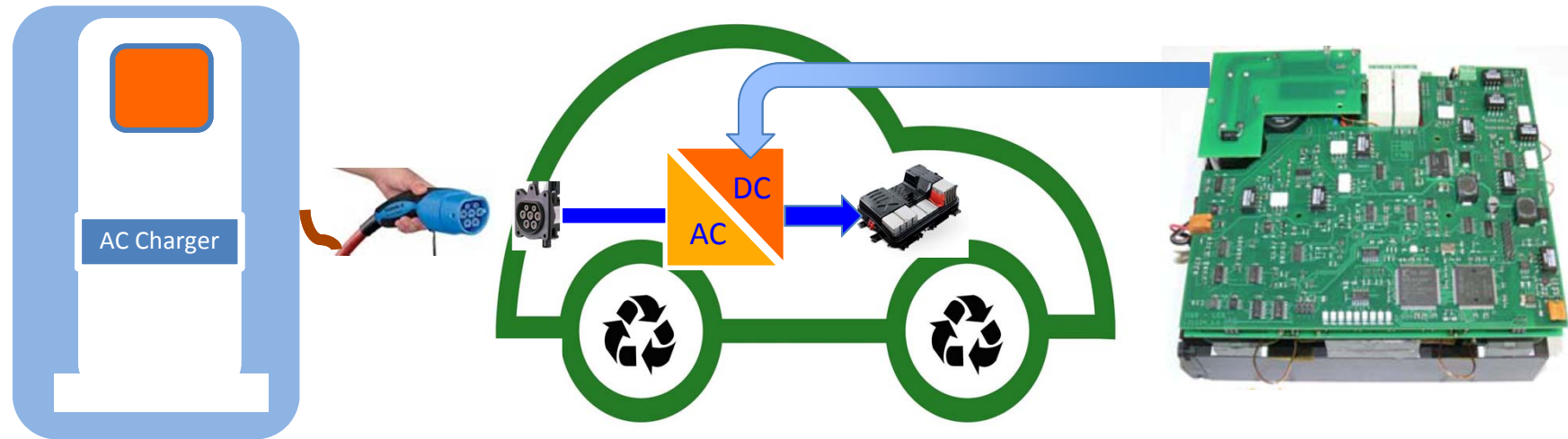
Ref. S. Zeltner, Fraunhofer, IISB

Power Electronics for Charging Electric Vehicles

Low & Medium Power On- Board Charger Topologies



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AC Input Voltage Range

✓ 220 VRMS...440 VRMS (311 Vpk.....622Vpk)

DC Output Voltage Range:

✓ 200 VDC.....450 VDC

PF > 0,99

Efficiency >0,9

Cooling: Water

Power Density: Typ. 2 kW/litre

Temperature Range: -40°C... +85°C

Power Electronics for Charging Electric Vehicles

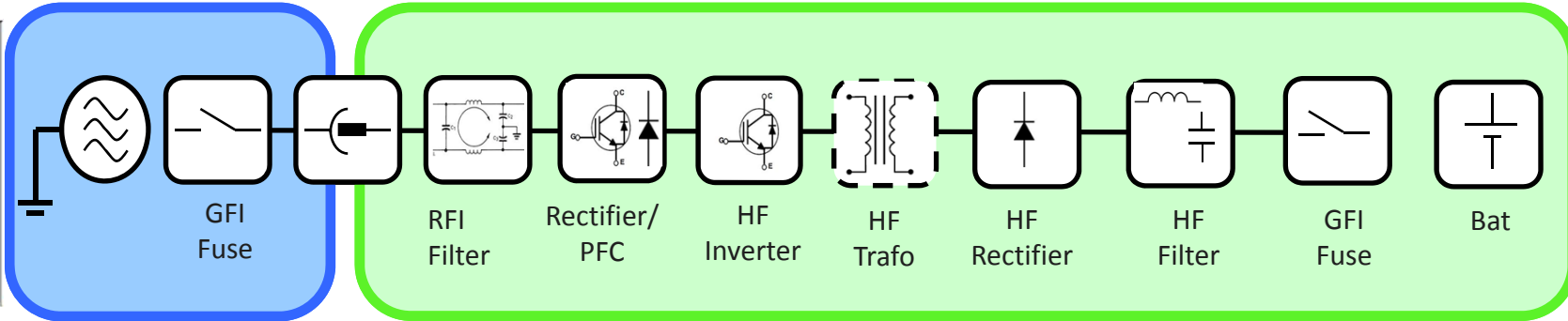
Low & Medium Power On- Board Charger Topologies



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Unidirectional



22 kW with galvanic isolation



Ref: BRUSA

Bridgeless PFC
B4 +Boost
Interleaved
.....

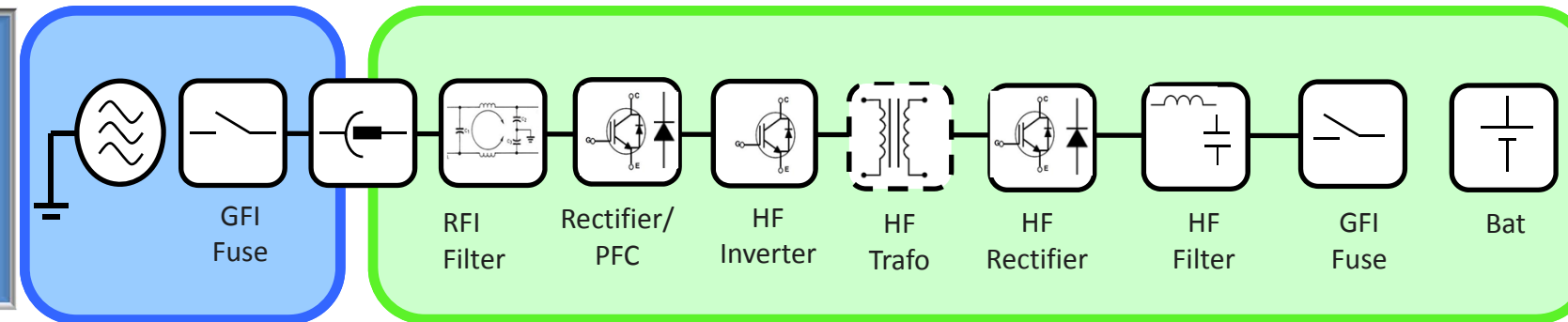
ZVT Full Bridge
Resonant
Phase shift
.....

3,3 kW with galvanic isolation



DELPHI

Bidirectional

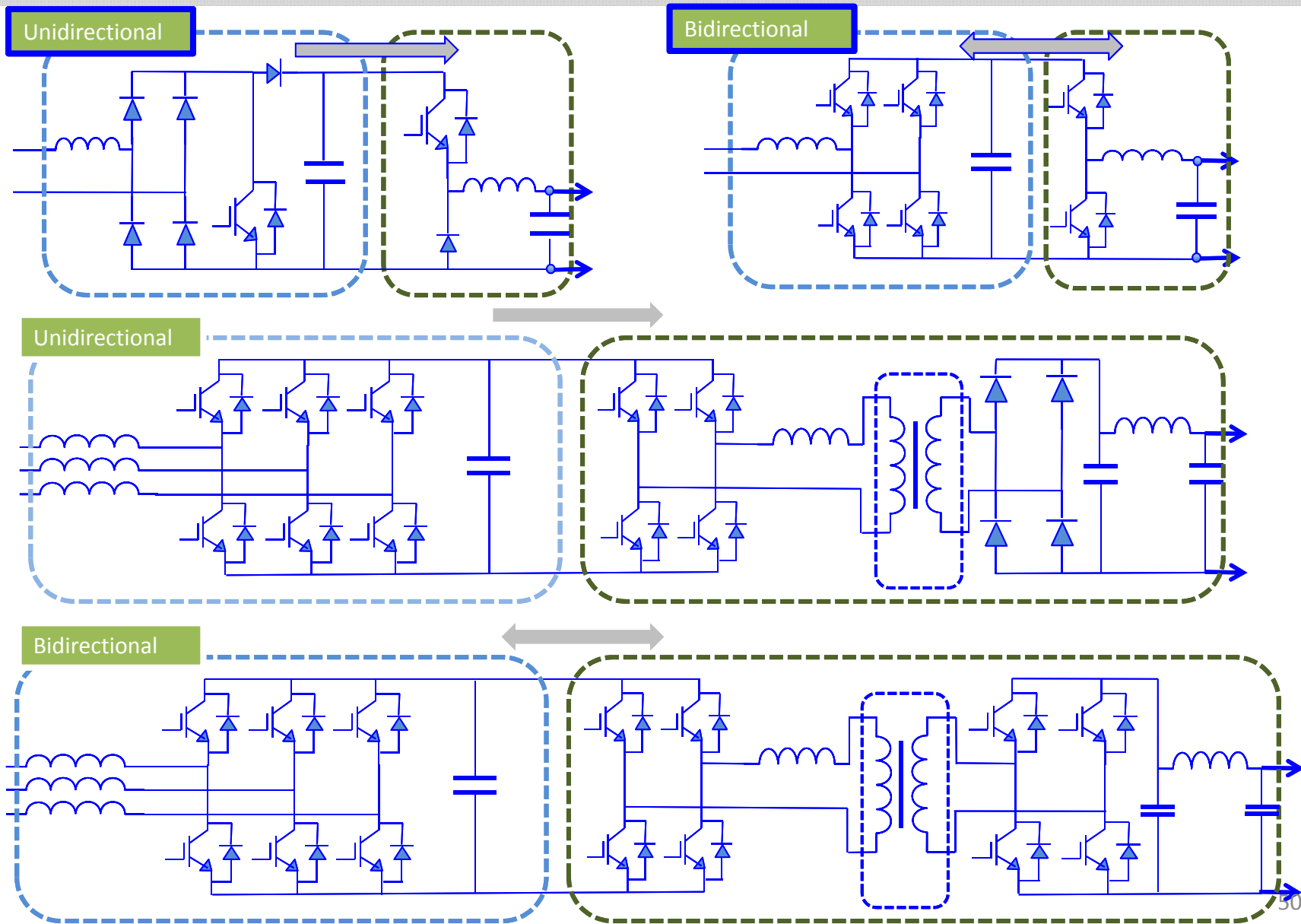


Power Electronics for Charging Electric Vehicles

Low & Medium Power On- Board Charger Topologies



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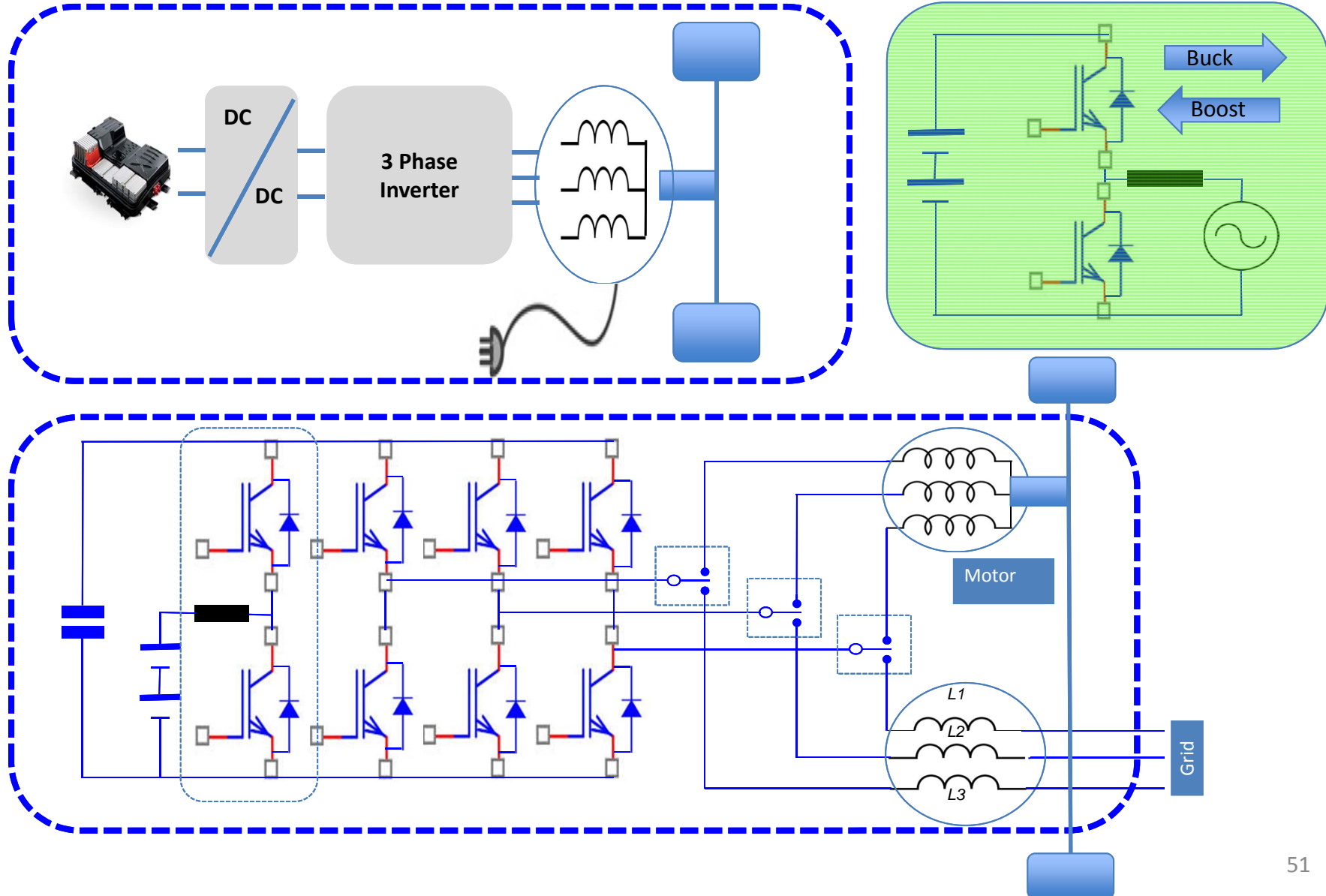


Power Electronics for Charging Electric Vehicles

High Power On- Board Chargers: Integrated Chargers



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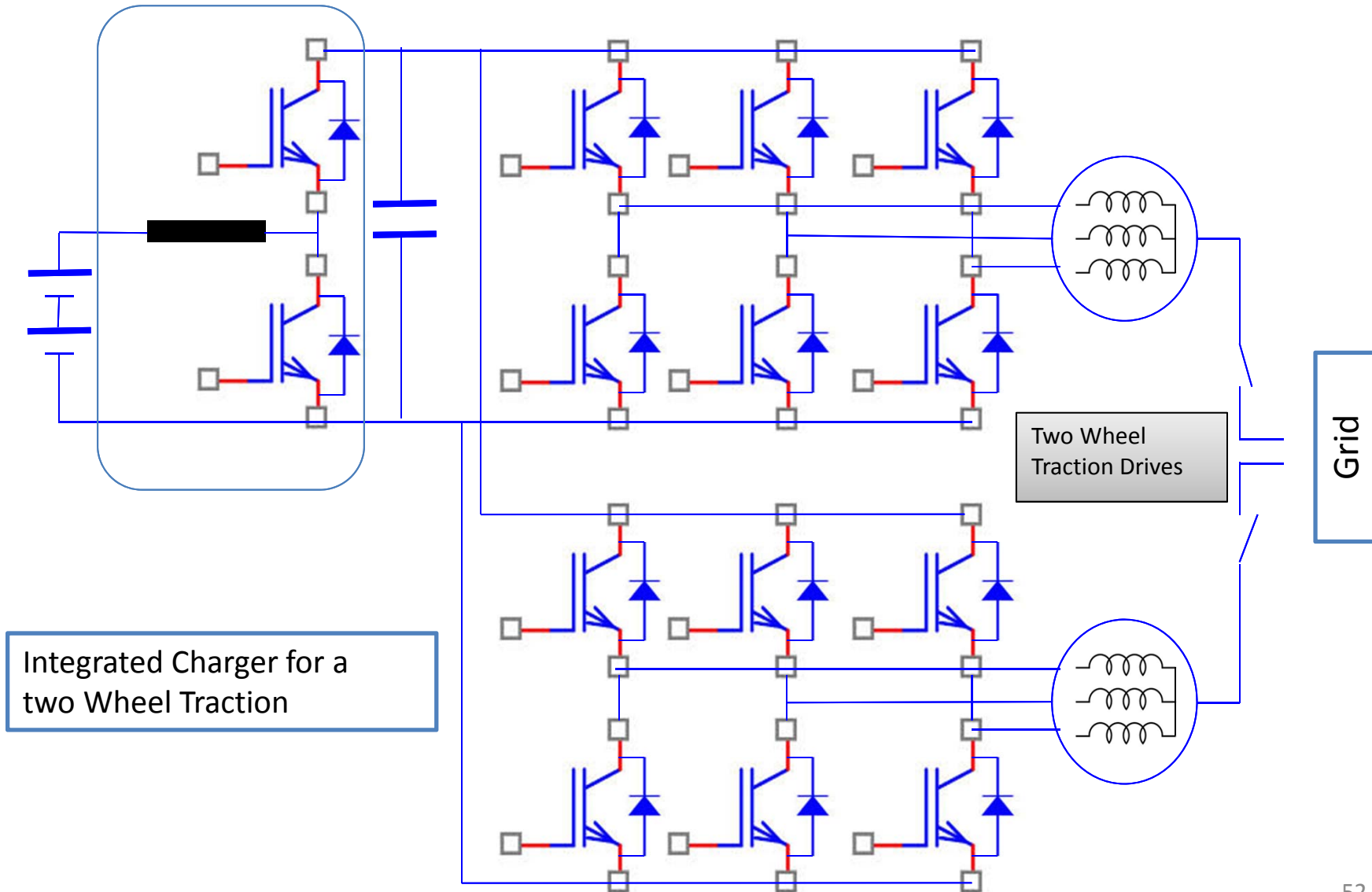


Power Electronics for Charging Electric Vehicles

High Power On- Board Chargers: Integrated Chargers



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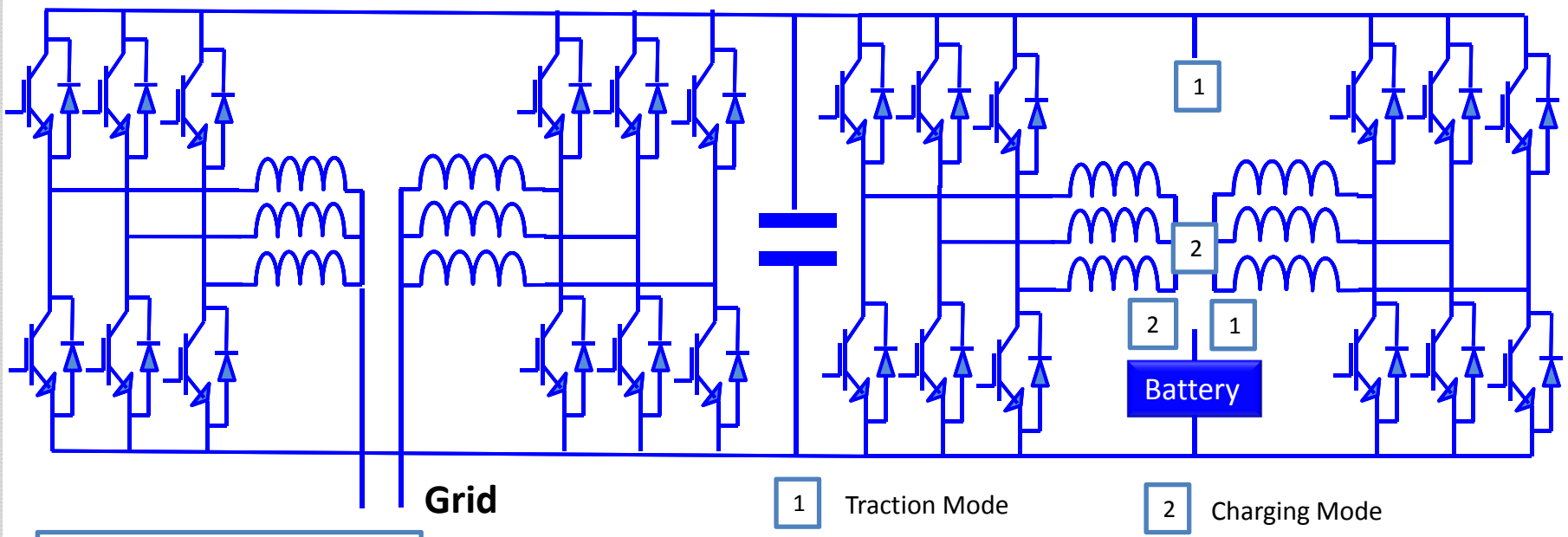


Power Electronics for Charging Electric Vehicles

High Power On- Board Chargers: Integrated Chargers

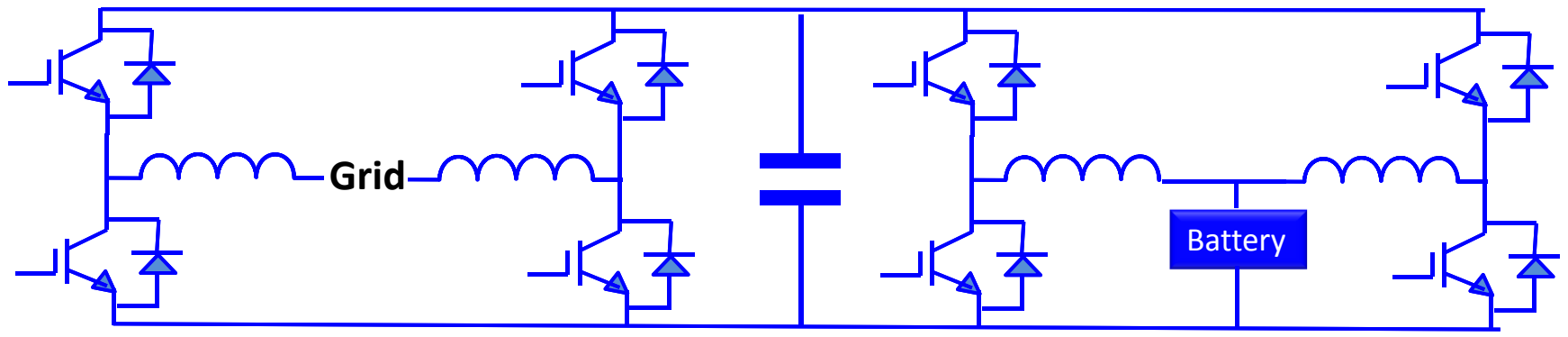


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Integrated Charger for a Four Wheel Traction

Charging Mode

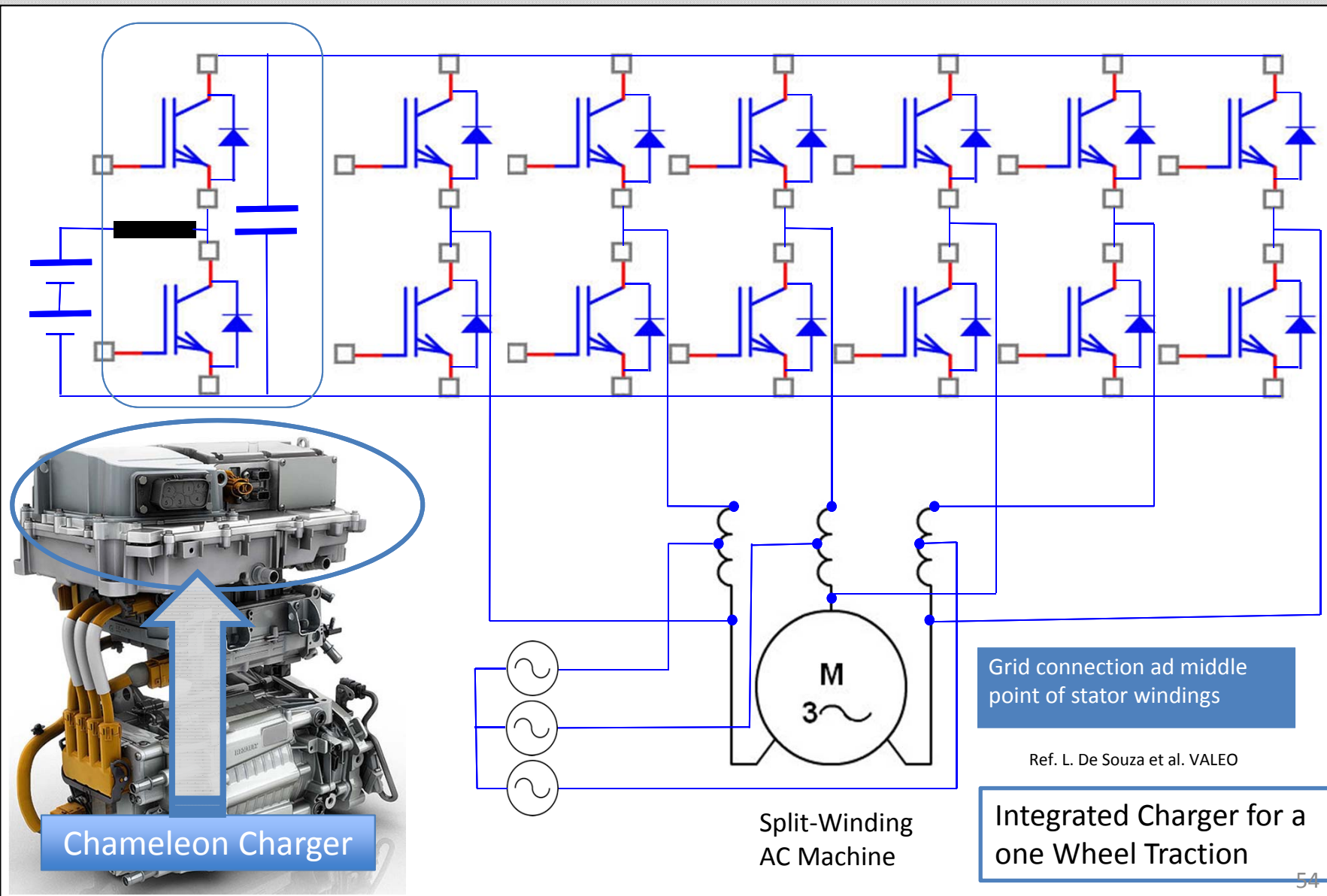


Power Electronics for Charging Electric Vehicles

High Power On- Board Chargers: Integrated Chargers



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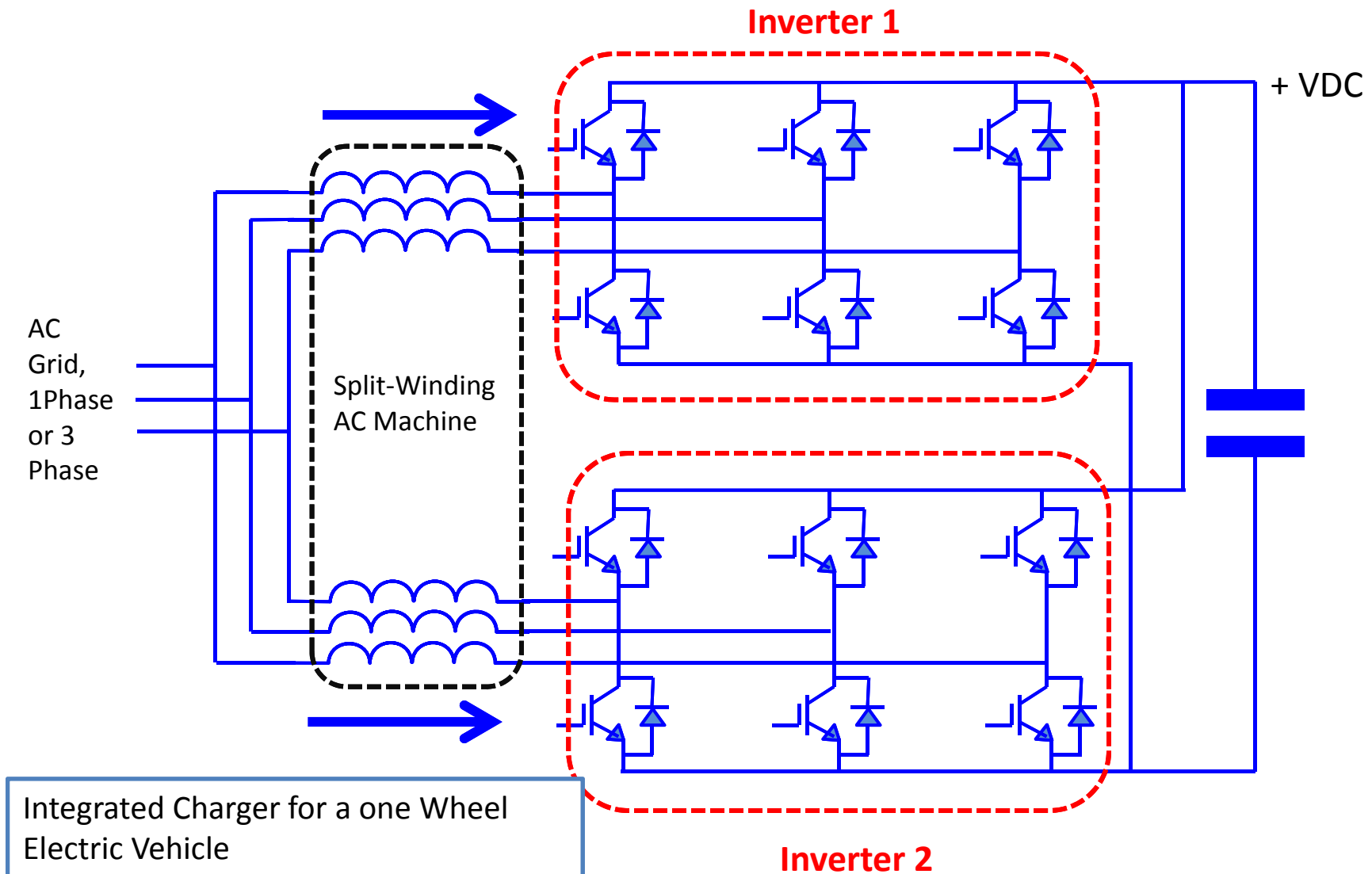


Power Electronics for Charging Electric Vehicles

High Power On- Board Chargers: Integrated Chargers

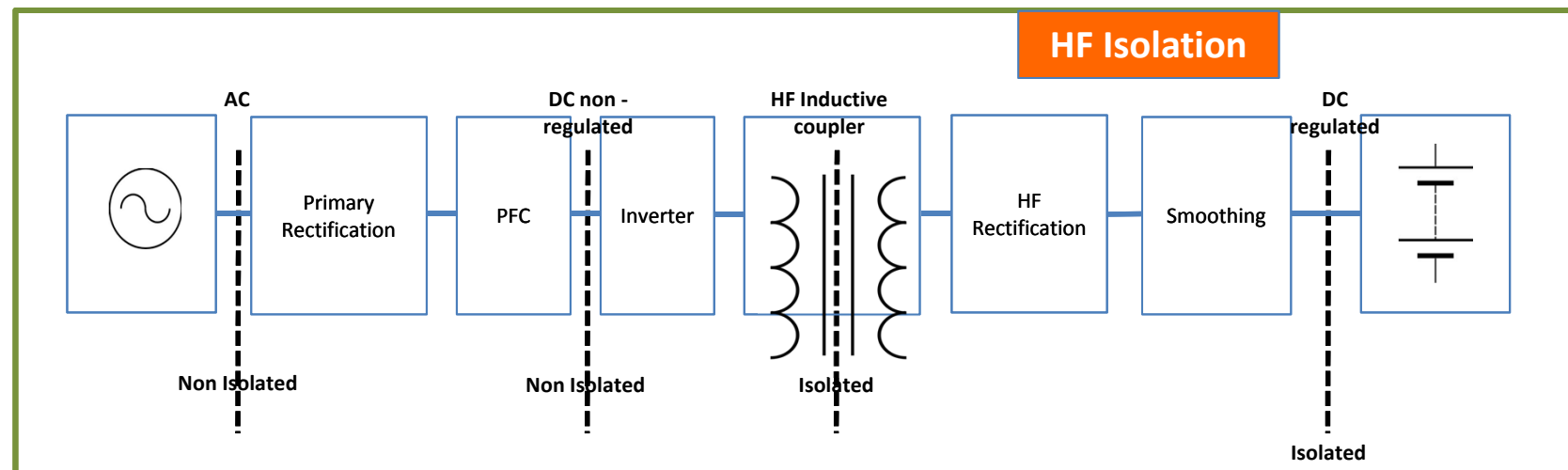
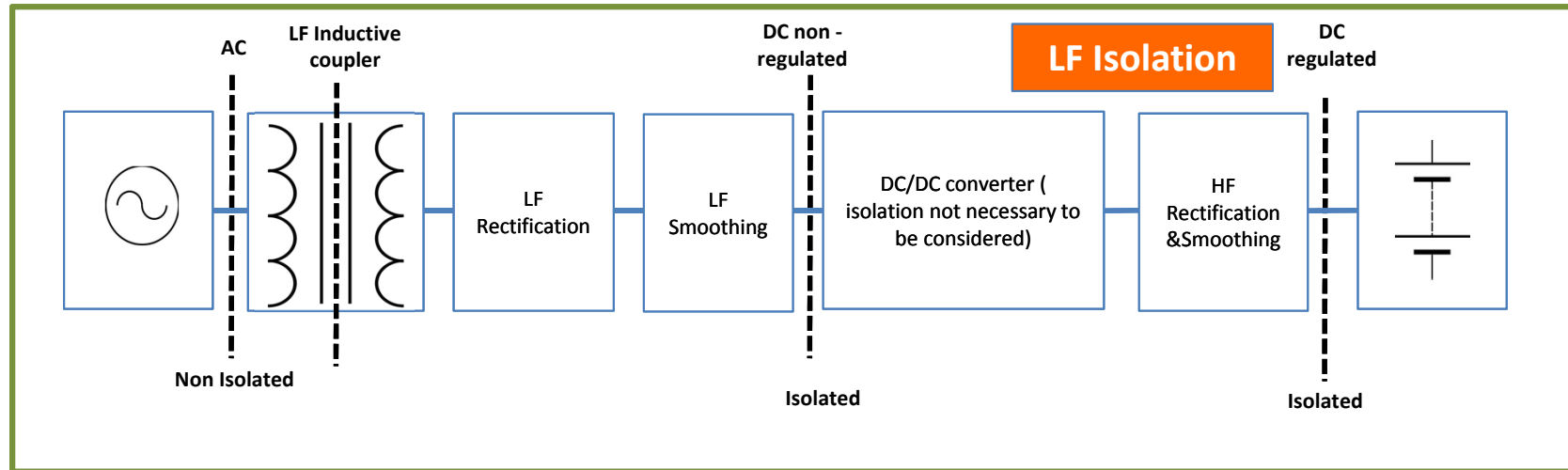


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Power Electronics for Charging Electric Vehicles

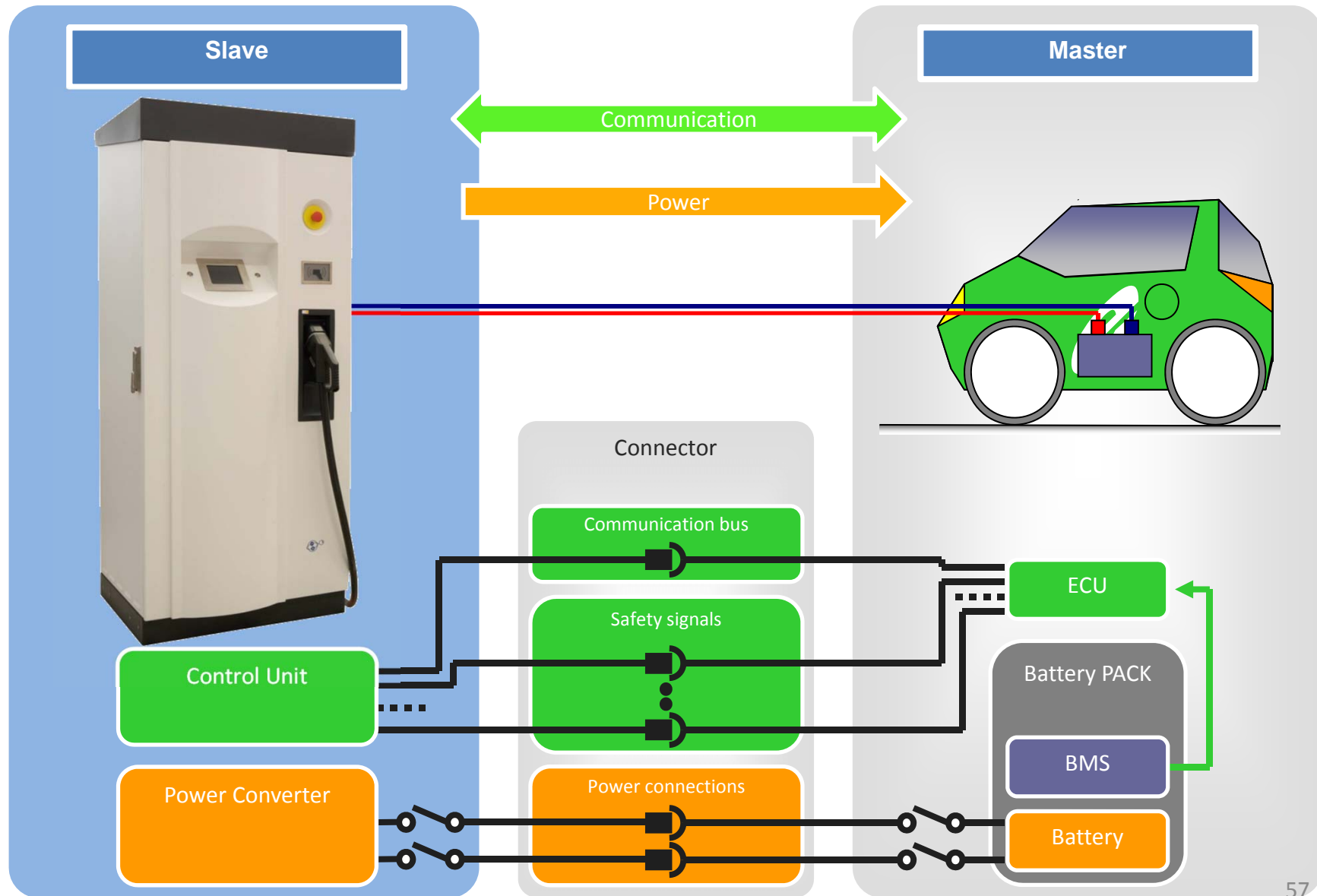
DC Charger Architectures acc. IEC 61.851-23



No isolation: Under consideration IEC 61.851-23 69/227 FDIS

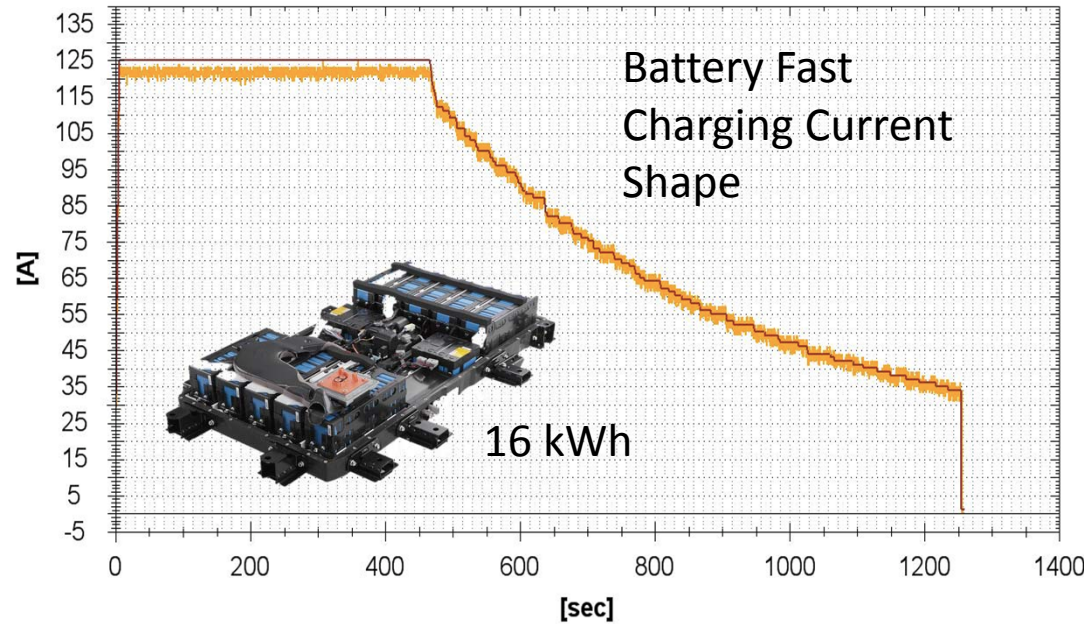
Power Electronics for Charging Electric Vehicles

Interoperability



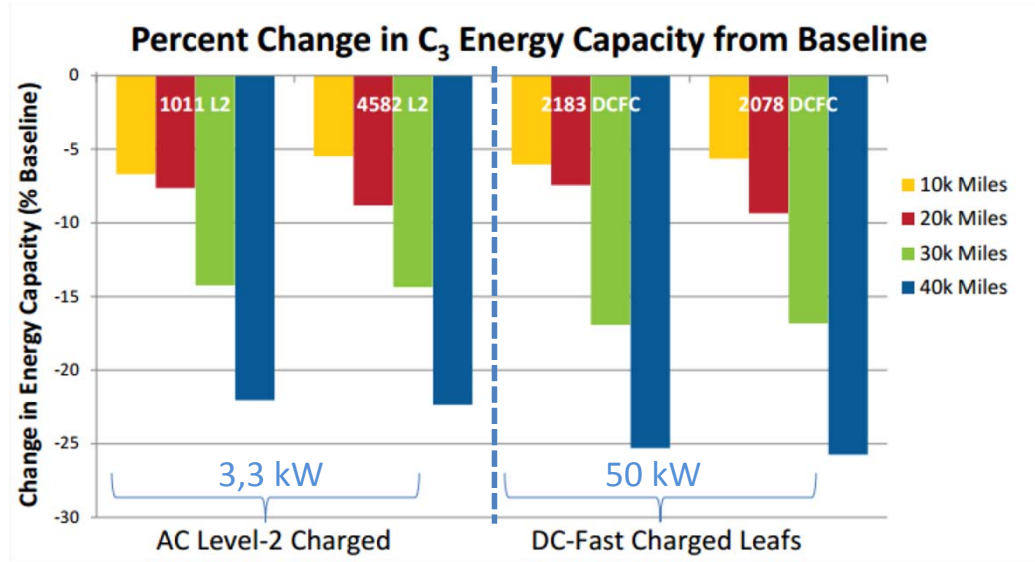
Power Electronics for Charging Electric Vehicles

Battery Charging



3 min Charge for 40 km range
 10 min charge for 80 km range

13 km/kWh



Battery degradation depends more on the miles travelled than on the nature of recharging

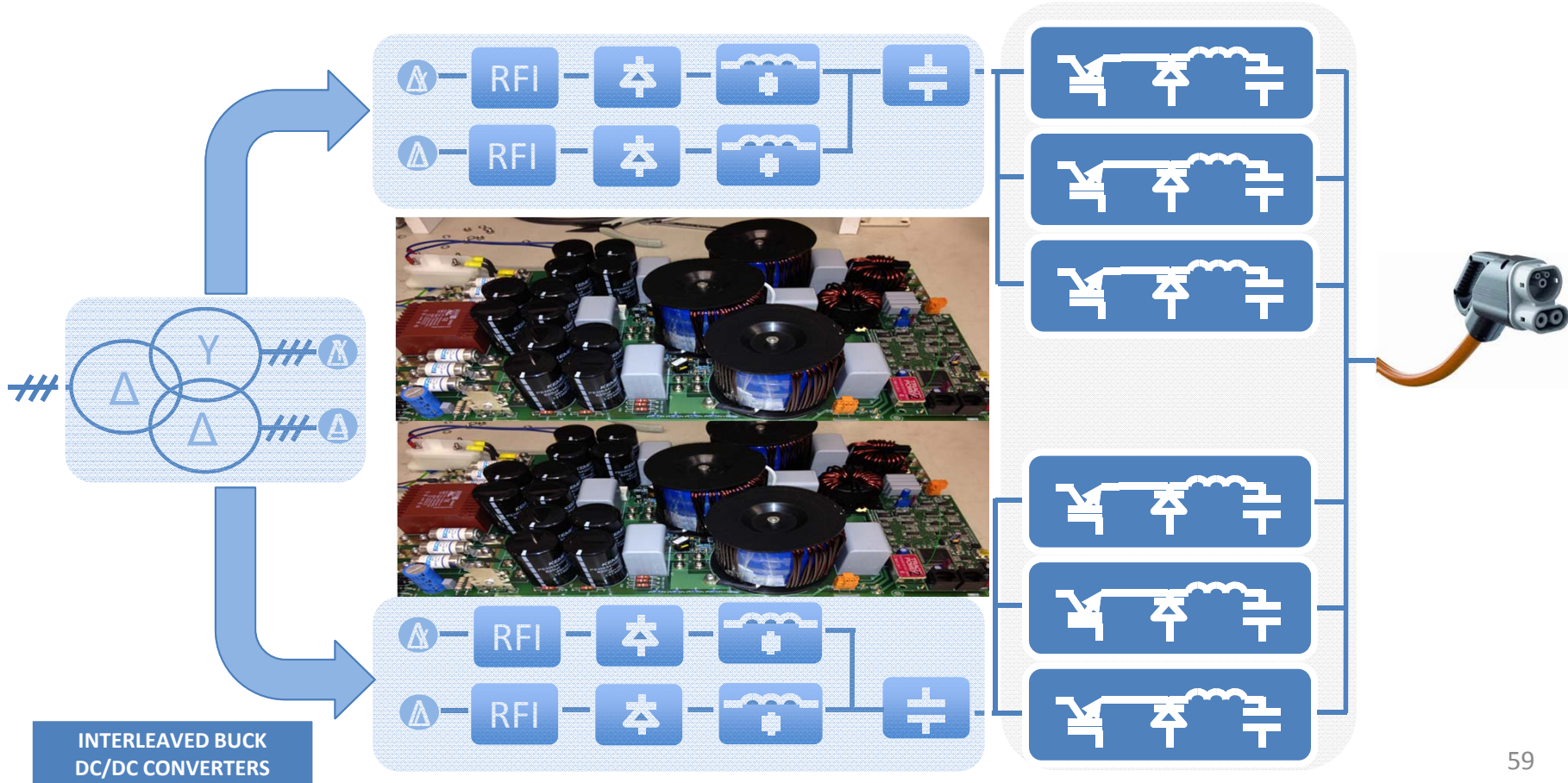
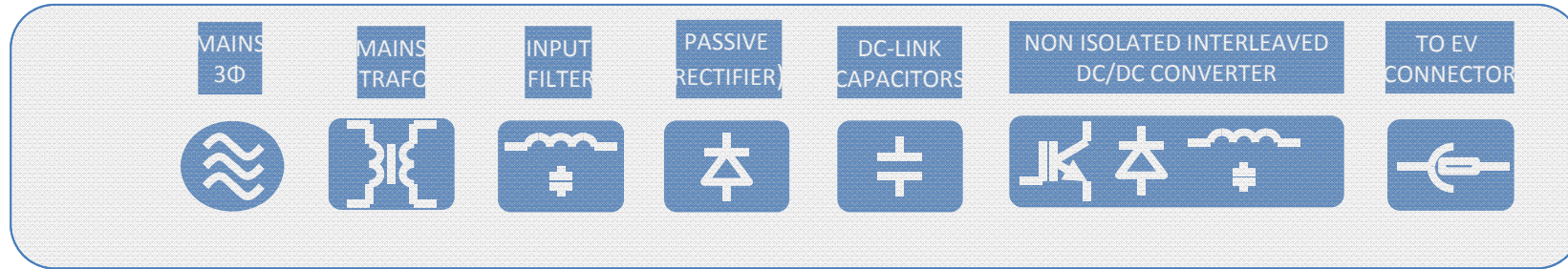
With 3,3 kW Charging after 40.000 miles around 23% of SoC is lost while with 50 kW DC Charging 25% of SoC is lost

Power Electronics for Charging Electric Vehicles

DC Off-Board Charger with LF Isolation



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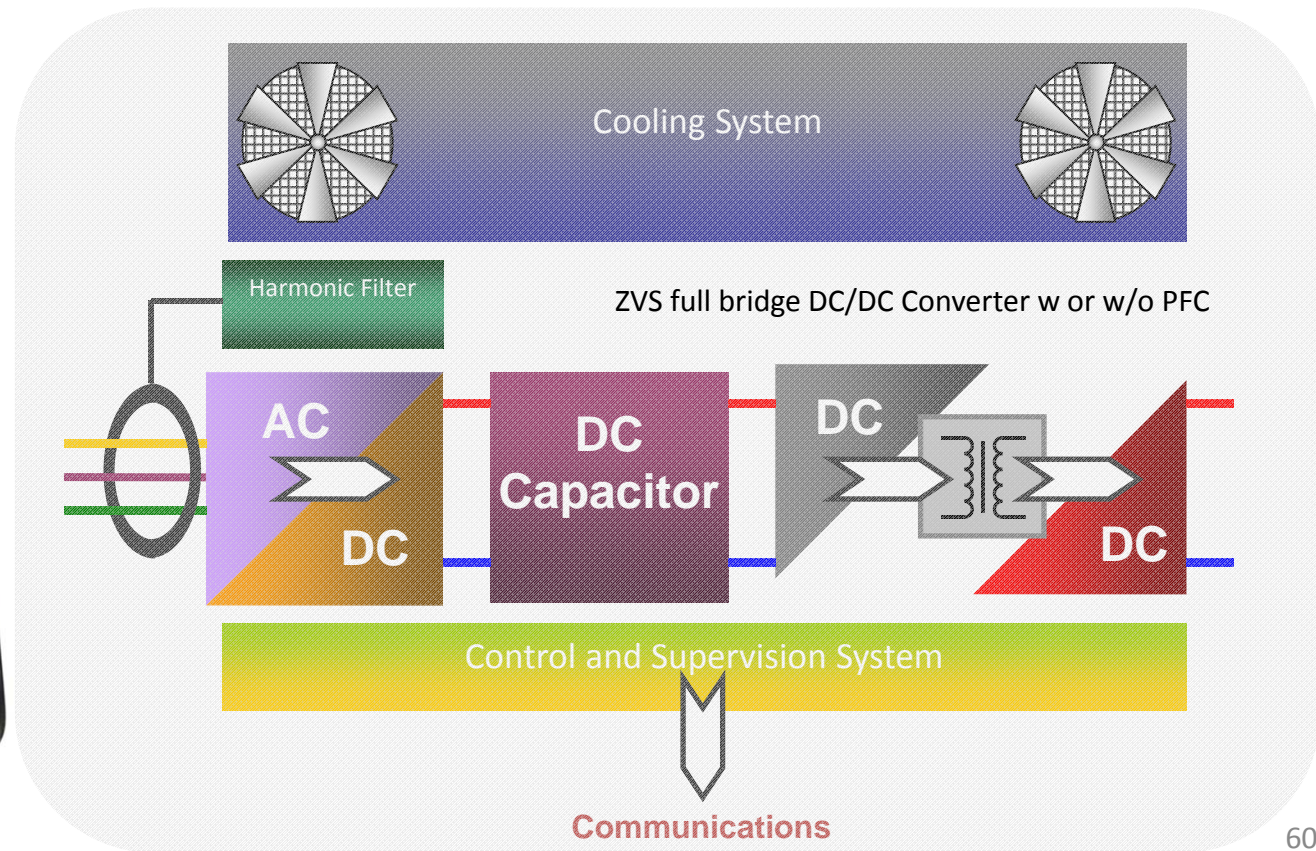


Power Electronics for Charging Electric Vehicles

DC Off-Board Charger with HF Isolation



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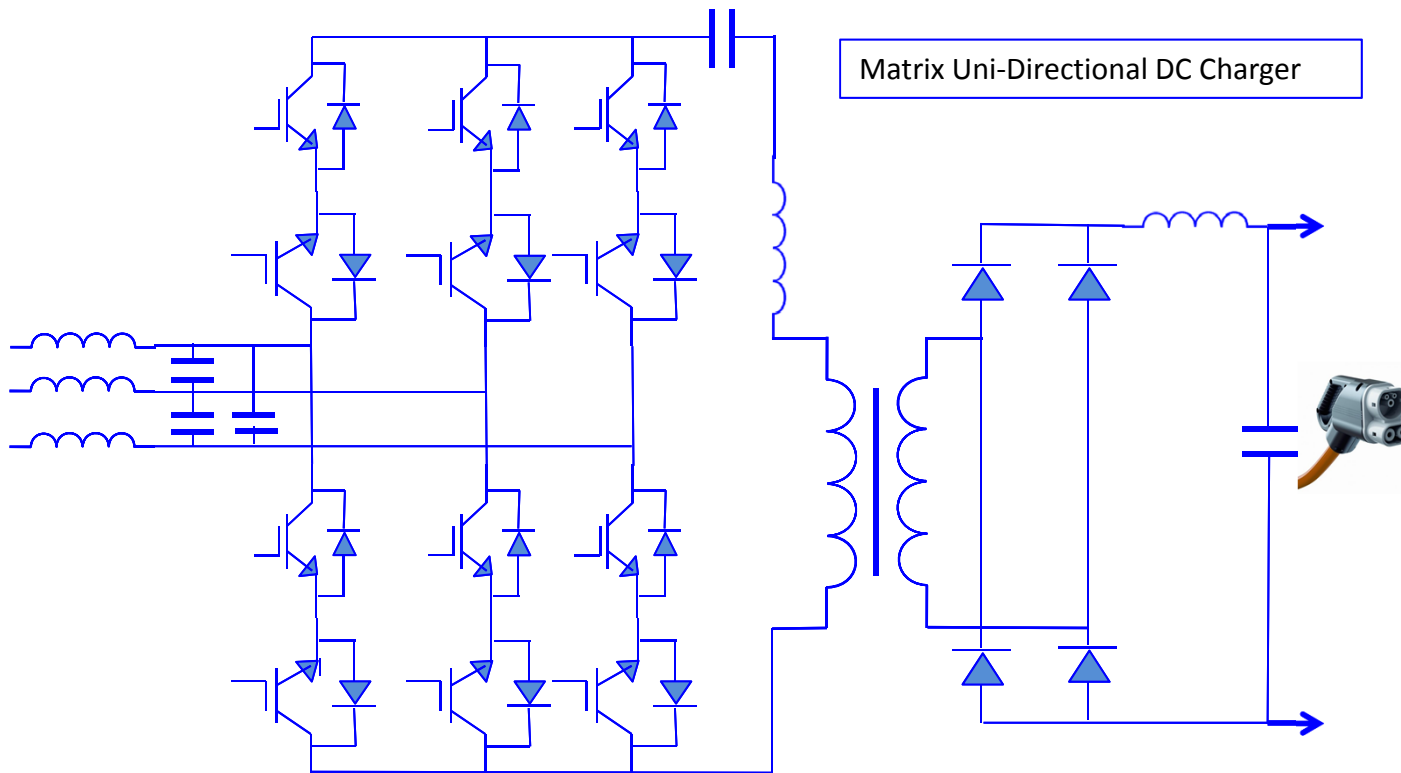
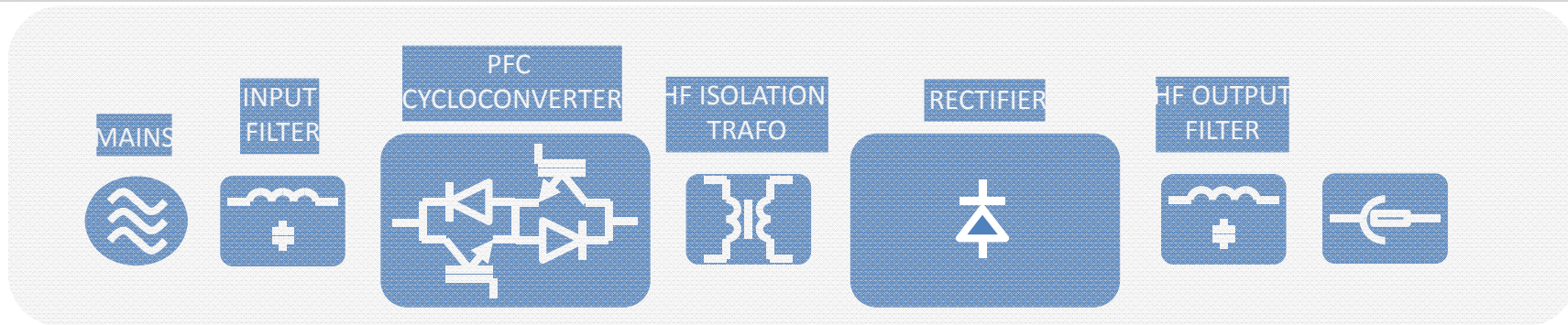


Power Electronics for Charging Electric Vehicles

DC Off-Board Charger with HF Isolation



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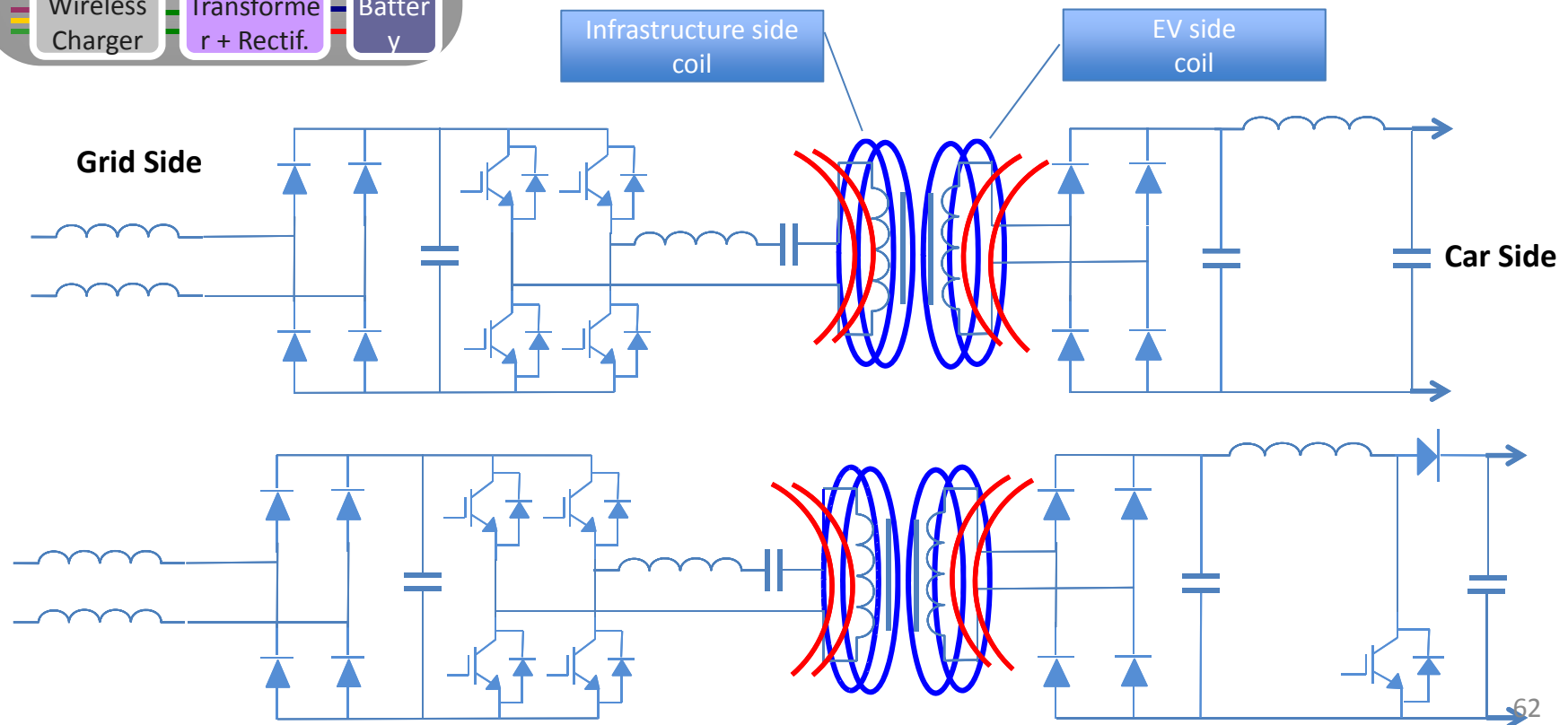
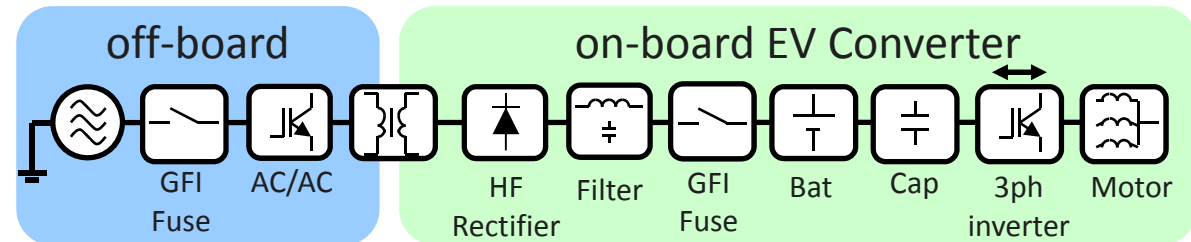
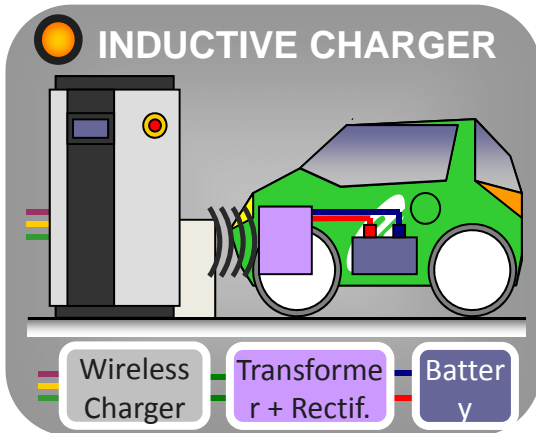


Power Electronics for Charging Electric Vehicles

Wireless Chargers



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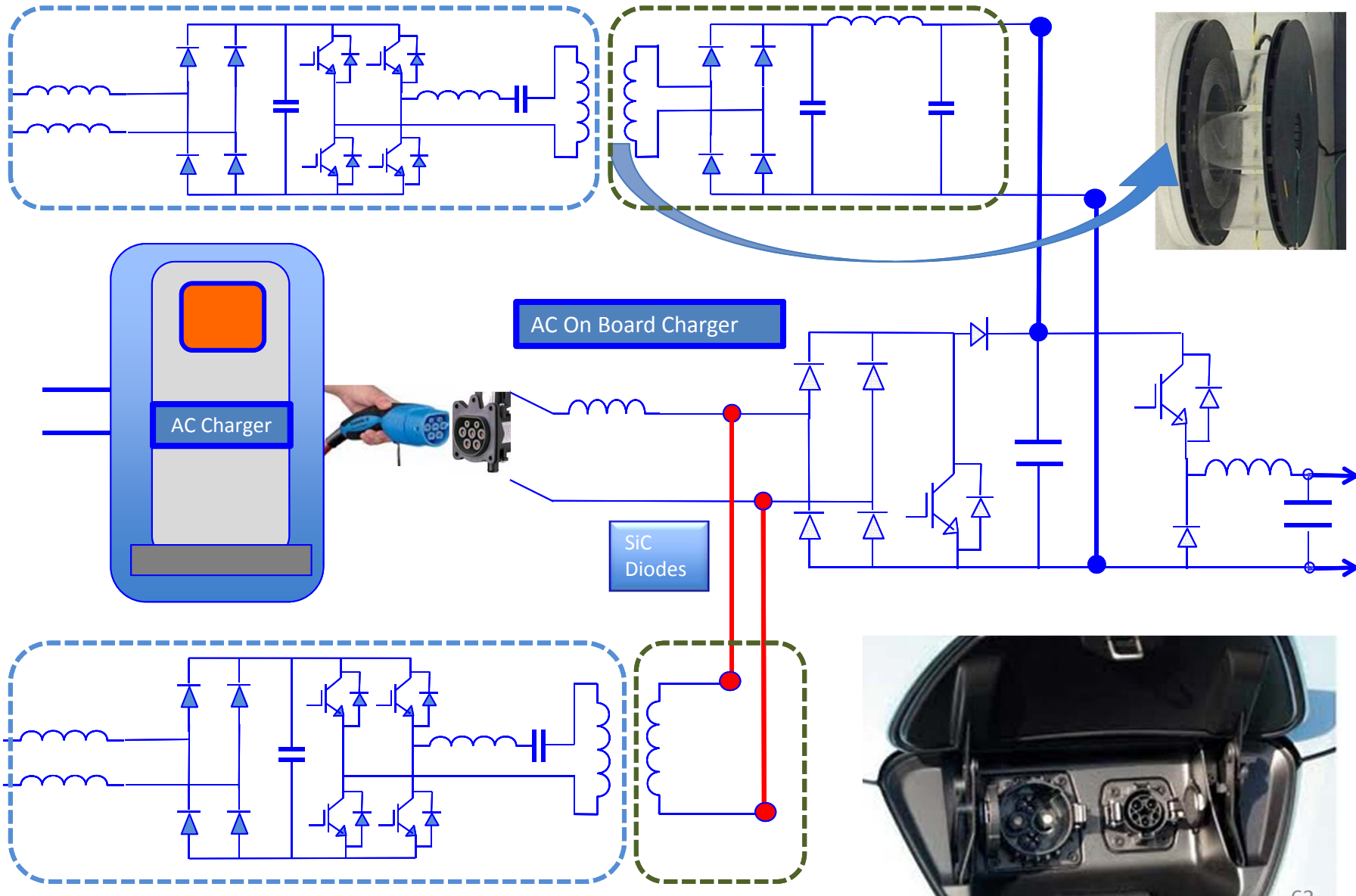


Power Electronics for Charging Electric Vehicles

Wireless Chargers



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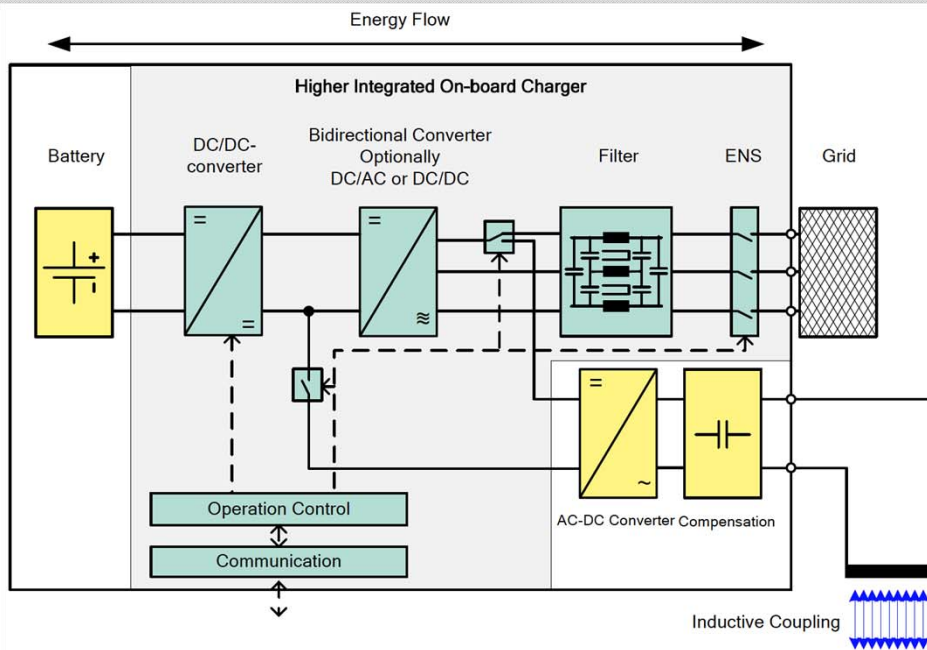


Power Electronics for Charging Electric Vehicles

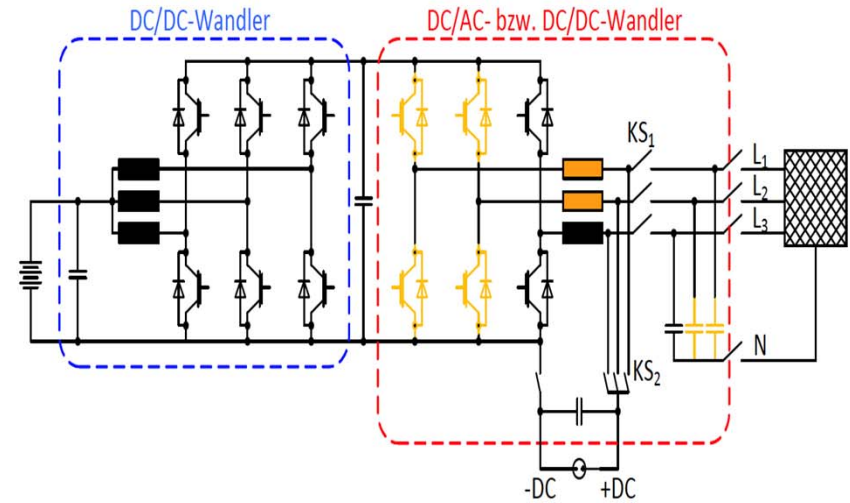
Universal On-Board Charger: Contact + Wireless



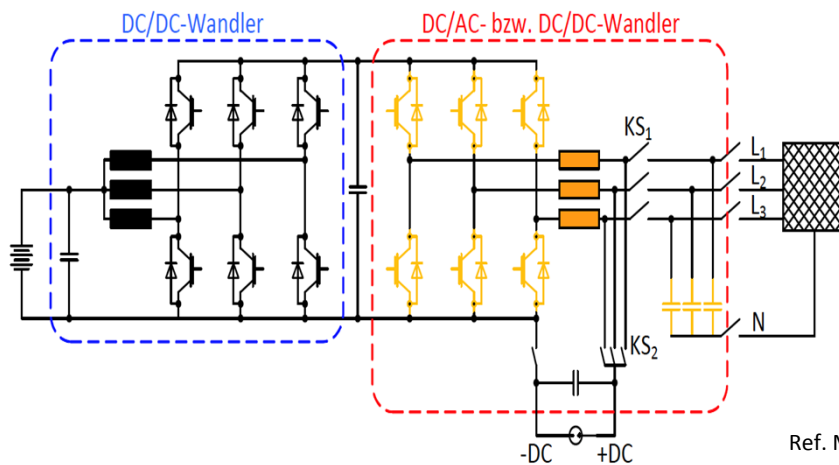
VNIVERSITAT DE VALÈNCIA



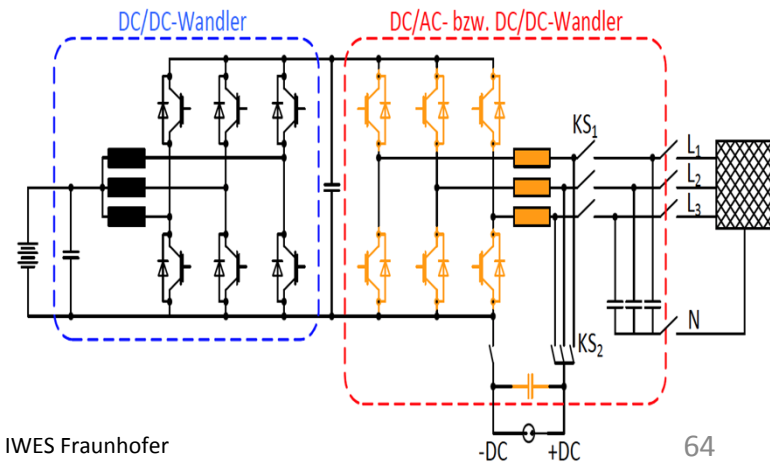
1-phasig kabelgebunden



3-phasig kabelgebunden



3-phasig kabellos



Ref. Marco Jung, IWES Fraunhofer

Power Electronics for Charging Electric Vehicles

Wireless Charging Requirements



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Frequency: 30-1.000 kHz
Power: 3,3 kW
Efficiency: 0,9%
Topology: Series Resonant Converter

RFID Identification
User friendly HMI
Interoperability
Wireless data transfer
between EVSE and EV

Transfer

Comm.

Position

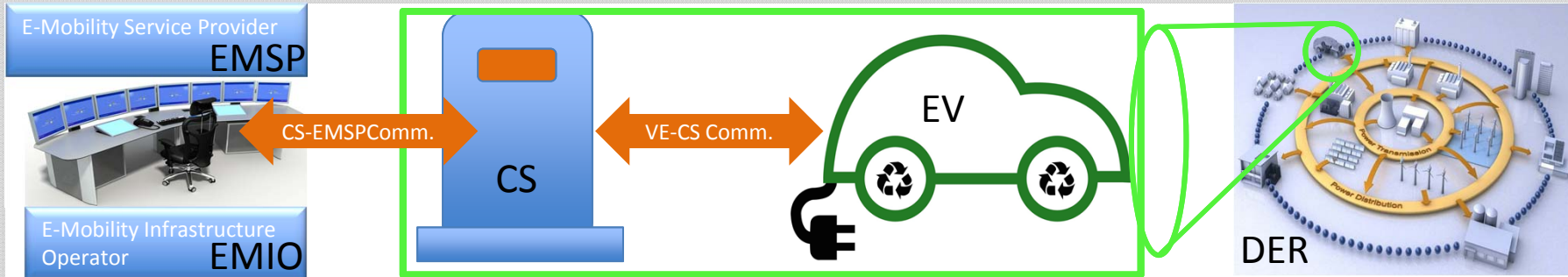
Standards
& Safety

Alignment
Geometry
Shape
Gap: Vehicle Standards Compatibility:
Merkblatt 751, Anhang 2, Absatz 5.1.9 (VdTÜV)

IEC 61.980-1 Electric vehicle wireless power transfer (WPT) systems
SAE J 2954: Electric Vehicle Inductively Coupled Charging
High Frequency Safety: EMC Regulations
Human Security: ICNIRP Recommendations

EV Charging Infrastructure

Charging Modes related to the Infrastructure



		DRIVER	CHARGE SPOT/ E-MOBILITY SERVICE PROVIDER	Communication Standard	
NO LOOP CHARGING (Charging lead by the Driver)	Non Controlled Charging	I want to charge my car NOW	<ul style="list-style-type: none"> ◆ CS Localization ◆ CS Reservation ◆ Identification, Authentication & Authorization ◆ Billing & Payment for the Charging Service 	VE-CS Communication <ul style="list-style-type: none"> ◆ IEC 61.851-1 ◆ IEC 61.851-24 CS- EMSP Communication <ul style="list-style-type: none"> ◆ OCPP 	NO Smart Grid Integration
	Programmed Charging	I Plug the car and want to start the charging at 3.00 am			
LOOP CHARGING (Charging lead by the Utility)	Smart Charging	I plug the car and my route will start tomorrow at 9.00 am and will be Charge the car for a minimum electricity price according the SoC of my battery	+ <ul style="list-style-type: none"> ◆ Negotiate Incentive plan for best electricity price ◆ Charging renegotiation during the charging ◆ Dynamic metering ◆ Roaming services 	VE-CS Communication <ul style="list-style-type: none"> ◆ ISO/IEC 15.118 CS- EMIO Communication <ul style="list-style-type: none"> ◆ IEC 61.850-90-8 EV integration in the DER <ul style="list-style-type: none"> ◆ IEC 61.850-7-420 	Allows Smart Grid Integration
	Smart Grid Integration	I plug the car and my route will start tomorrow at 9.00 am and will be Charge/ discharge the car for a optimum electricity price	+ <p>Negotiate the best electricity price in the smart grid context by optimising charging/discharging the battery</p>	VE-CS Communication <ul style="list-style-type: none"> ◆ ISO/IEC 15.118 CS- EMIO Communication <ul style="list-style-type: none"> ◆ IEC 61.850-90-8 EV integration in the DER <ul style="list-style-type: none"> ◆ IEC 61.850-7-420 	

EV Charging Infrastructure

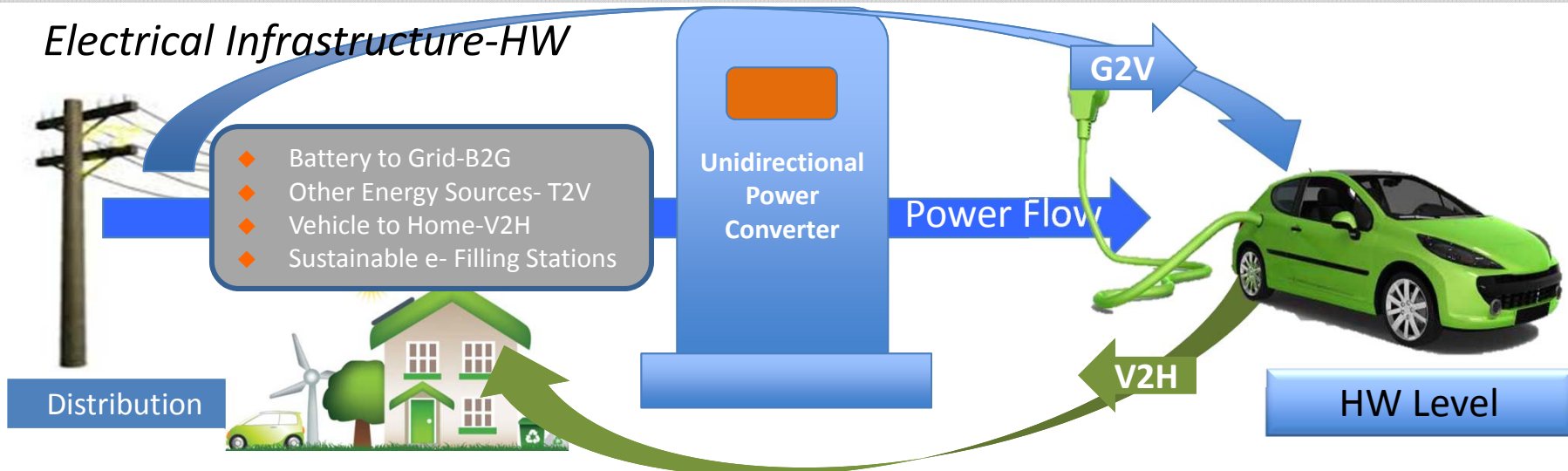
Grid Integration



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Electrical Infrastructure-HW



Secure Communication Protocol for billing	EMSP
Identification, Authentication & Authorization	
Billing & Payment for the Charging Service	
CS Localization	
CS Reservation	

IEC 61.851-1/24

- ◆ Safety Basic Requirements through CP Signal
- ◆ Battery Information

NON CONTROLLED CHARGING (IEC 61.851-1/24)

The charging process is initiated at any moment according EV user wishes

PROGRAMMED CHARGING (IEC 61.851-1/24)

The charging process is programmed by the EV user..



OCPP

Non Controlled Charging

Programmed Charging

IEC 61.851-1/24



SW Level⁶⁷

Intelligence Infrastructure-SW

EV Charging Infrastructure

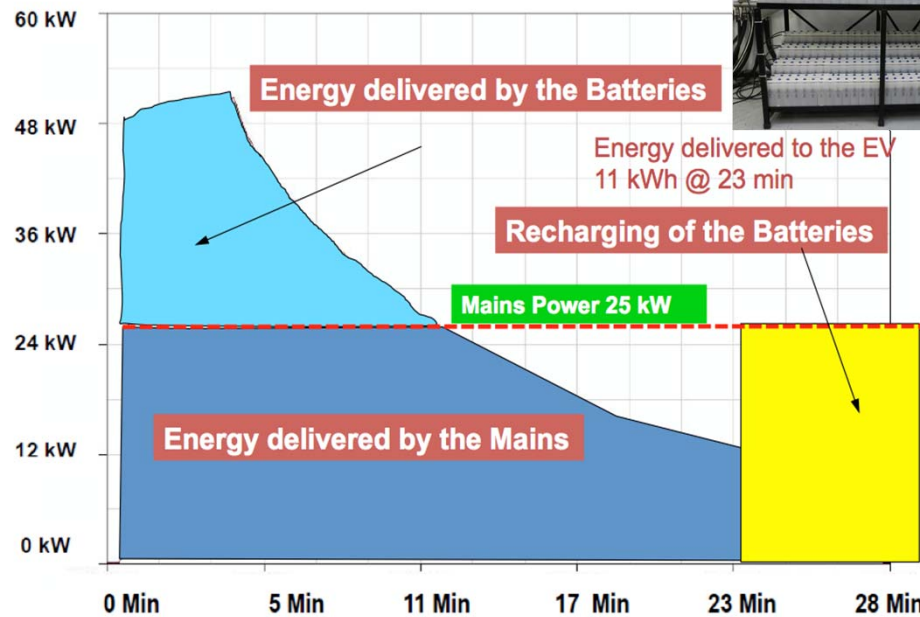
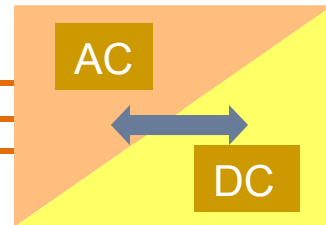
Grid Integration: Battery to Grid System-B2G



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Grid Capacity 25 kVA



B2G System

- ◆ Lower Impact to the Grid
- ◆ Less Grid Power infrastructure needed
- ◆ Battery Recharging after charging the EV
- ◆ Capability of Integration in a Smart Grid due to Storage & Bidirectional Input Rectifier

EV Charging Infrastructure

Train to Vehicle-T2V

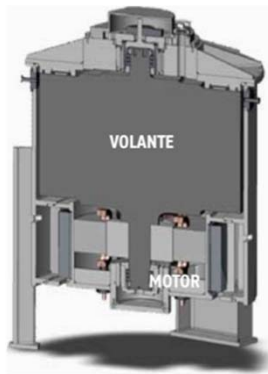


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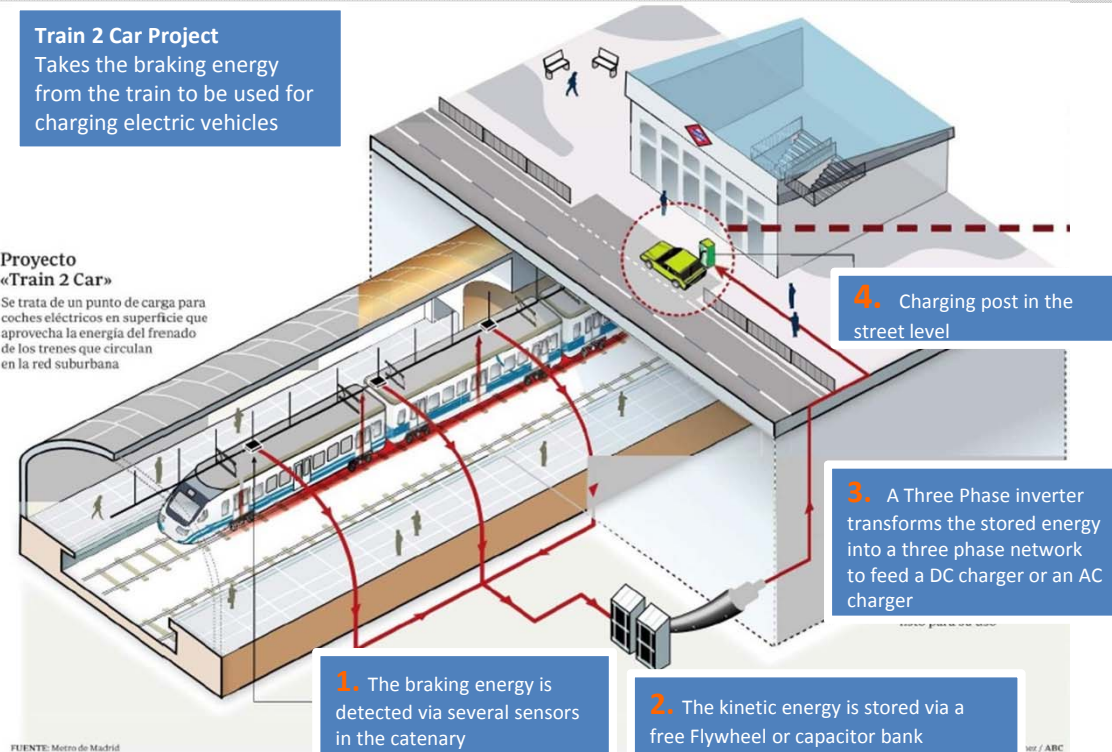


Train 2 Car Project
Takes the braking energy from the train to be used for charging electric vehicles

Proyecto «Train 2 Car»
Se trata de un punto de carga para coches eléctricos en superficie que aprovecha la energía del frenado de los trenes que circulan en la red suburbana



55 kWh
350 kW
6.500 rpm



1 Flywheel Charging

- When stopping the train gives back energy to the HV Grid
- This energy charges the free wheel to 6.500 rpm
- The energy is stored in the free wheel



2 Flywheel Discharging

- The motor behaves as an energy generator
- This energy charges the EV
- The motor stops feeding energy to the EV when the rotor speed is 900 rpm

EV Charging Infrastructure

Vehicle to Home Concept-V2H



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G2V



Bidirectional AC/DC converter
Mitsubishi Power Box

DC ↔ AC

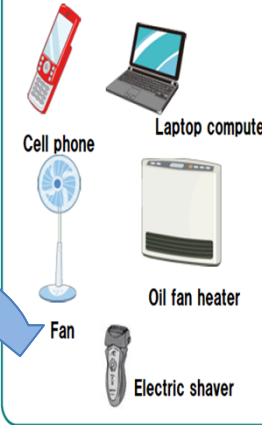
V2H

◆ V2H concept allows user of EV's, to have an electricity reservoir in the case of need

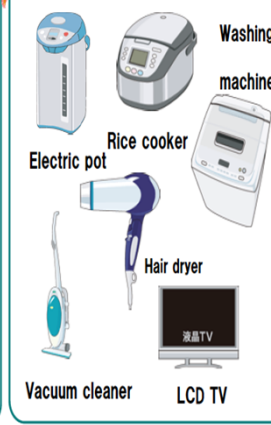


Autonomous Auxiliary Power Supply

Low-power-consumption electrics
100W or less
<available>



High-power-consumption electrics
(1500W class)
<under development>



Low-power-consumption electrics
100W or less
<available>

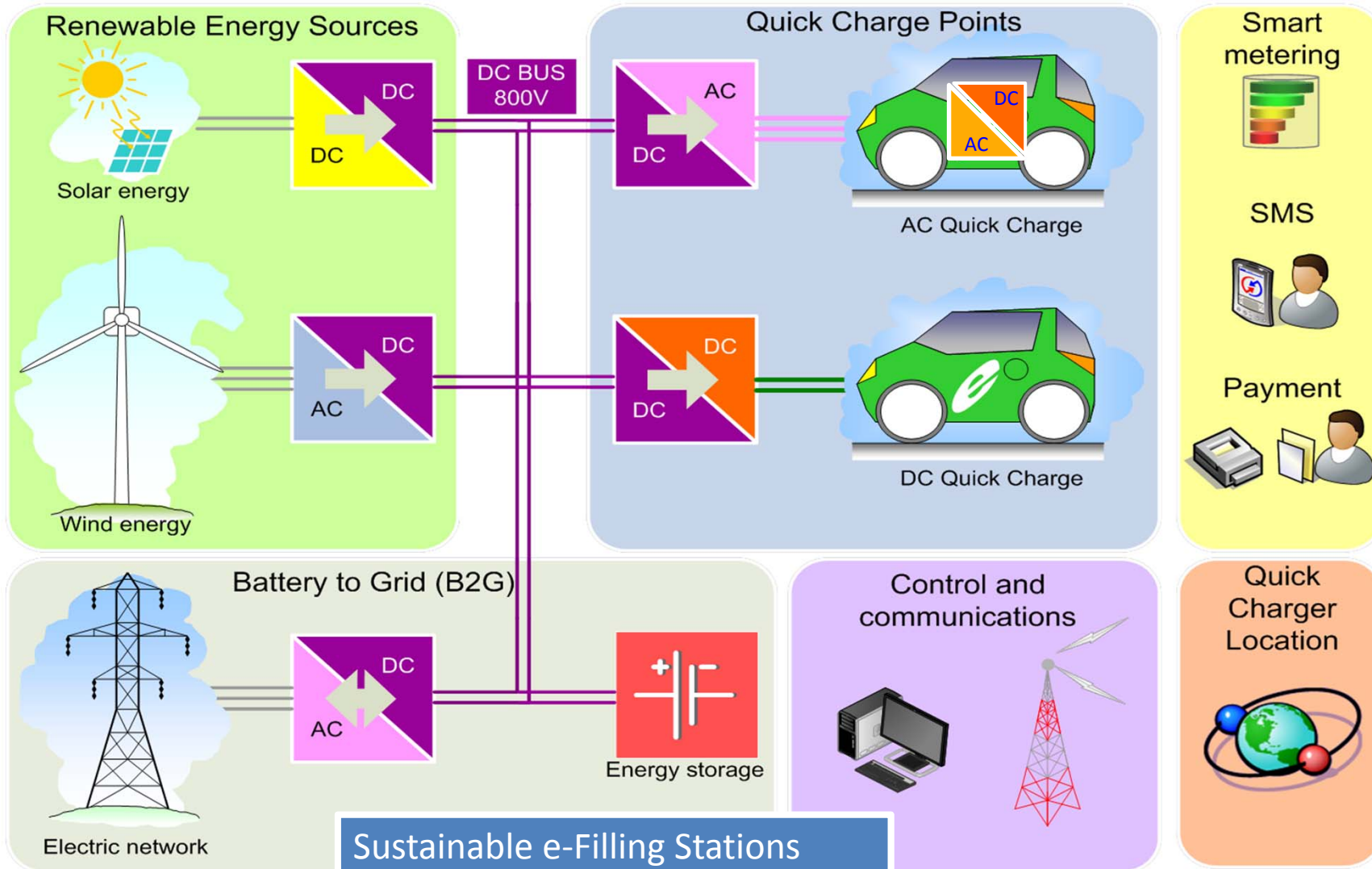


EV Charging Infrastructure

Sustainable e- Filling Stations



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EV Charging Infrastructure

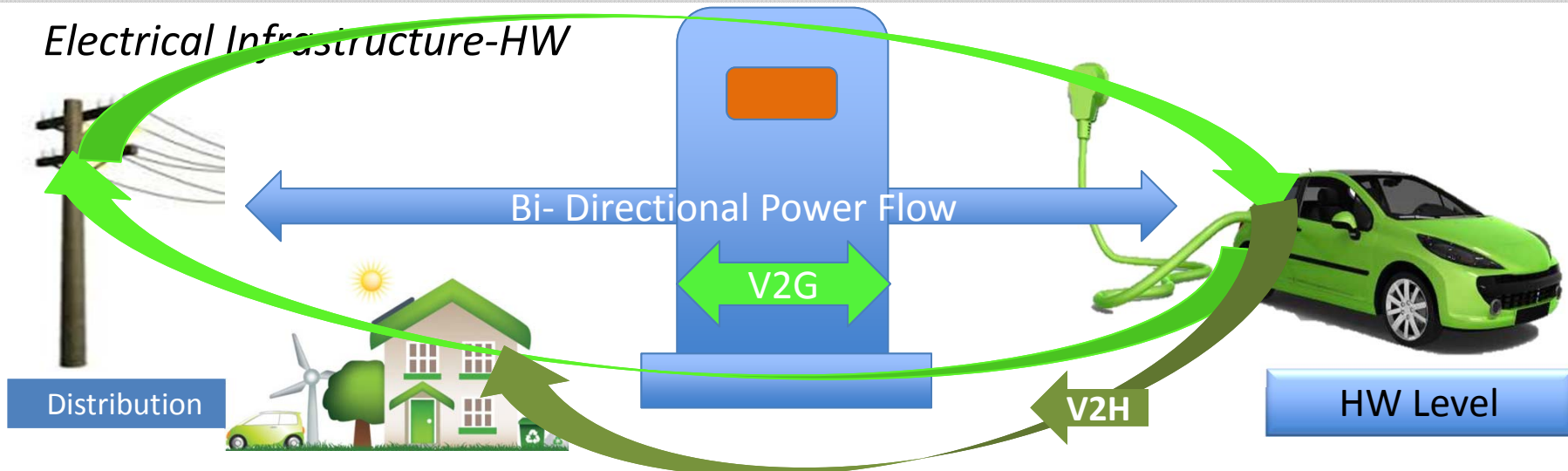
Smart Grid Integration



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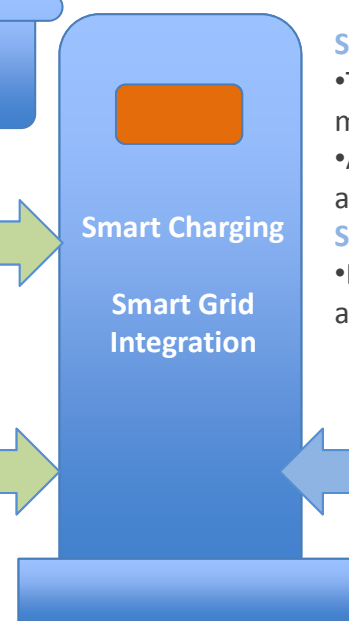
Electrical Infrastructure-HW



- ◆ ISO 15.118: Comm. between EV and CS
- ◆ IEC 61.850: Comm. Between CS and EIOP



Intelligence Infrastructure-SW

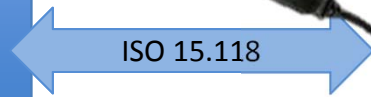
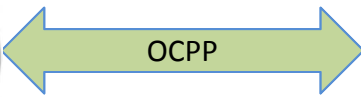
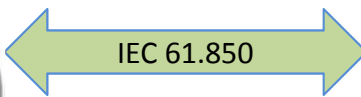


SMART CHARGING (ISO/IEC 15.118 + IEC 61.850)

- The charging process is authorised by the charge manager according to energy prices and grid stability
- A negotiation process is initiated according the grid availability and the user wishes

SMART GRID INTEGRATION (SAE J 2847 + IEC 61.850)

- Energy can transferred from the grid to the car and also from the battery of the car to the grid



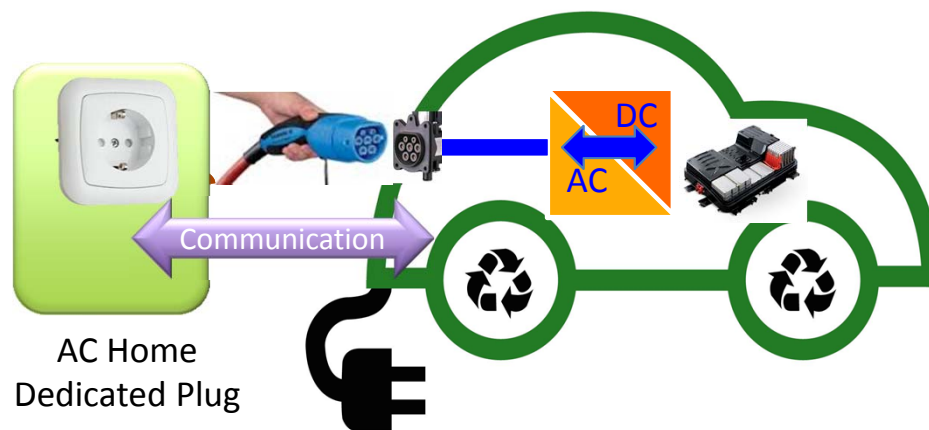
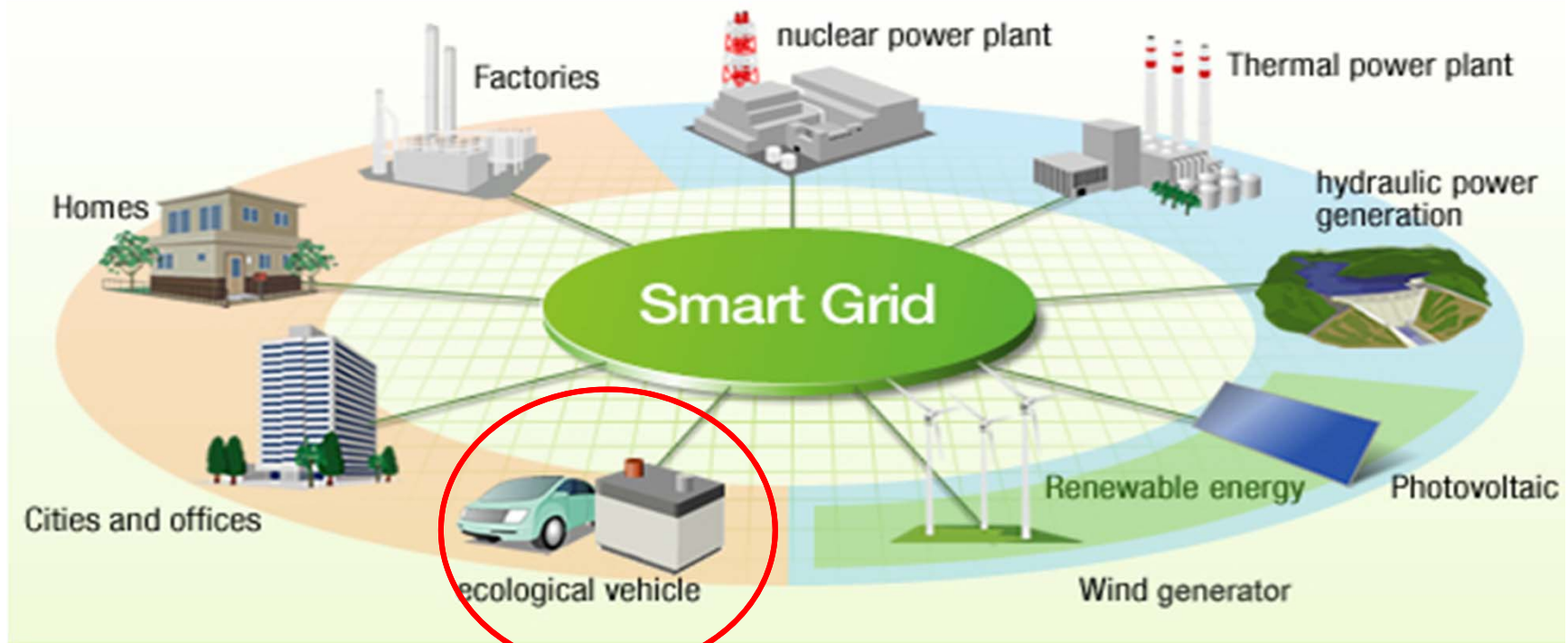
SW Level

EV Charging Infrastructure

Smart Grid Integration



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The EV integration into the Smart Grid is more complex than just a battery integration as the EV has to try to fulfil the grid needs as well as the EV driver route planning wishes and this means more complex communication between the EV and the grid

EV Charging Infrastructure

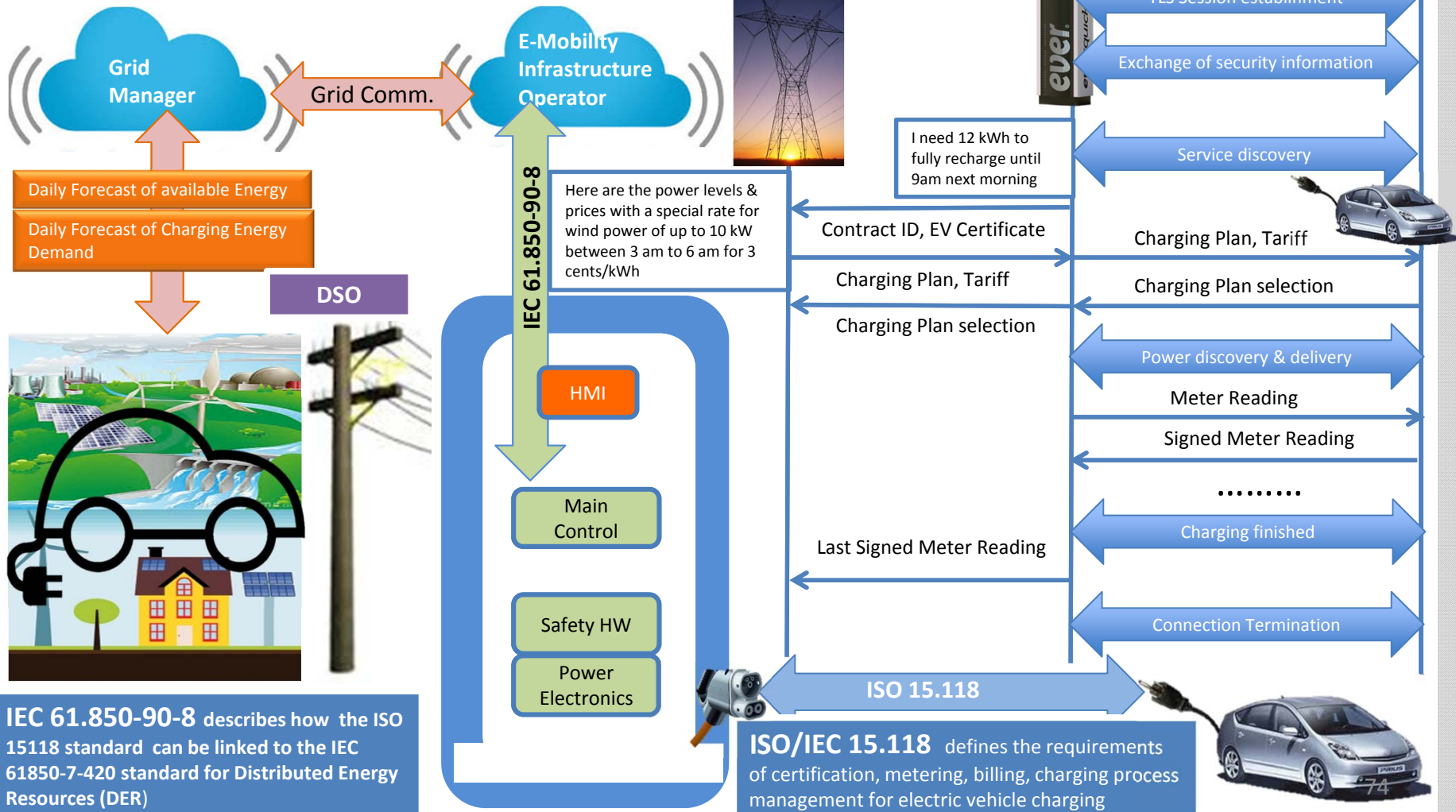
Smart Grid SW Integration



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Smart charging is the ability for an electric vehicle to communicate information and services between electro-mobility and Smart grid stakeholders, in order to supply and maintain a safe, reliable and user friendly charging infrastructure.

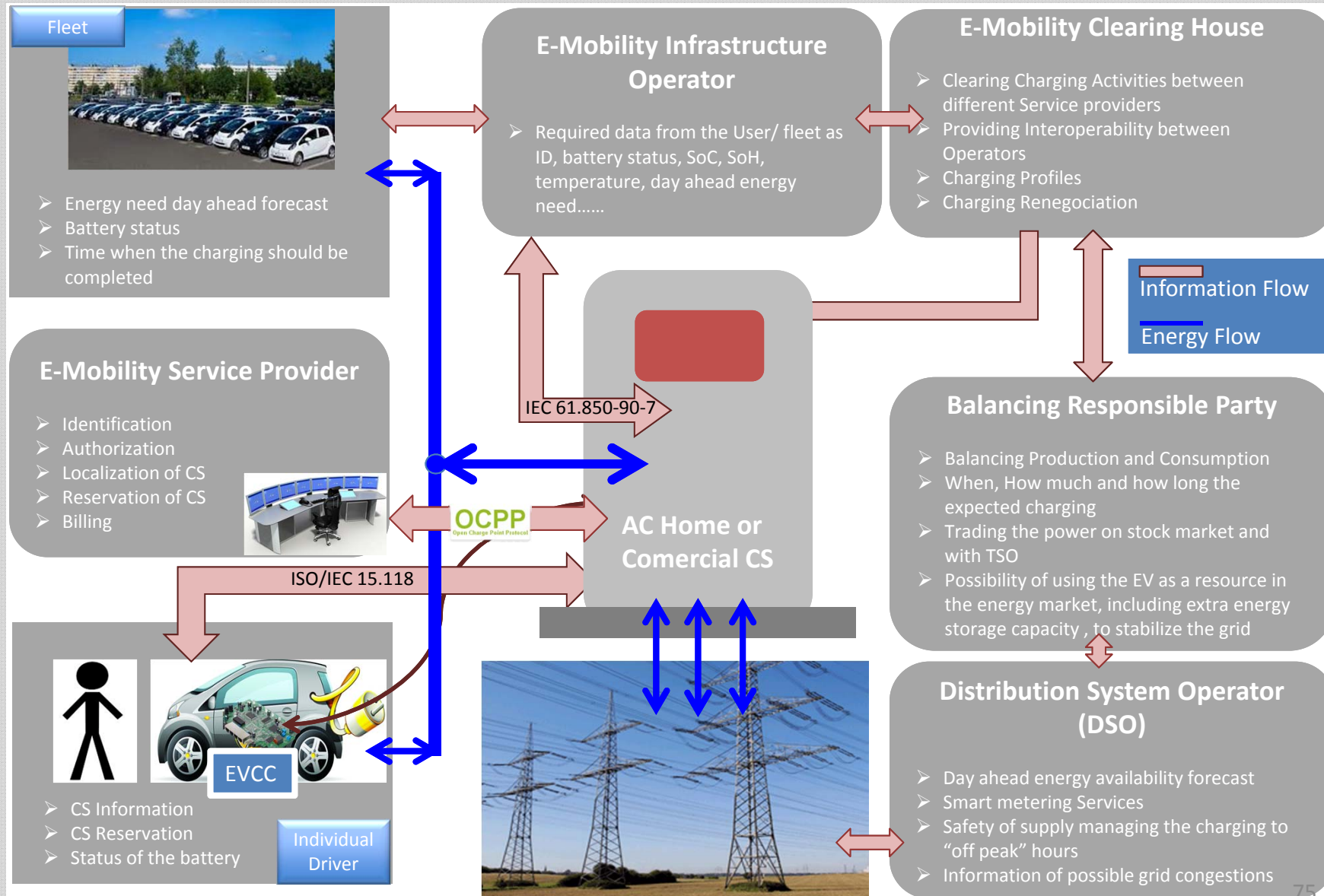


EV Charging Infrastructure

Smart Grid Services Integration



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EV Charging Infrastructure

V2G HW Integration Trial System (Mitsubishi)

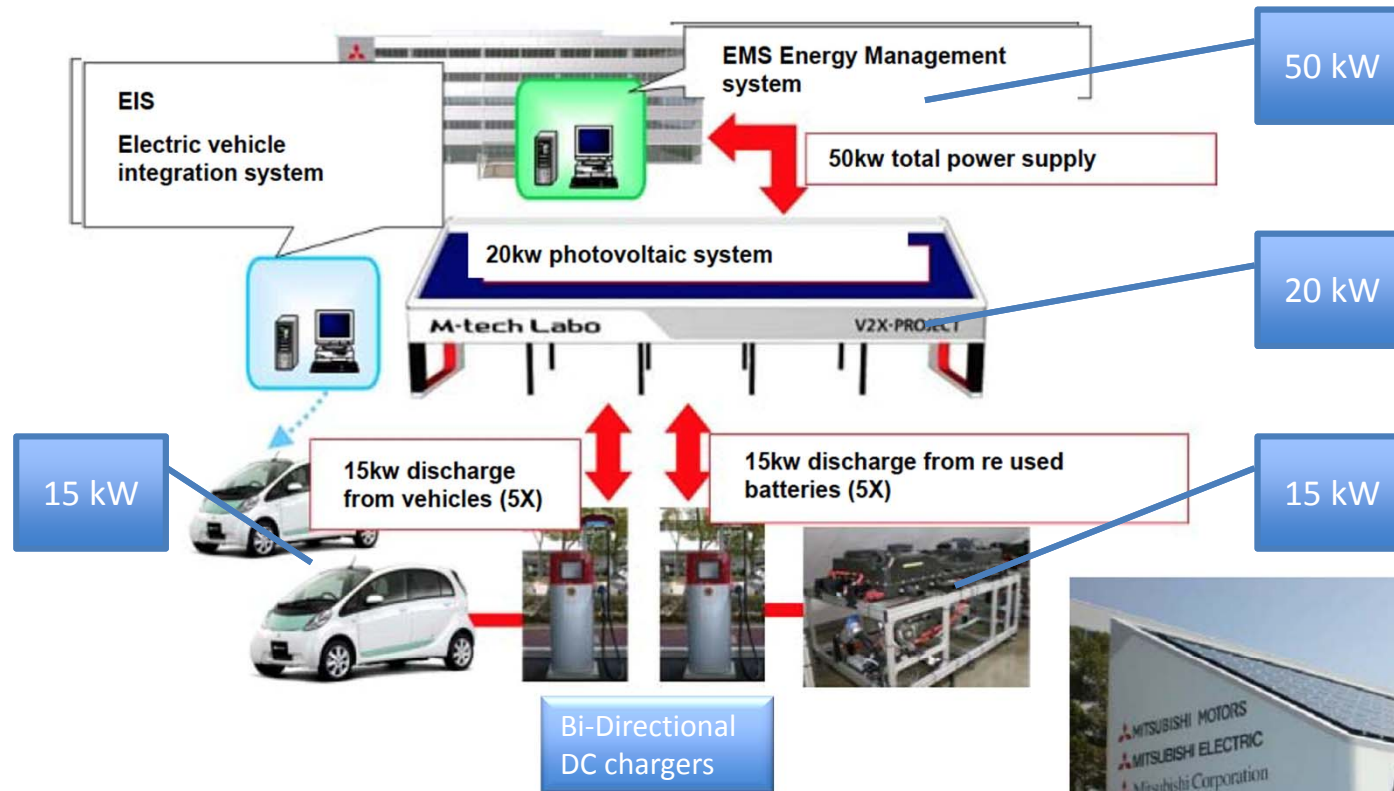


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Industrial application V2X (Japan)

V2G



V2G System in Okazaki – Mitsubishi Factory / Development centre – as trial system to check V2G in an industrial application.

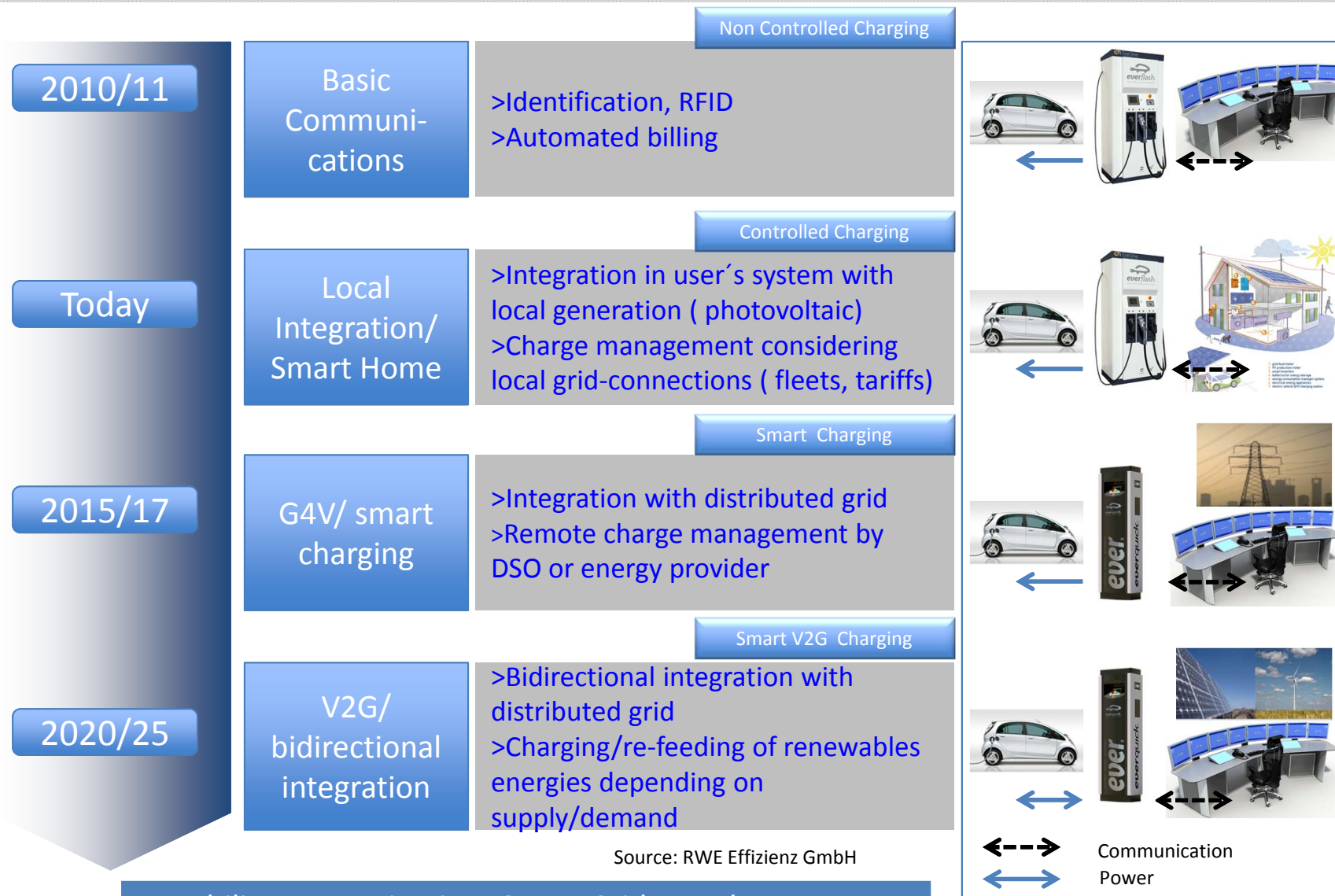


EV Charging Infrastructure

Smart Grid Integration Roadmap



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Source: RWE Effizienz GmbH

e-Mobility Integration into Smart Grids Roadmap

Communication
 Power



POWER ELECTRONICS, A KEY TECHNOLOGY FOR THE DEPLOYMENT OF ELECTRIC VEHICLES IN A LOW CARBON SOCIETY

**-MOBILITY
2020**

Thanks for your attention

Uni- Prof. Dr. Enrique J. Dede
R&D Director, GH Group