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The importance of power electronics in modern electrification

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The importance of power electronics in modern electrification

Outline

ABB overview

Changing world around us

Devices and components

EV chargers trends

Summary and Discussion – all

ABB overview

The new ABB: focused, simpler, leading

Pioneering technology leader in digital industries

$410 bn market, growing at 3.5 – 4% p.a.

Electrification	Industrial Automation	Motion	Robotics & Discrete Automation

33% Asia, Middle East and Africa | 31% Americas | 36% Europe

$29 bn revenues, 110,000 employees

Note: revenues include annualized contribution from GEIS based on H2 2018

ABB will focus in digital industries and divest Power Grids

Divesting Power Grids to Hitachi

The new ABB – focusing in digital industries

Electrification

Industrial Automation

Motion

Robotics & Discrete Automation

ABB – pioneering technology leadership since the 19th century

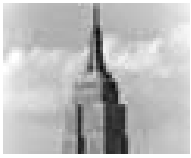
	Mechanical	Electro-mechanical	Software	Digitalization
1900s – 1940s	 Founding fathers	 Steam turbine	 Stotz MCB with thermal & magnetic tripping	 Empire State Building Electrical Equipment
1940s – 1980s	 Microprocessor-based relay	 MNS: modular arc-resistant LV switchgear	 Gearless motor drives	 MV vacuum interrupter  Electrical drive system for locomotives
1990s – now	 Modular UPS	 Electric Vehicle fast charger	 UniGear – Digital switchgear	 SF6 free MV GIS  Cloud connected LV Breaker  Smart Home

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ABB power electronics portfolio: From a few-watts to mega-watts

Power supply and UPS

Solar inverter and EVCI

Drives and wind converter

STATCOM, FACTs, HVDC

Large portfolio of power converters for different applications

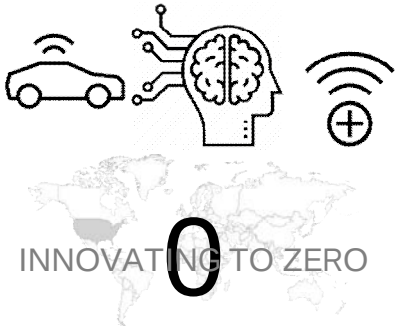
Changing world around us

The importance of power electronics in modern electrification

Mega vision: innovating to zero

Innovating to zero

Urbanization

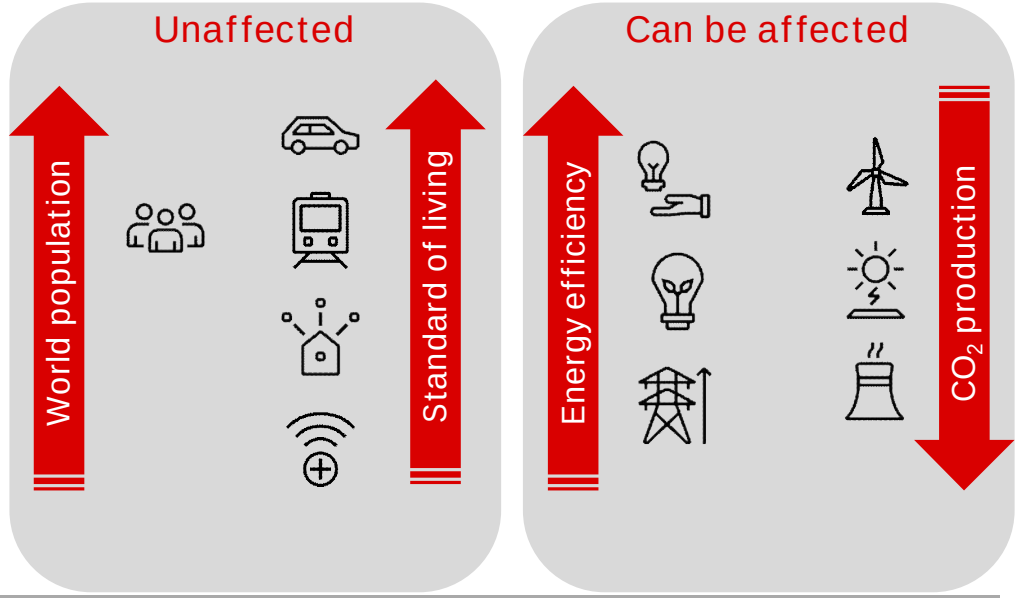


Aging World

Innovating to zero is a Mega Vision of a zero concept world with zero emissions, zero accidents, zero fatalities, zero defects, zero impact on natural resources and zero breaches of security

Innovating to zero

CO_2 = Population × Service × Energy × CO_2 production



The energy transition

Mega trends – zero emission

Meet growing energy demand

Global energy needs will expand by 30% between today and 2040

– The equivalent of adding another China and India to today's global demand

Minimize environmental impact

The share of all renewables in total power generation reaches 40% by 2040

– China, India & the US lead the charge for solar PV

– Europe is a frontrunner for onshore & offshore wind

Limited fossil fuel resources

Global electric car fleet up to 280 million by 2040, from 2 million today

– Electric cars are helping to transform energy use for passenger cars, slowing the pace of growth in global oil demand

Emission = Population × Energy × CO_2 production

Devices and Components, trend towards Wide Band Gap materials

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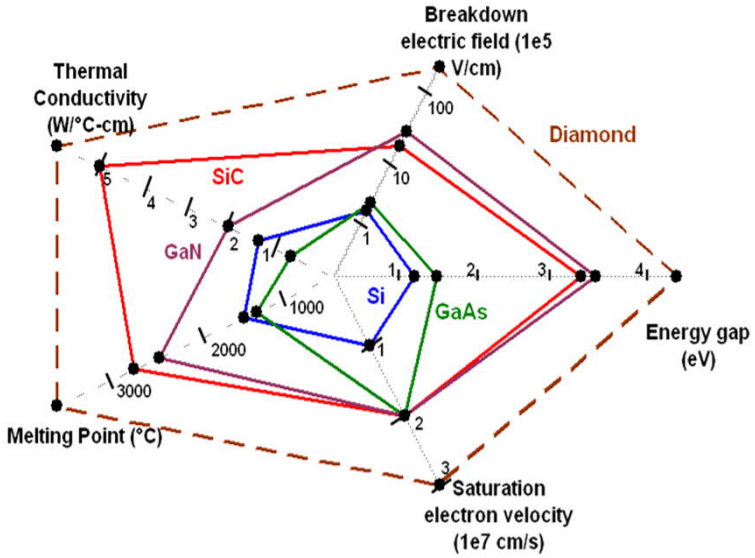
Wide Band Gap Semiconductors: Features and Challenges

Theoretical Benefits and features



Physical Characteristics

WBG materials permits the devices to operate at :

- 10x higher blocking voltage
- 3x higher operating temperature
- 10x higher switching frequency
- 3x higher current density

Negligible switching losses – Higher efficiency

Main Challenges

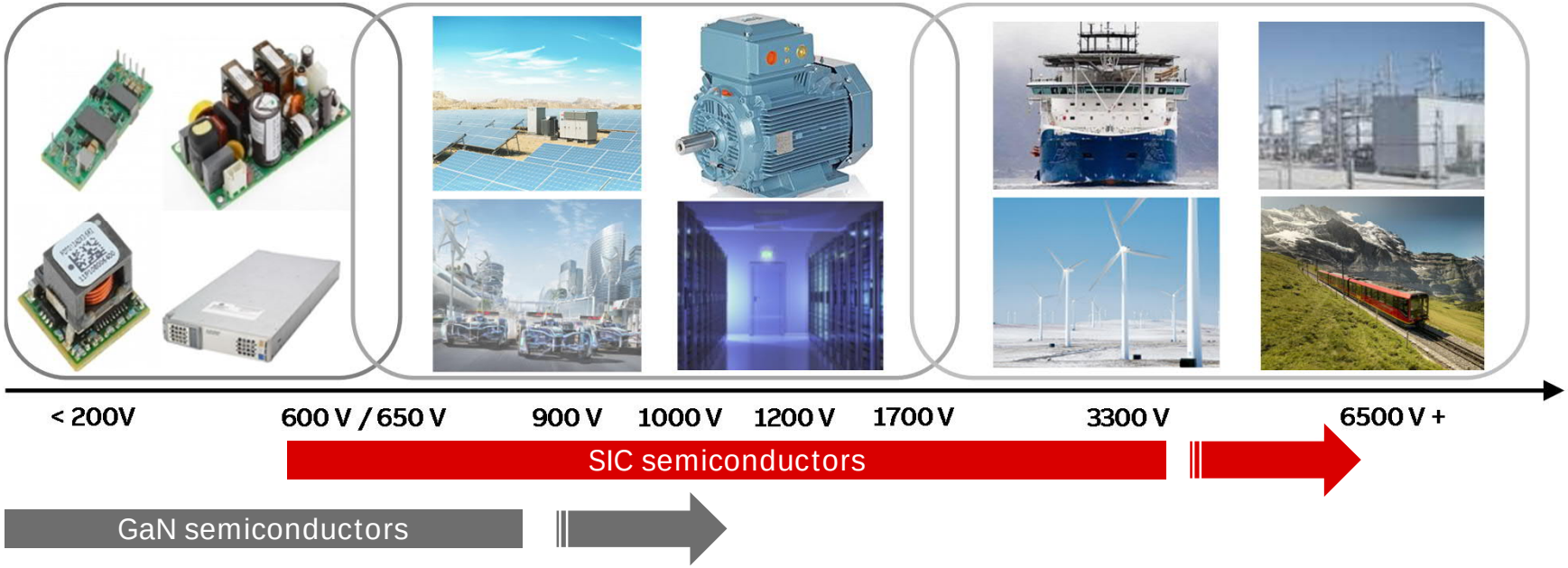
- Material quality
- Device Size and Yield
- Cost

10% of the global semiconductor market will be served by SiC and GaN in 2025 *

* Leo Lorenz, PCIM 2017
Follow the link: Graph

Applications for Wide Band Gap devices

Potential applications and available choices at different voltage levels



Challenge: Delivering higher customer value while maintaining reliability and profitability

Figure adapted from: Yole Developpement, *"Si IGBT and SiC: which repartition for power devices?,"* APEC, March 2016

EV Chargers trends

Major achievements

2010
Founding of CHAdeMO

Pilots

2010
First 50 kW charger in EU

2010
Launch ABB Terra 51

CHAdeMO

2010
First EV's with DC charging

2012
Founding of CCS alliance

First EV's

2012
First demo of CCS charging

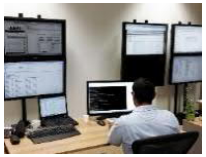
CCS alliance

2012 – 2013
First nationwide DC networks

2013
Launch CCS & multi-standard Terra 53

IEC 61851-23

Multi-standard



2012, >
Leading connectivity & uptime

2013 – 2015
Launch global variants Terra 53

Global EV spread

2014, >
DC networks spread globally

2016
First e-bus chargers in EU

E-bus

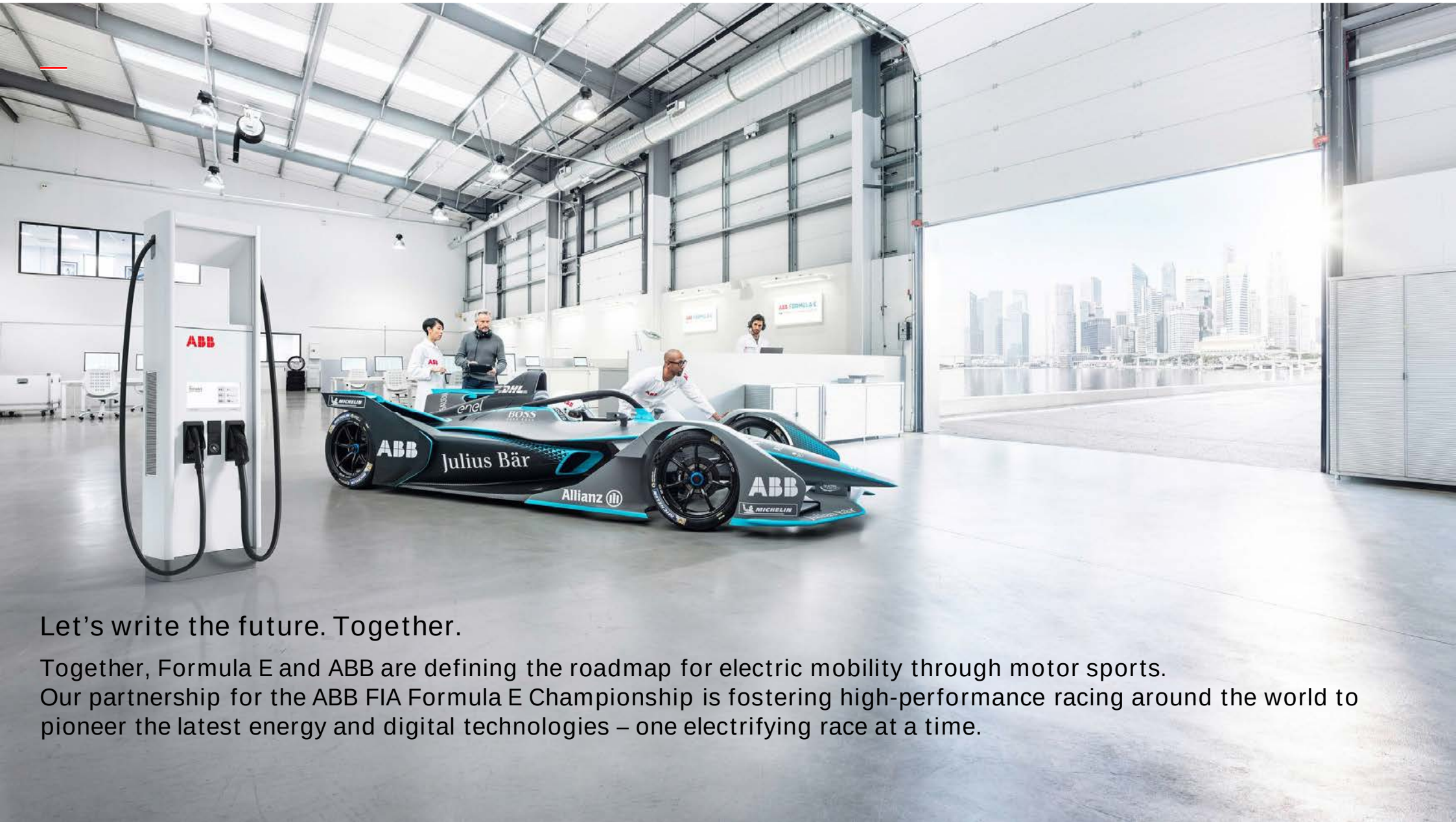
2017
Launch of high power for cars

OppCharge

2018
First e-truck chargers Global

Higher power

2018
Launch of Gen2 charge post and Terra 54HV

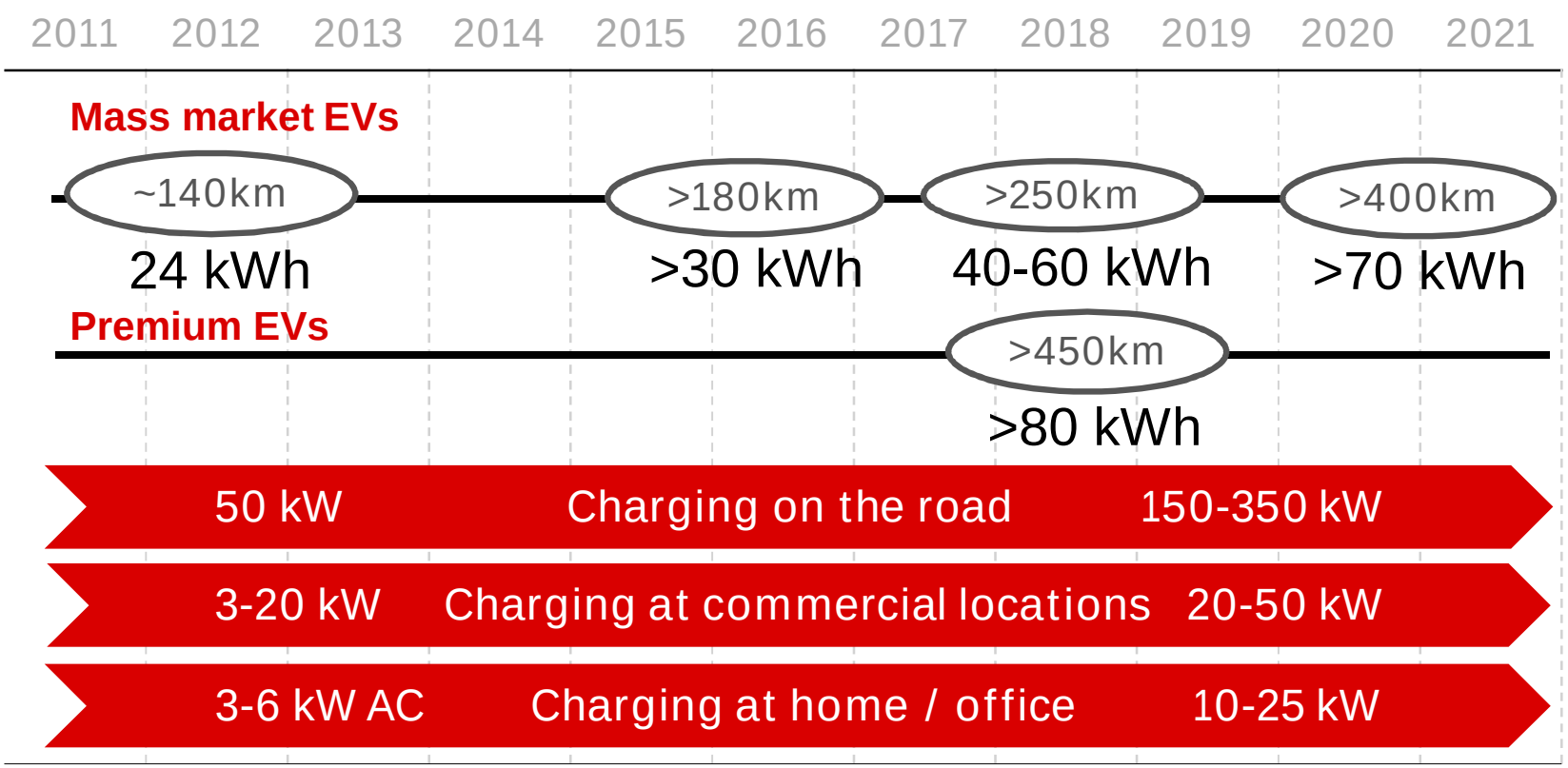


Let’s write the future. Together.

Together, Formula E and ABB are defining the roadmap for electric mobility through motor sports.
Our partnership for the ABB FIA Formula E Championship is fostering high-performance racing around the world to pioneer the latest energy and digital technologies – one electrifying race at a time.

Driver: the EV range roadmap for EU, USA, APAC

Batteries get bigger, range gets longer



Small cars:
50 – <150 kW

Mid / high segment:
120 – 150 kW

Top segment:
~300/350 kW

Public and commercial car charging – use cases

Charging service should match charging application and demand

Public and commercial EV Charging

AC destination	DC destination	DC Fast	DC High Power
3-22 kW	20-25 kW	50 kW	150 to 350 kW+
4-16 hours	1-3 hours	20-90 min	10-20 min
			
• Office, workplace • Multi family housing • Hotel and hospitality • Overnight fleet • Supplement at DC charging sites for PHEVs	• Office, workplace • Multi family housing • Hotel and hospitality • Parking structures • Dealerships • Urban fleets • Public or private campus • Sensitive grid applications	• Retail, grocery, mall, big box, restaurant • High turnover parking • Convenience fueling stations • Highway truck stops and travel plazas • OEM R&D	• Highway corridor travel • Metro ‘charge and go’ • Highway rest stops • Petrol station area’s • City ring service stations • OEM R&D

Public and commercial car charging – use cases

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Conclusions

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Sustainable world enabled by power electronics

Impact of Power Electronics

1995 – 2015: 390 GW of power stations avoided

- The “greenest” electricity needs not to be produced
- IGBT-based power electronics has saved CO2-emission, which correspond to the emission of 390 large coal-based power plants, each of 1 GW at a utilization of 85% (> 10% of global capacity)

2015 – 2050: Power Electronics enables the low carbon society

- Renewable power generation, i.e. Solar and Wind
- Interconnection of renewable sources, i.e. HVDC
- More electric transportation, i.e. EV, E-Bus and Trains
- Variable speed drives in multiple applications
- Efficiency in IT infrastructure, i.e. data centers and telecom
- Efficient lighting infrastucture (LED)

SiC devices offer a new dimension of efficiency and compactness-10% of PE market by 2025

[1] M. Mori: “Power Semiconductor Devices Creating Comfortable Low Carbon Society” Hitachi, CiteWeb id: 20081073821, 2010