Worldwide Trends impacting the Automotive Industry

Dr. Herbert Demel

Global Trends

Environment

Climate Change CO2 and Fleet Consumption

Economy

Shrinking Resources

Politics

Entry Restrictions

Urbanization

By 2030, over 60% of the world's population will live in cities

Culture

Sustainable mobility as part of modern lifestyles, social responsibility

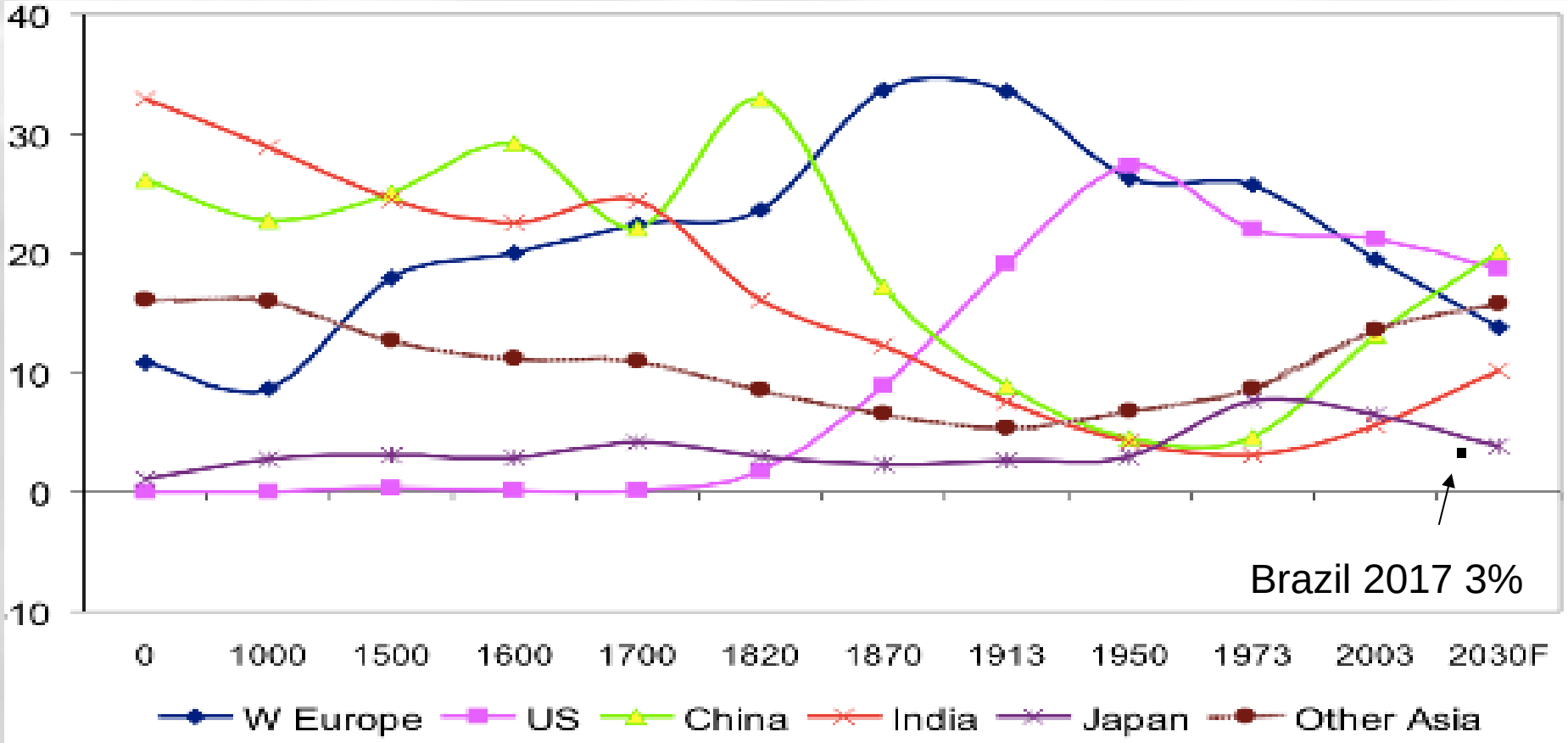
Customer

Wishes Value Change

Electric Vehicles | Industry 4.0 | Automated Drive | Smart City | Connected Car | Mobility on Demand

Source: 39. Internationales Wiener Motorensymposium 2018

Shares of Individulal Economies in the World. GDP measured in PPP%



Source: Citi estimates based on original data from Angus Maddison, 2001, The World Economy: A Millennial Perspective, Development Research Center, OECD, Paris, and Angus Maddison, 2005, "The west and the rest in the world economy: 1500-2030", Australian National University, Canberra.

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Global population and World Primary Energy Consumption

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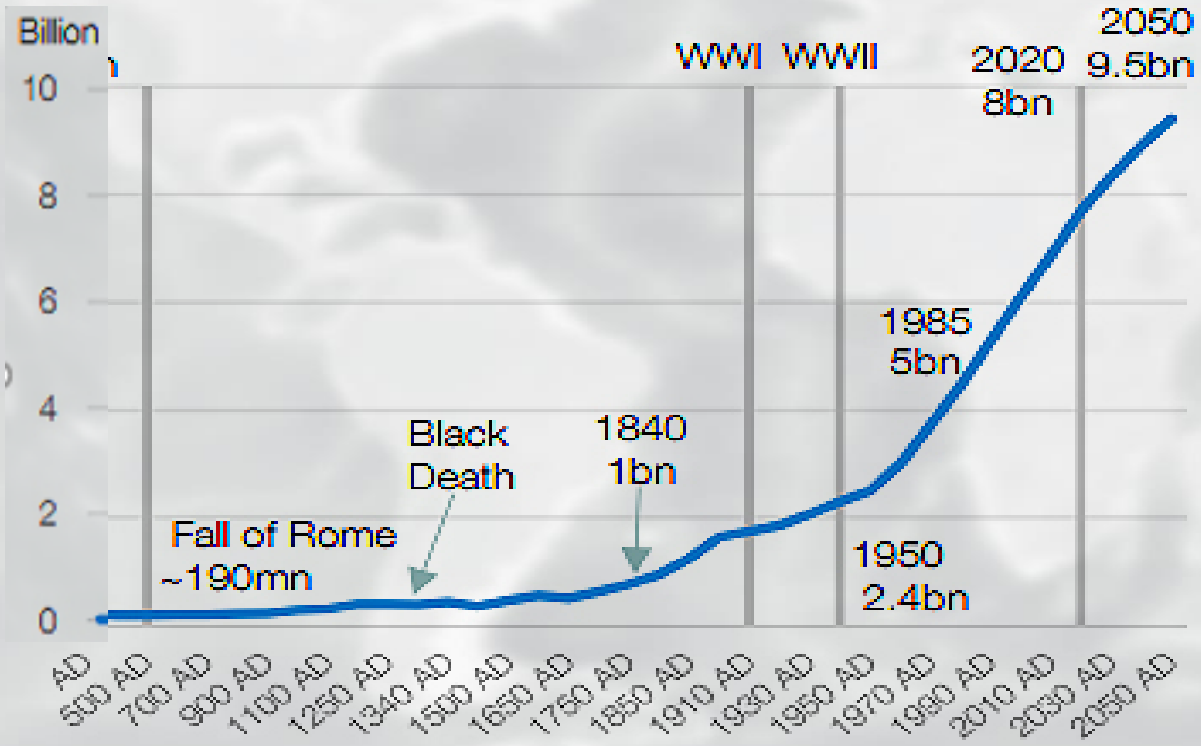
- The end of two world wars spurred the greatest boom in human history
- Growth is now waning

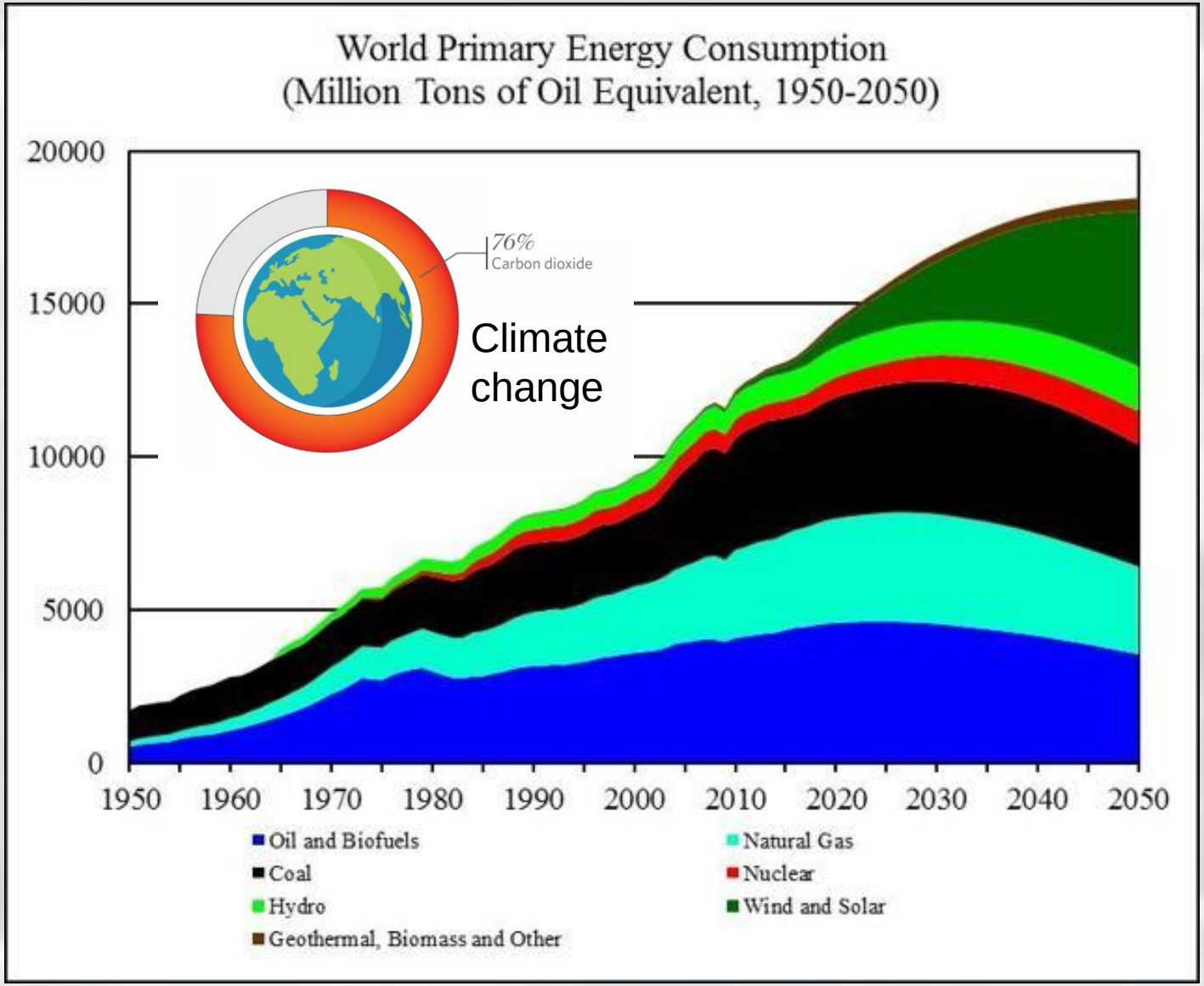
Last estimates
9,8 bn



under 1,5 bn
Industrialized Countries

Source: US census bureau, Thomlinson, Biraben, Durand, Haub, McEvedy

World Primary Energy Consumption



Source: World Energy 2017-2050 Annual Report Seeking Alpha

Emissions and temperature rise

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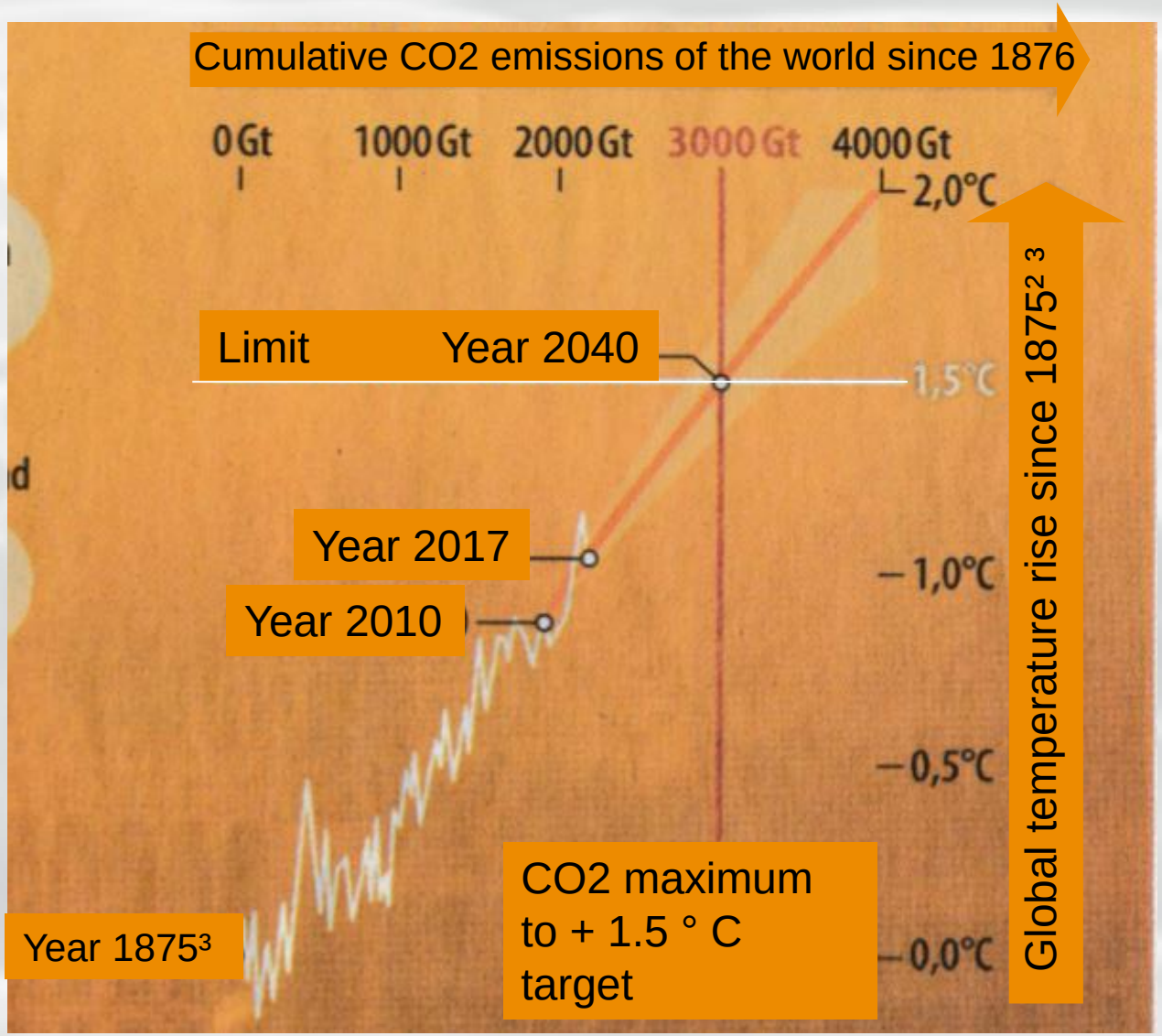
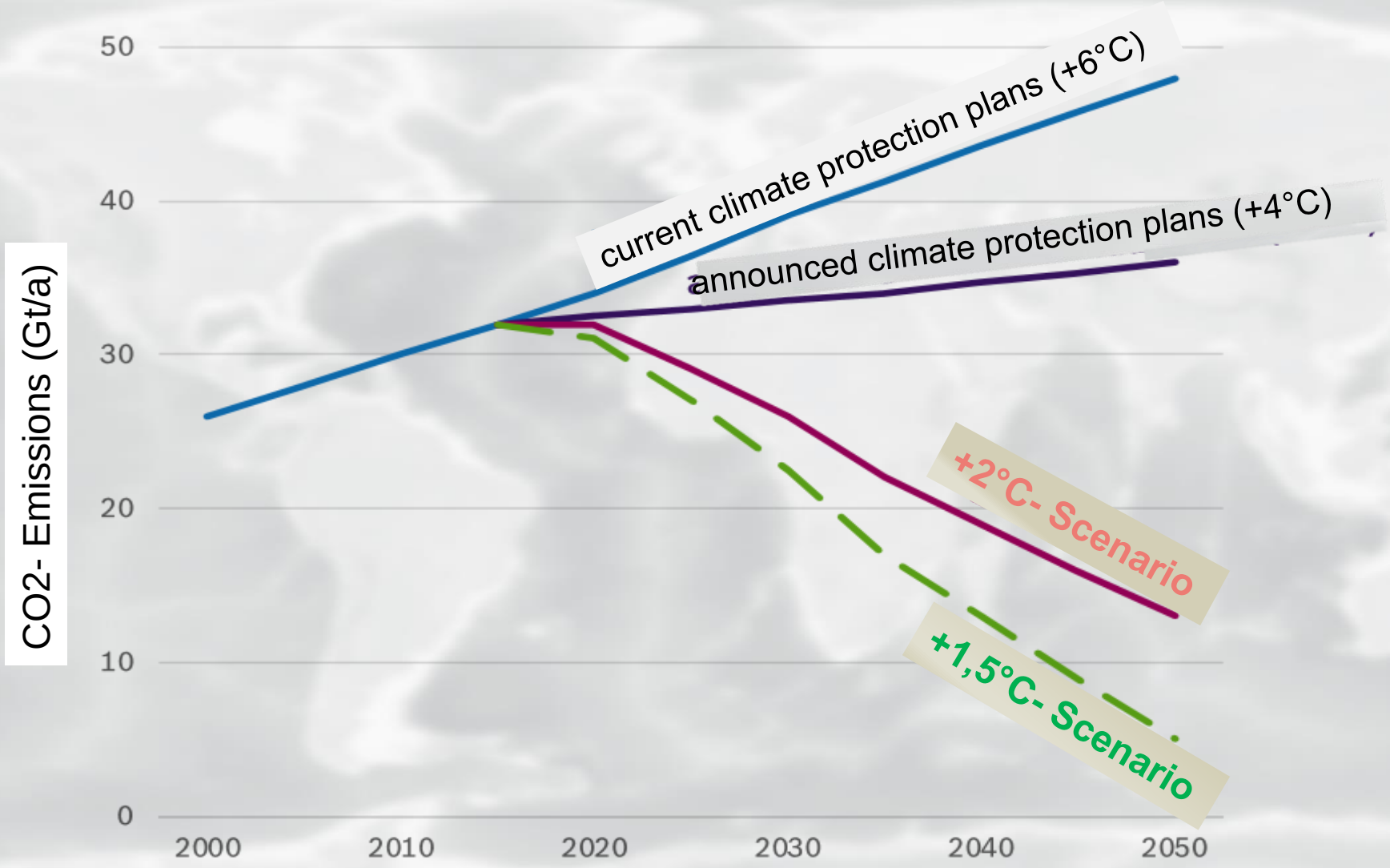


Source: IPCC; Global Carbon Project
Foto: Getty/F.A.Z.-Grafik Brocker

2) After 2017: projections
3) Average temperatures between 1850 and 1900

Scenario consideration of CO2 exposure

Paris, Kattowitz



Source: International Energy Agency (IEA), 2015

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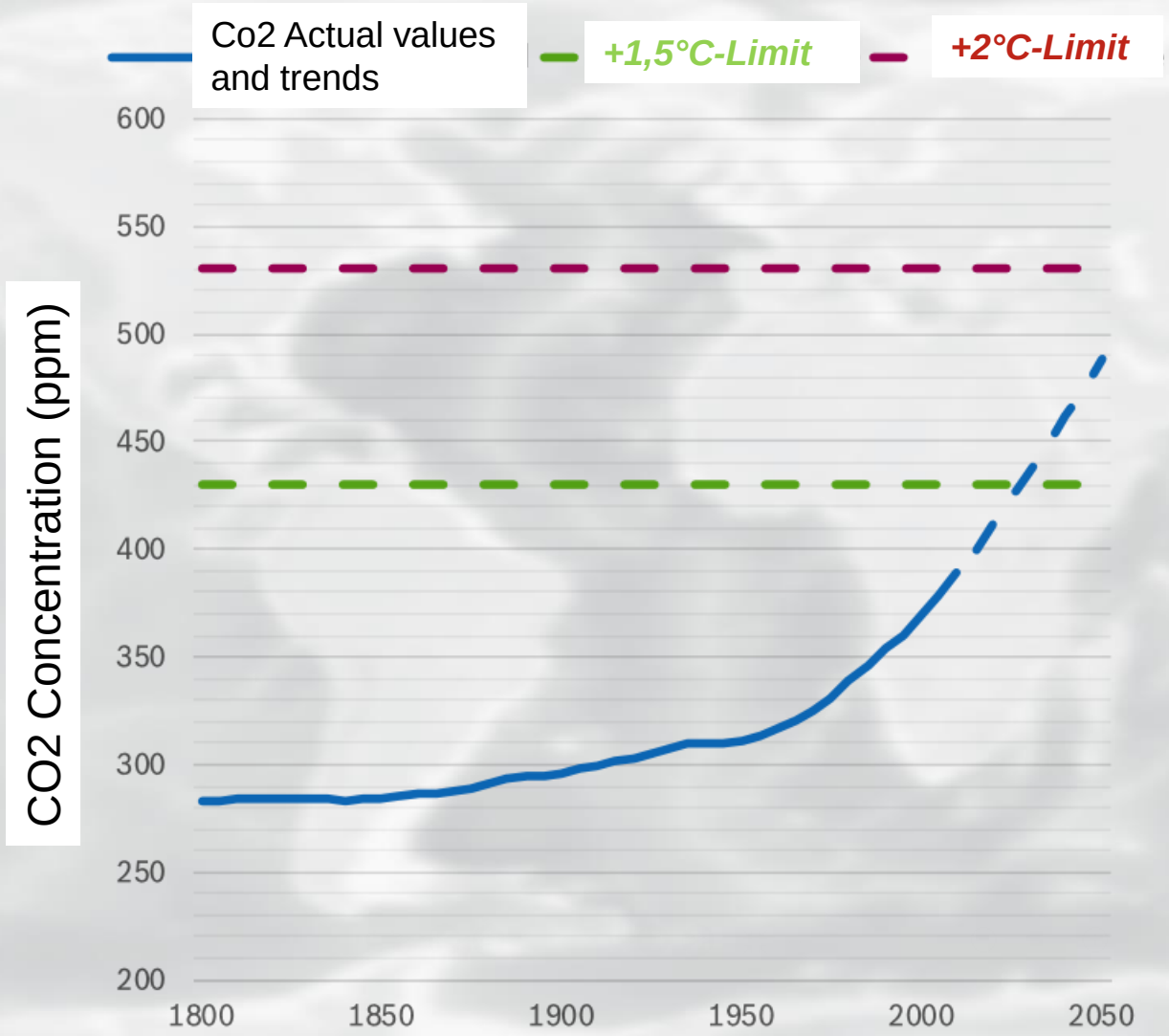
Atmospheric concentration of CO2[ppm]



Source: National Oceanic and Atmospheric Administration, USA, 2016

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Historical development of drive concepts

- **In 1900, the electric motor was the leading car drive, gradually being displaced by the internal combustion engines (ICM).**

<u>Worldwide production of electric cars</u>
2012: 168.000 (0.2% of 80 million)
2014: 403.000 (0.5% of 86 million)
2016: 800.000 (0.85% of 95 million)
2018: 2,100.000 (2,2% of 95 million**)**

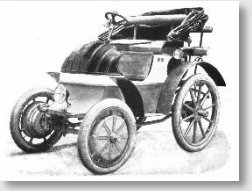
USA / 1900:
40% steam
38% electric
22% gasoline

2018 China´s global EV share was 56%

1886:
Benz Patent Motor Car Number 1 with ICM

1902: First“Hybrid”

1899: The Porsche / Lohner with wheel hub motors is developed and presented in 1900 at the Paris World Fair.



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Vertical shifts in automotive value creation until 2030

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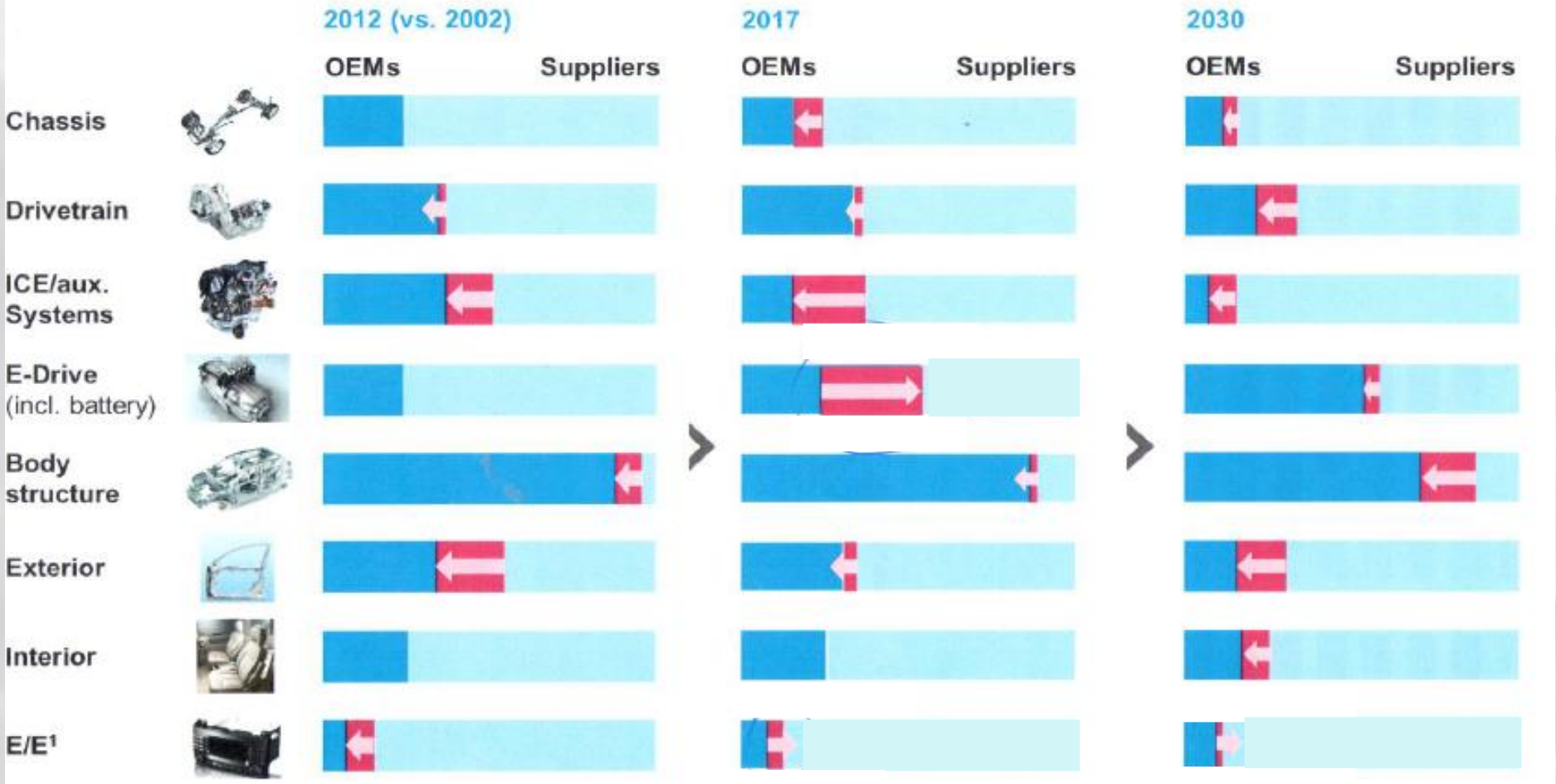
Outsourcing from OEMs to suppliers will continue but slow down; in E-Drive, OEMs will gradually build up own competence and rely for ADAS on suppliers



1. Driven by advancement of ADAS and autonomous driving (AD)
Source: Oliver Wyman value creation model

Platforms & Reversal of Weight Spiral

New Platform Concepts

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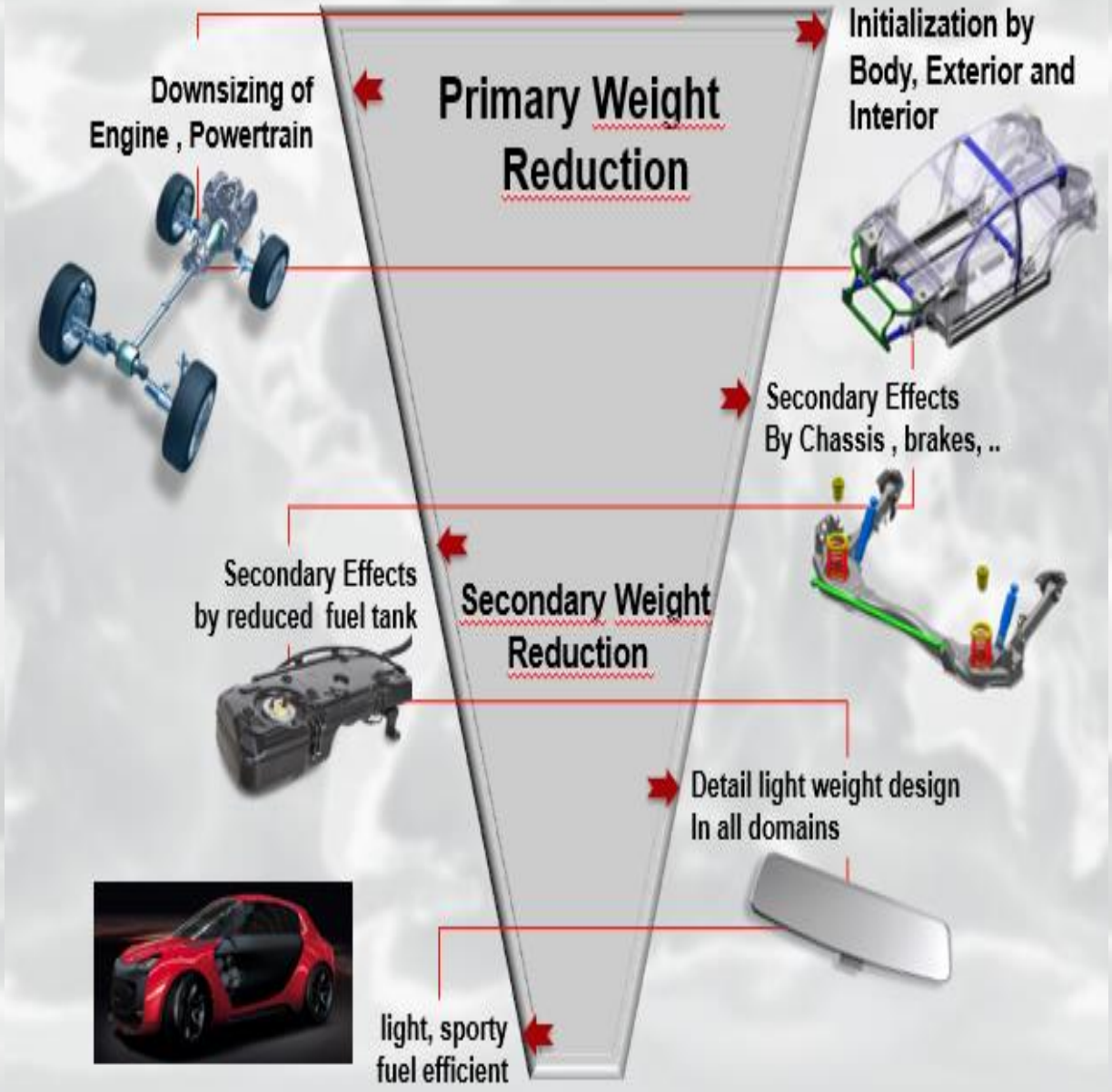
MQB

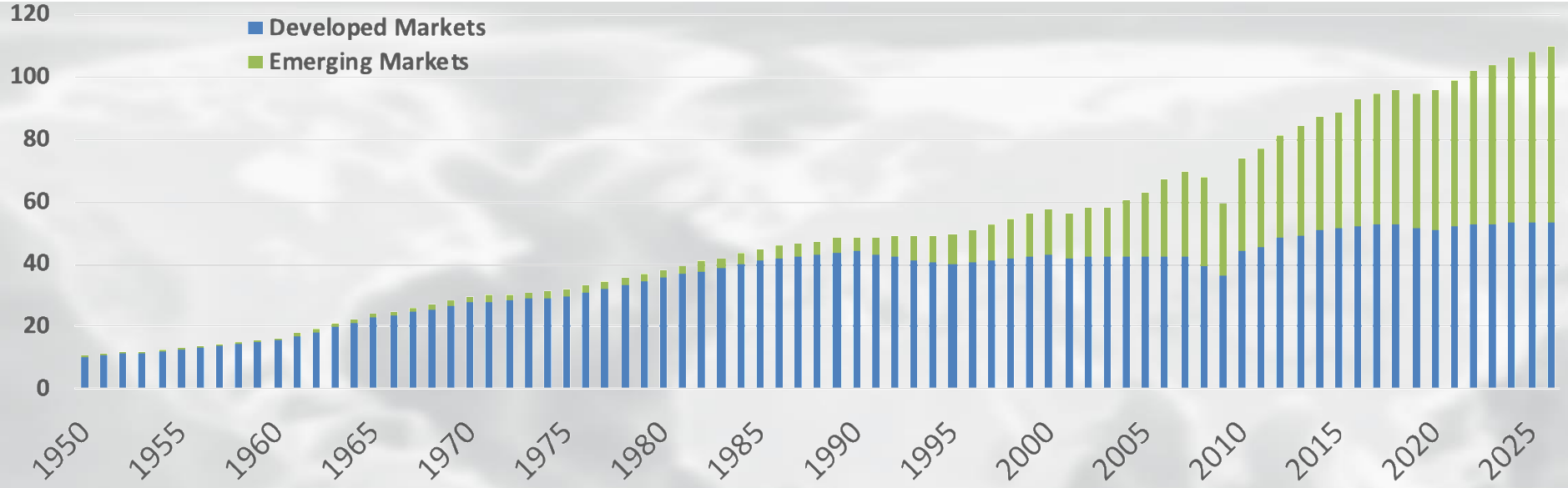
"One of the prominent characteristics of the Modular Transverse Matrix is the uniform mounting position of ALL engines. Assembly kit allows for synergies between all vehicle classes"

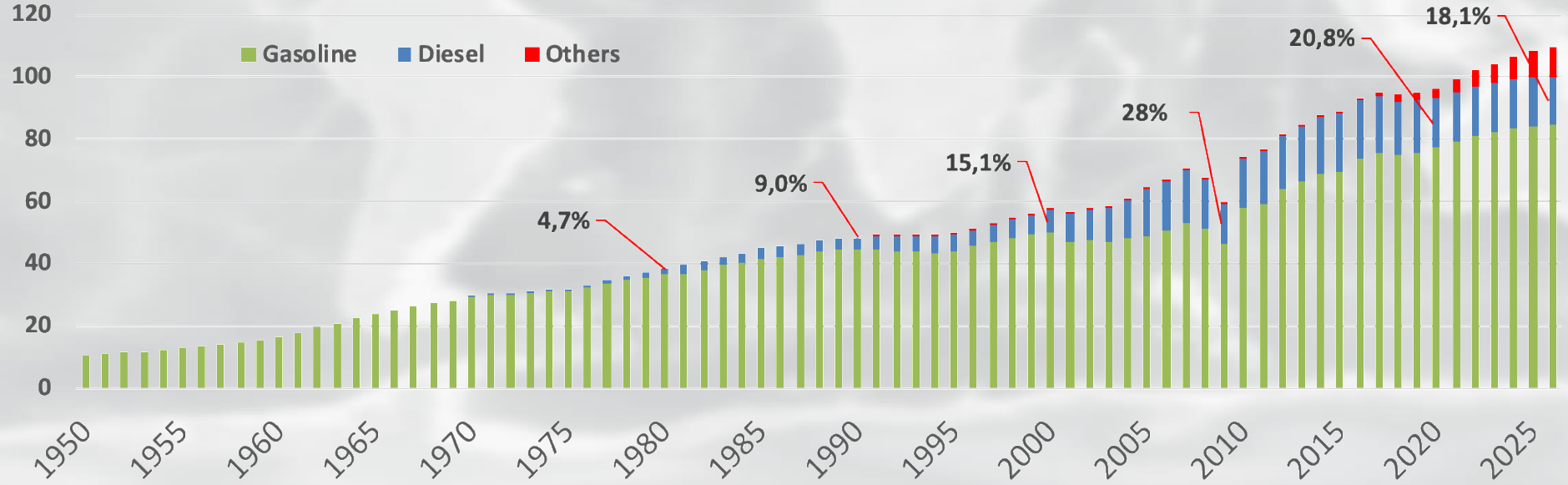
- 2020 scale: 5.6 million units
- 2020 program count: 130+



Source: IHS December 2013

Global Light Vehicle Production 1950-2026





Sources: ACEA, Environmental Sciences Europe, ICCT, IHS, OICA, Turner, Mason & Company, Wards Communications, IHS March 2019

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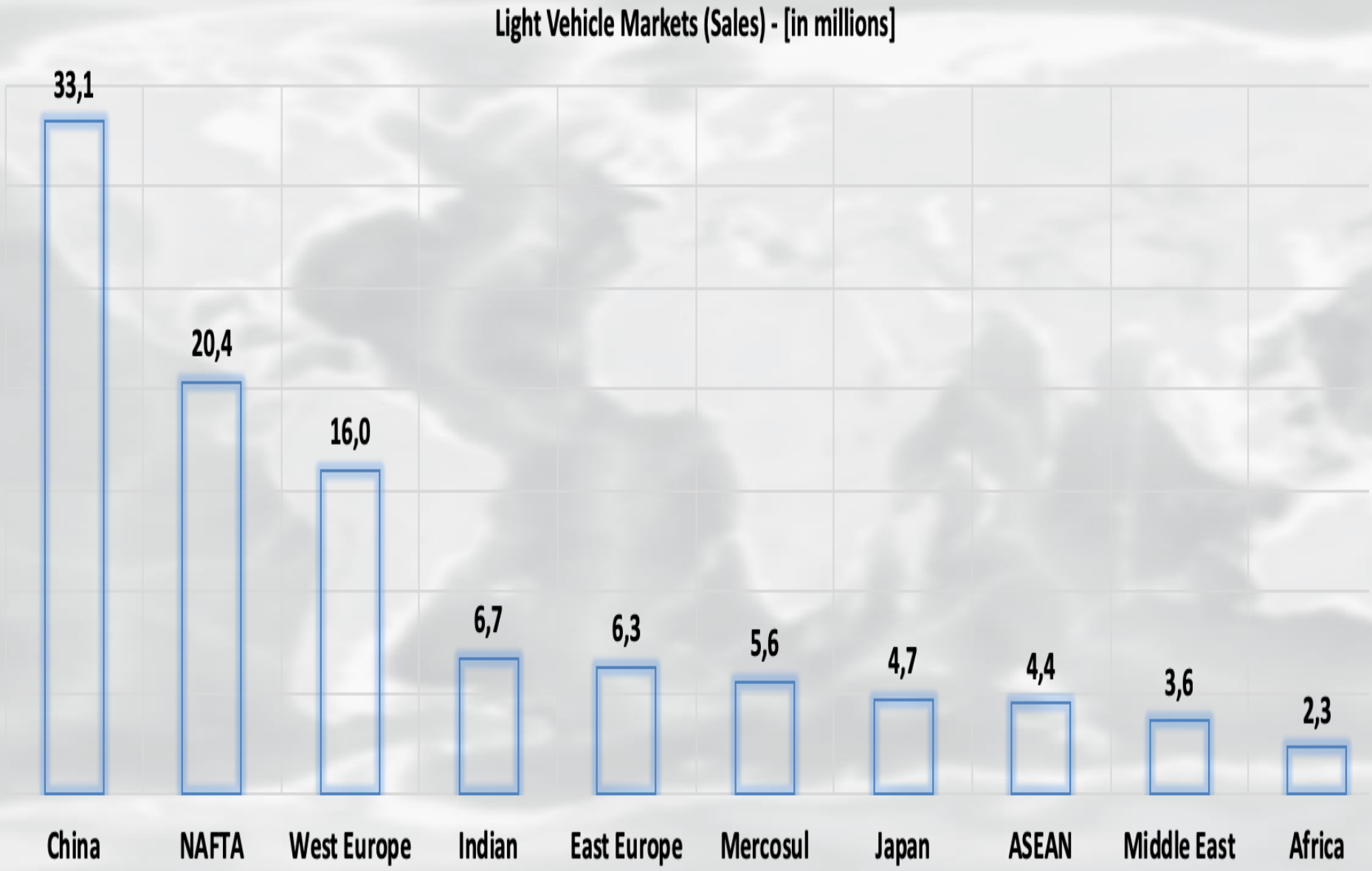
Top 10 Light-Vehicle Markets - *2025*



Source: IHS March/2019 – 2025/108M Total Global Vehicle Volume

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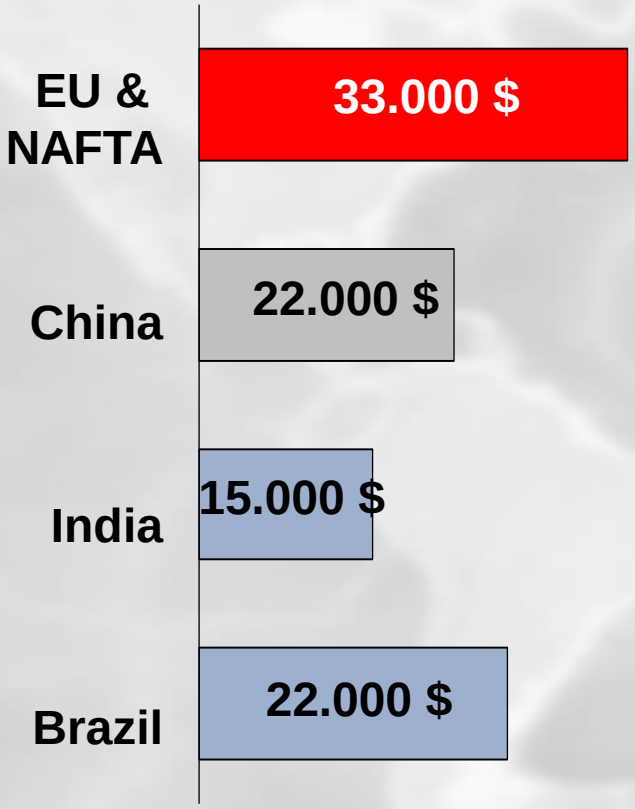
Average Light Vehicle Transaction Price

EU&NAFTA/ China / India / Brasil



	GDP per capita 2017 (PPP)	Vehicles per capita/ 1000 inhabitants
EU & NAFTA	37.200 $ 46.000 $	USA 788 EU 500
China	16.800 $	~ 173
India	7.000 $	~ 22
Brazil	15.500 $	~ 341

GDP PPP World = 17000 $ (2017)

Sources: CIA Factbook, U.S. Census Bureau, Worldbank, Statista.com, own estimates

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The automotive revenue pool will grow and diversify [USD billions]

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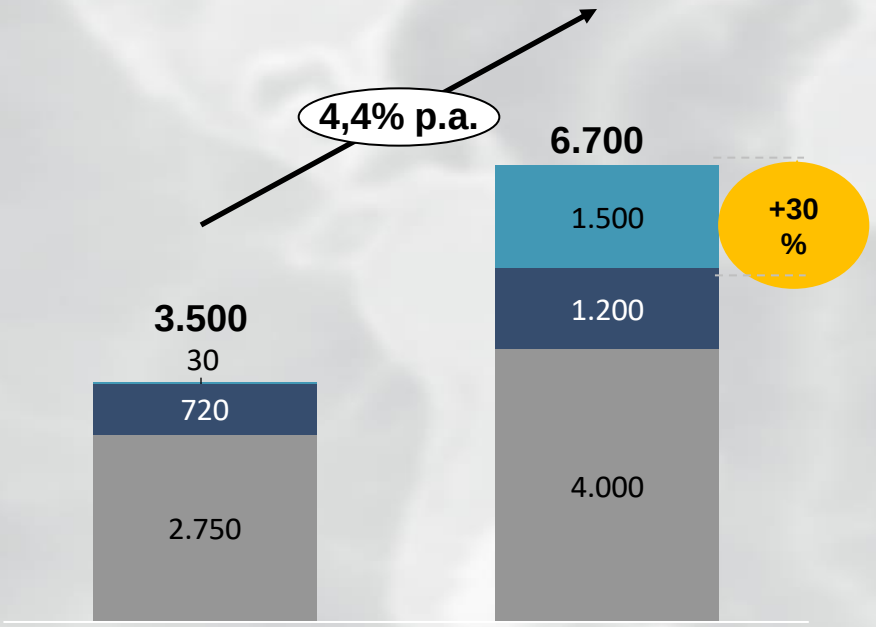
Traditional automotive Revenues 2016
Vehicle Sales dominant

New automotive revenues, 2030
Recurring revenues significantly increasing

Today



Recurring revenues

- Shared mobility penetrates and suburban cities with new car sharing and e-hailing business models[1)]
- >USD 100 billion from data connectivity services, incl. apps, navigation, entertainment, remote services, and software upgrades

Aftermarket

- Growth with increased vehicle sales
- Higher annual maintenance spend for shared vehicles
- 20-30% lower maintenance spend on electric powertrains
- Up to 90% lower average crash repair per autonomous vehicle

One-time vehicle sales

- ~2% annual global increase in vehicle sales
- Price premiums paid for electric powertrains and autonomous driving technology features

[1)]Does not include traditional taxi and rentals, Source: McKinsey (2016)

Passenger car GHG emissions/fuel consumption [g/km]

- Emission regulations force automotive OEMs to introduce an increasing share of xEVs from 2020 onwards in major regions
- Changes in US regulations likely

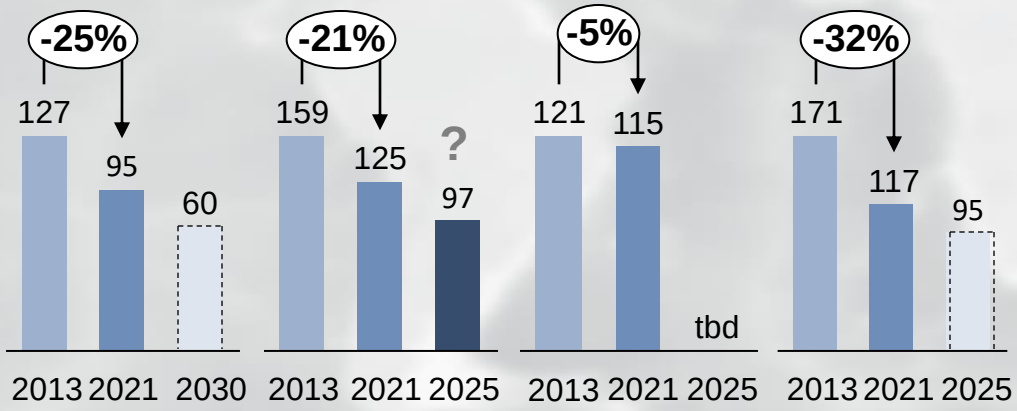
GHG emissions/fuel consumption (CO_2)

- CO_2 emissions target[1)]

- CAFE[2)]
- Additional ZEV regulation CARB

- Fuel efficiency targets[3)]

- CAFC[4)] (ph.IV)
- Add. Potential fleet xEV target share



99 % of toxic emissions CO, HC, Nox will have been reduced between 1970 and 2020

[1)] Weight-based corporate average [2)] Footprint-based corporate average: converted to NEDC [3)] Weight-class based corporate average: showing JC08 [4)] Weight-class based per vehicle and corporate average
Source: Roland Berger (2017)

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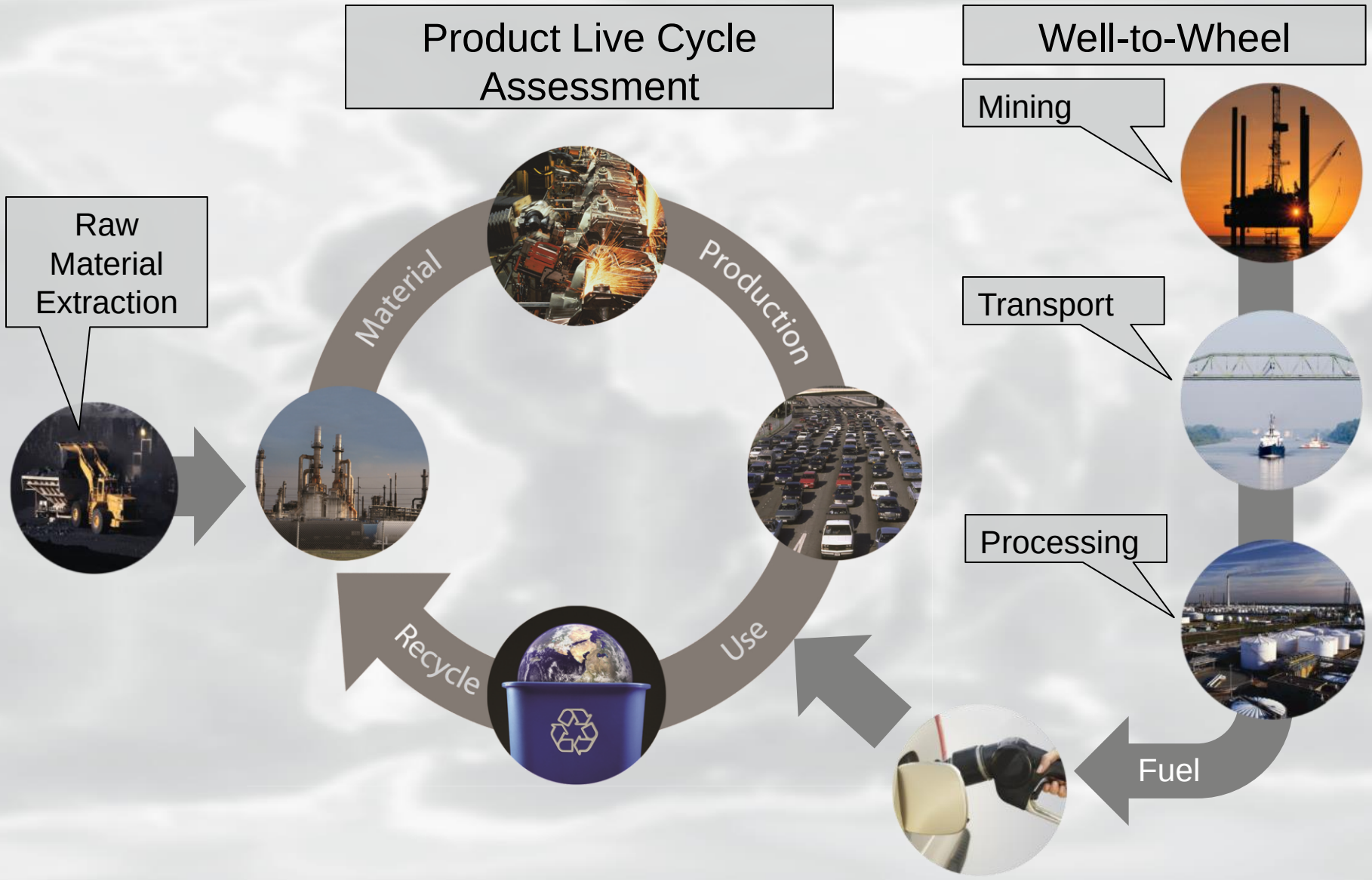
Energy: total balance of a car



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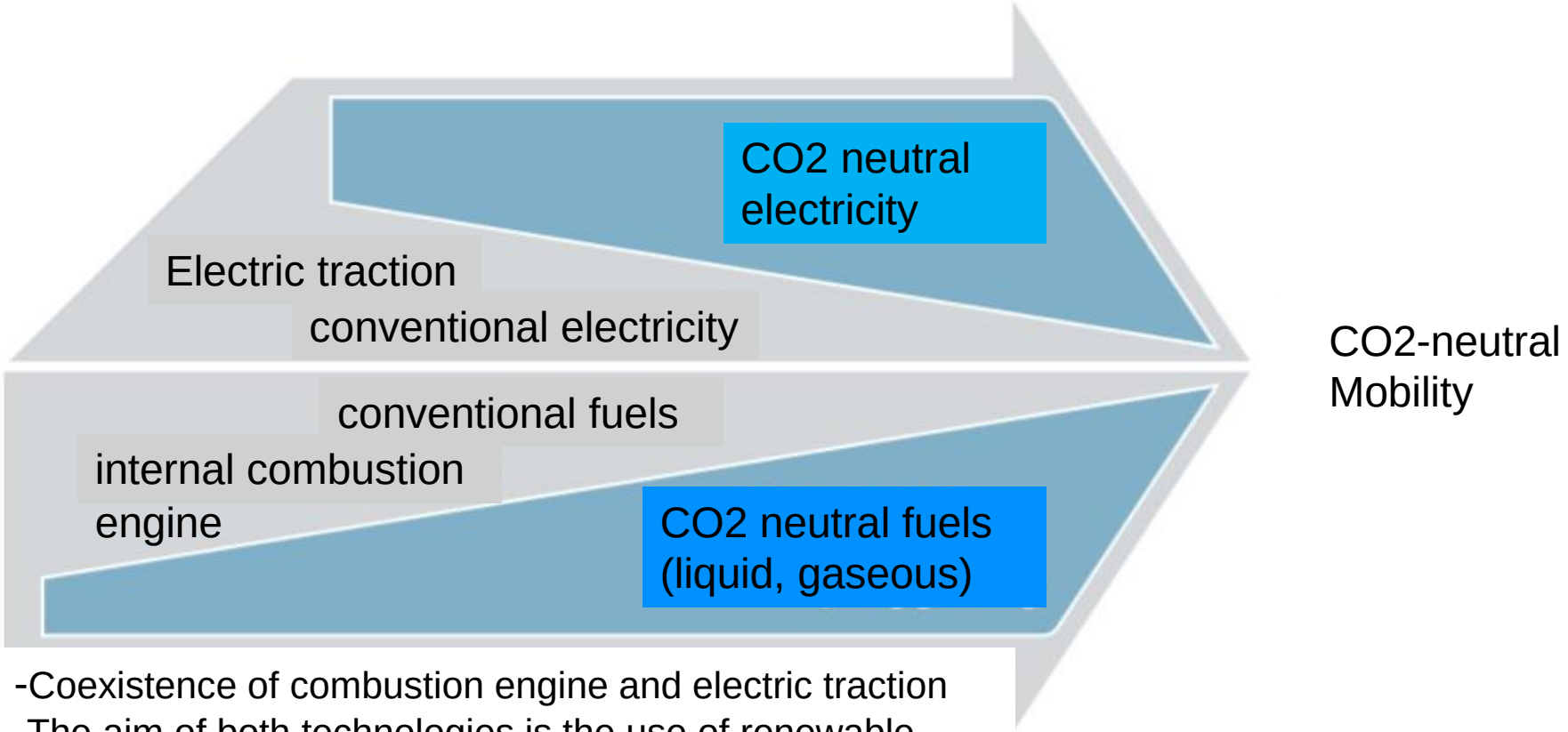
Transition to Renewable Energy for Mobility



-Coexistence of combustion engine and electric traction
-The aim of both technologies is the use of renewable energies

Source: 39. Internationales Wiener Motorensymposium 2018

CO2 life-cycle emissions: conventional, CNG and electric vehicles

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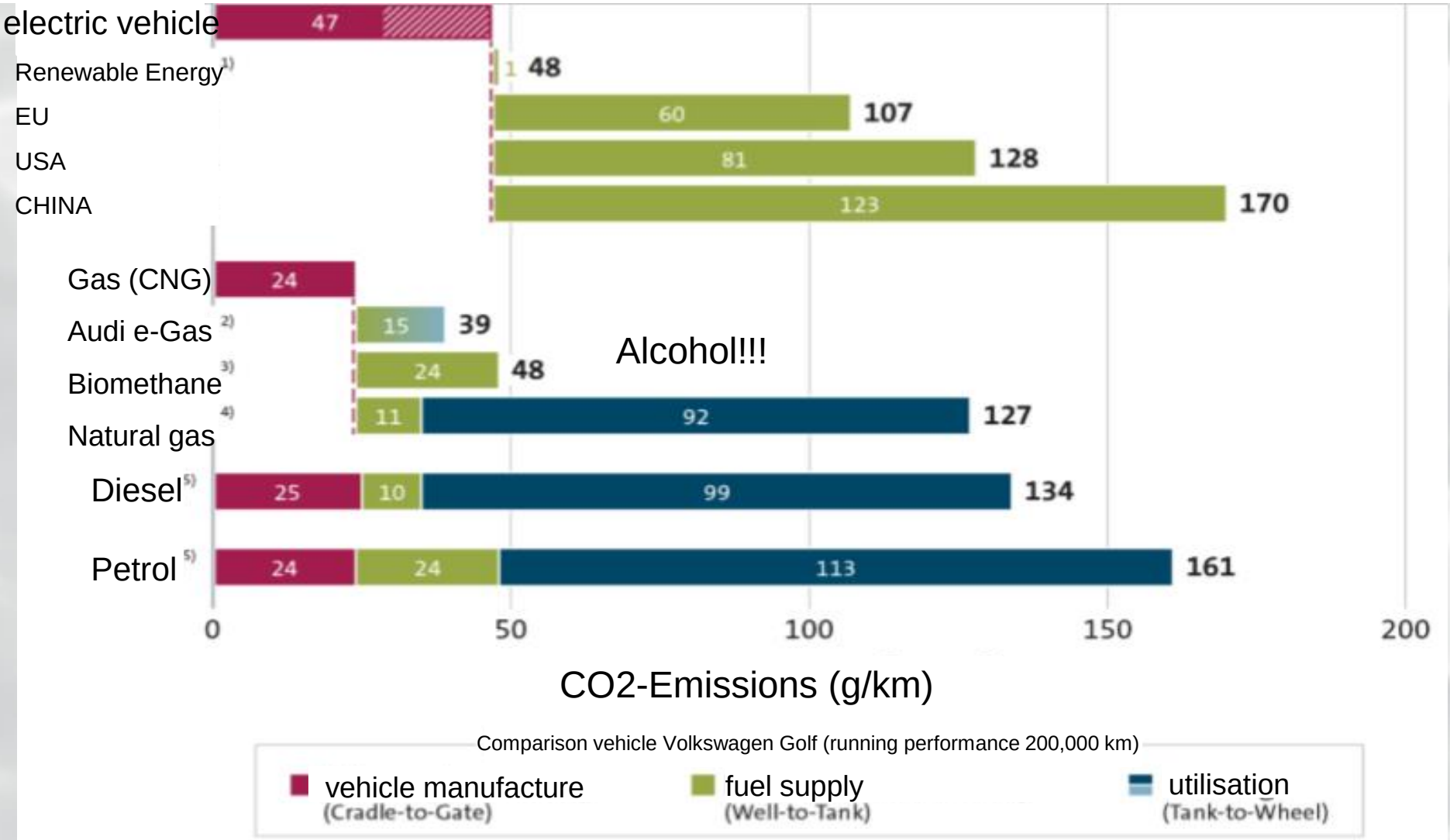
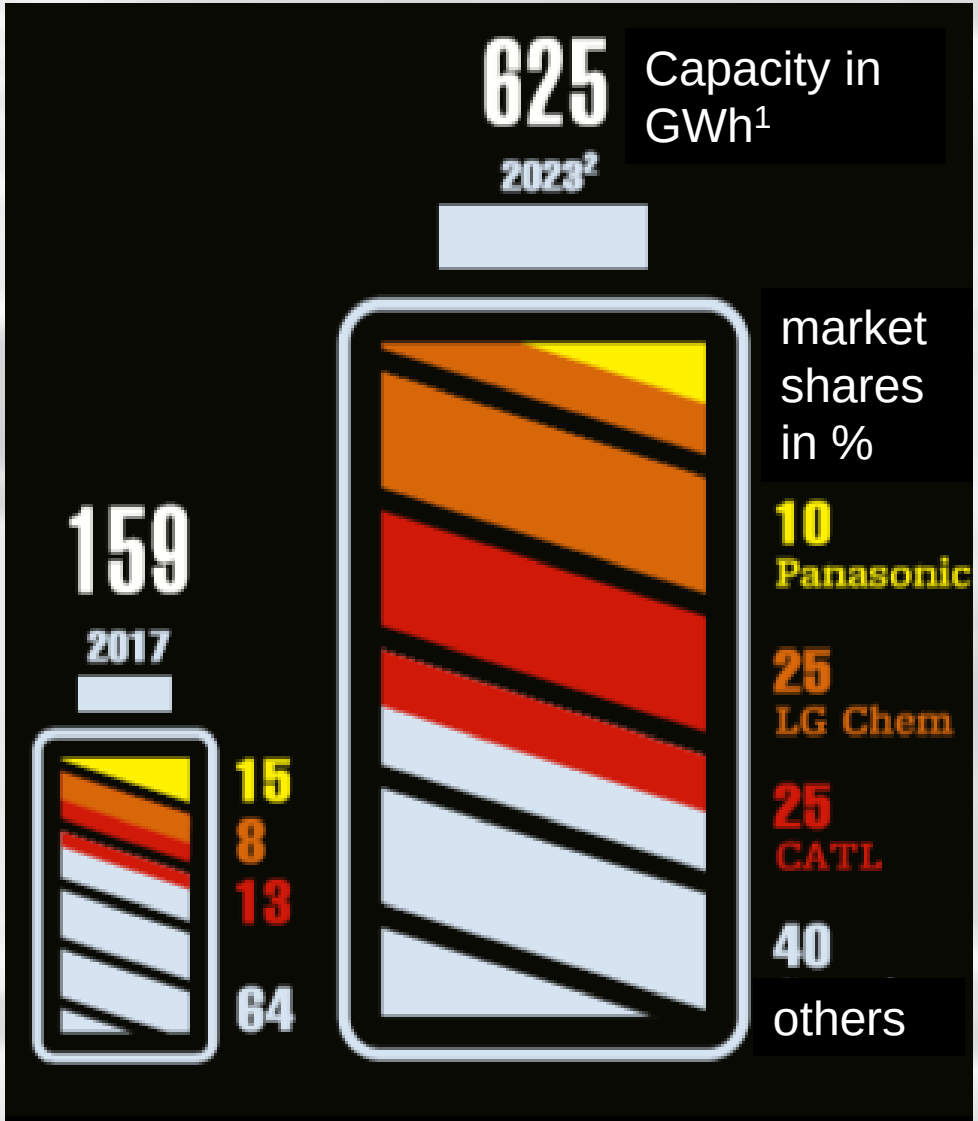


1) Calculated with wind power 2) Methane from wind power using the example of the Audi e-gas plant Werlte 3) Renewable Energy Directive (EU) 4) Assumption BAT: Erdas from Norway without biogas share 5) WtW balance with 7% or 5% bioethanol according to EN 590 and EN 228 specific CO2 reduction of biofuels amounts to 35% according to EU directive 2009/28 EC

Source: 39. Internationales Wiener Motorensymposium 2018

World leader in battery manufacturing



1; gigawatt hours; 2 forecast. Source: Roland Berger, Bernstein Research, mm- Research; Graphic: MM

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Future investments to meet the need for chargers in Billion$

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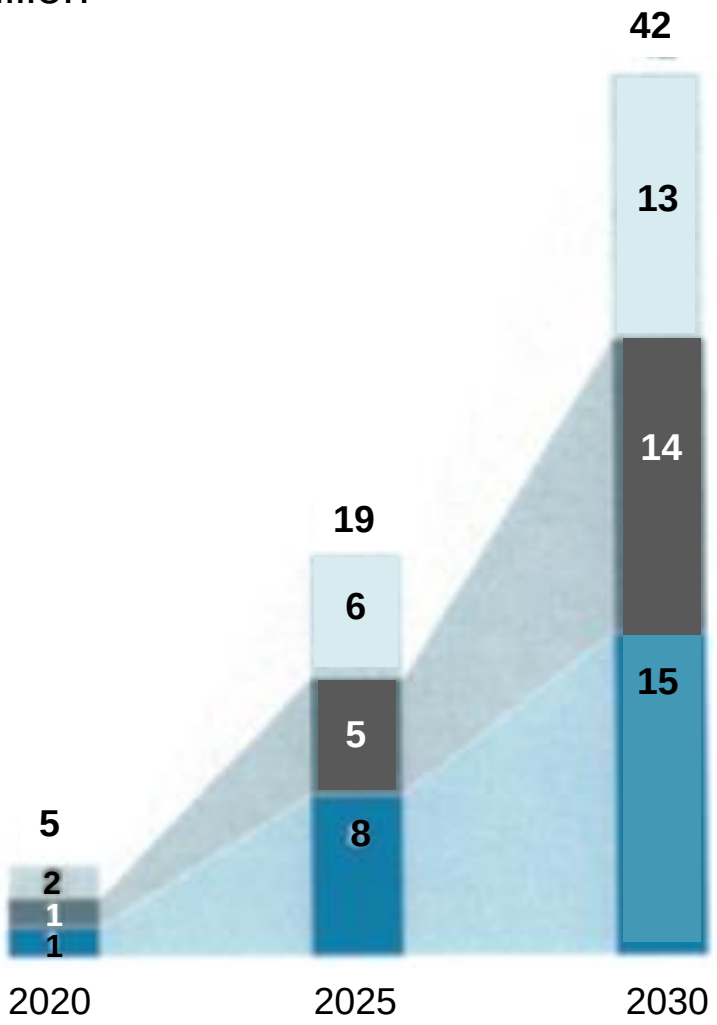
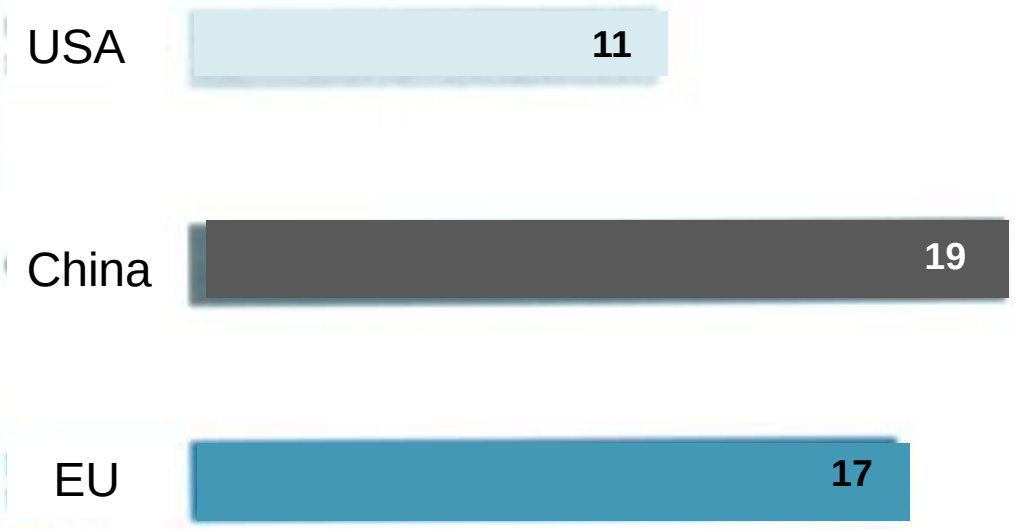
Estimated number of chargers,[1] million



Estimated capital investment, $ billion

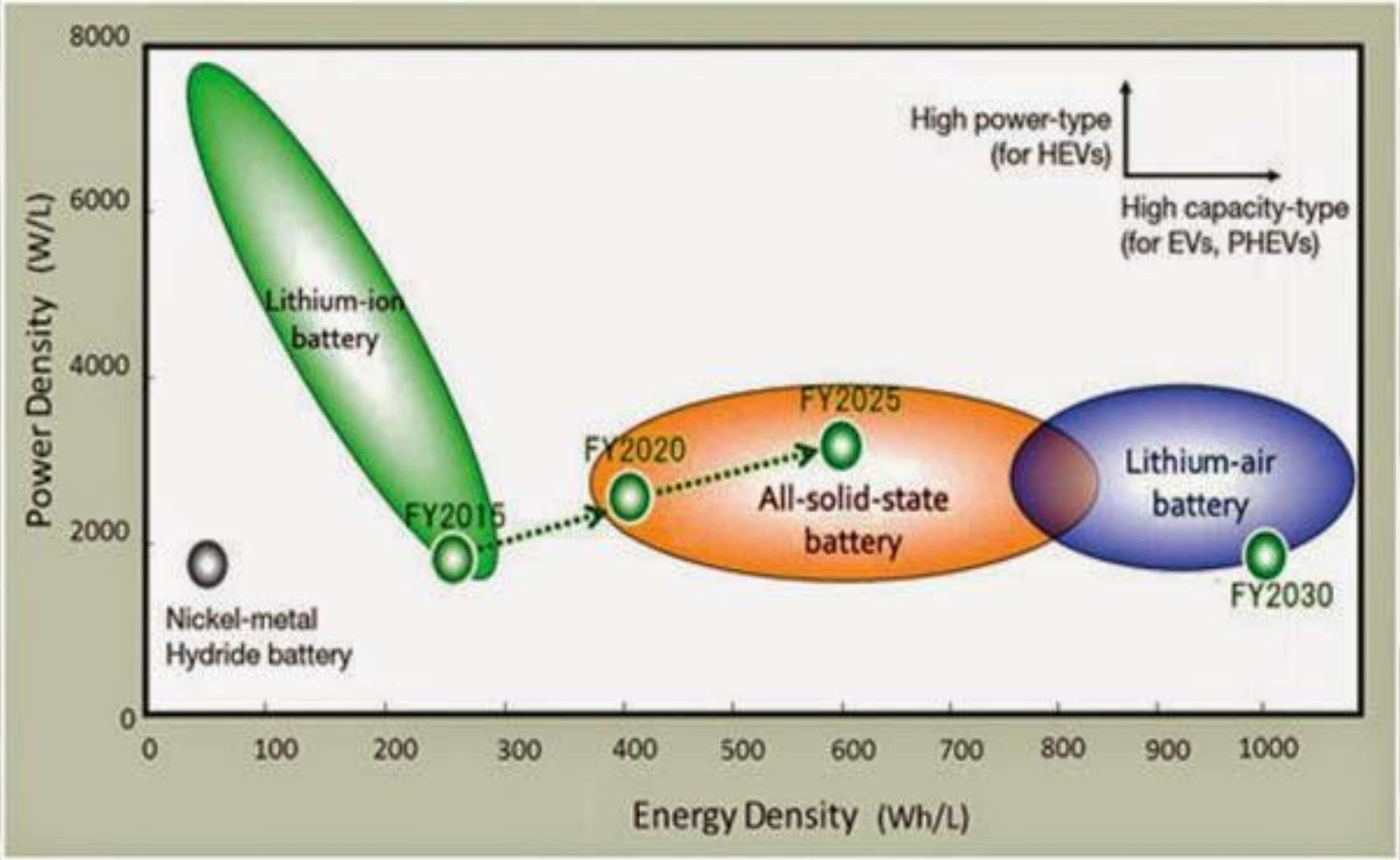


Charging time for 400 km
24 h at 3.6 KW up
12 min. at 350 KW
Target under 10 min.

[1]Figures may not sum, because of rounding

McKinsey&Company

Upcoming battery development steps



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Lithium-ion battery demand by segment

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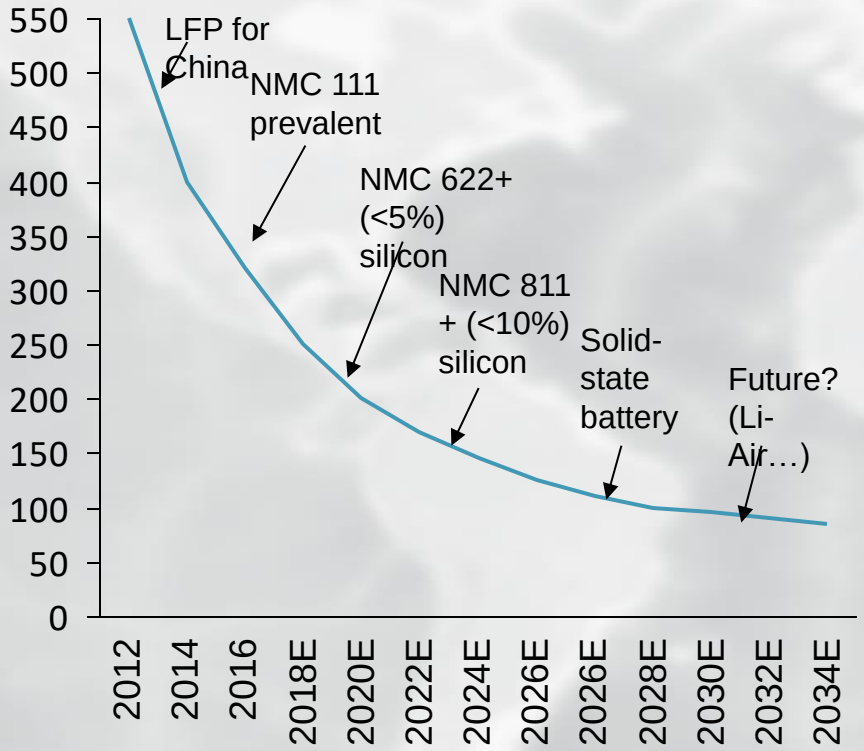
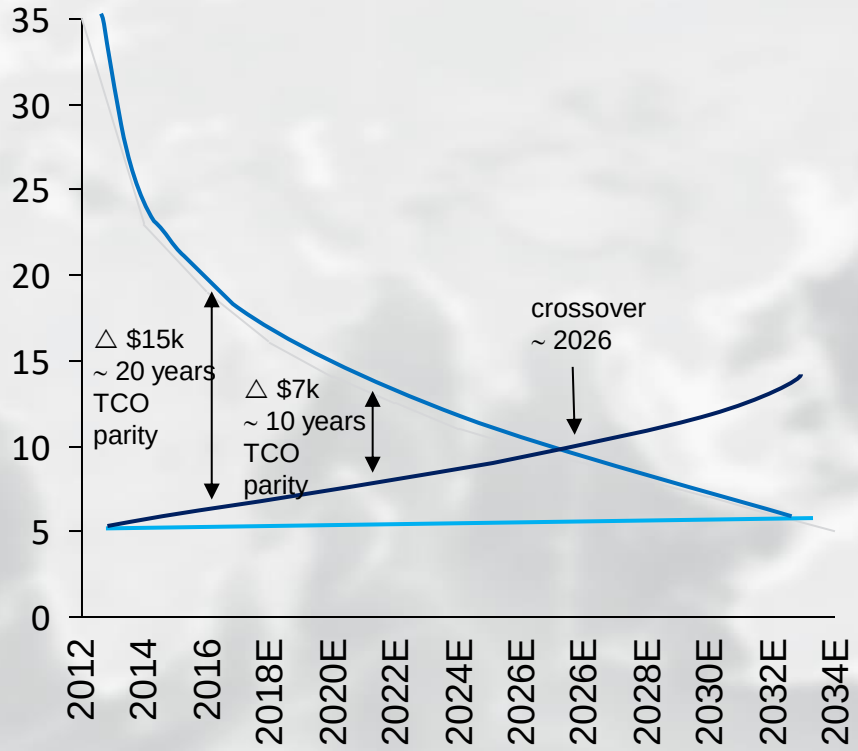
EV battery pack price reduction



- Updated battery pack price projections: New battery technologies lead the cost reductions

Note: Analysis is based on a 60kwh BEV, the cost for an ex-battery powertrain part for an EV is estimated at US$2.000
Sources: Bloomberg L.P., SNE Research, and Bernstein estimates and analysis

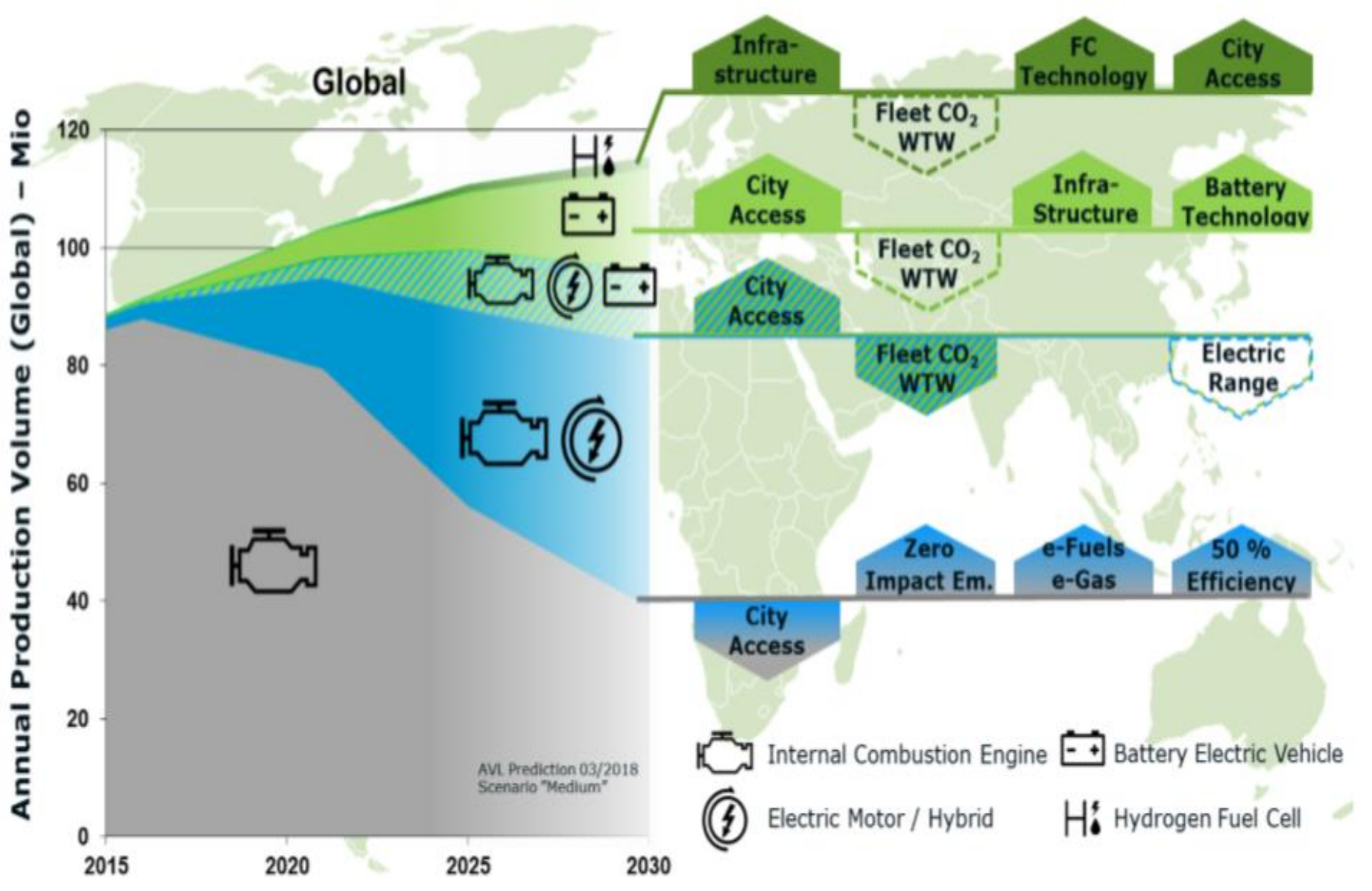
Powertrain cost comparison for 60kWh/500km range (w/o subsidy)



- Technological innovation has historically driven declining battery costs, prediction: this will continue, which will keep improving EV economics

BEV
ICE – aggressive compliance
ICE – poor compliance

Main factors influencing the long-term Global technology distribution



Source: 39. Internationales Wiener Motorensymposium 2018

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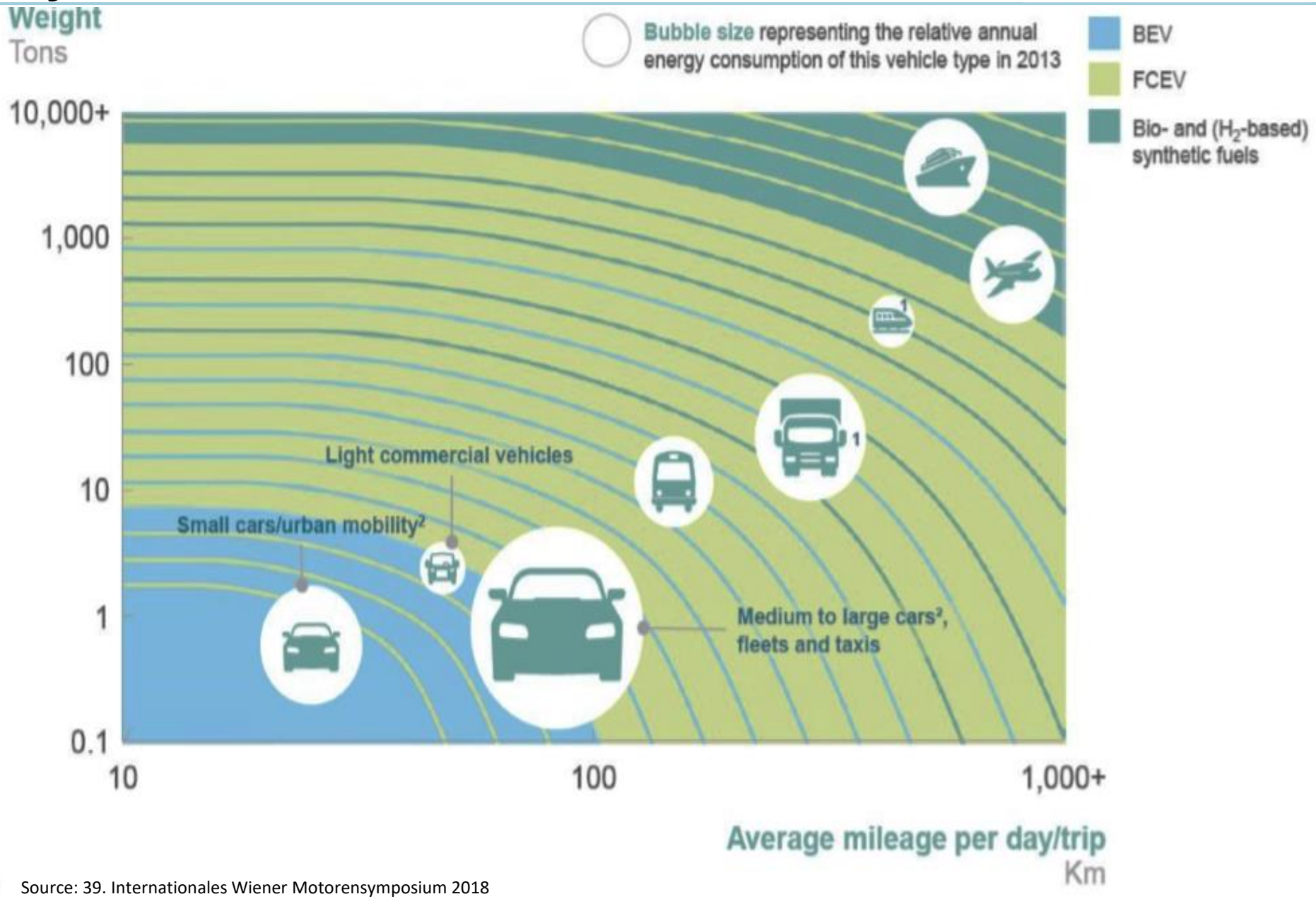
Role of FCEVs in the decarbonized mobility system



Source: 39. Internationales Wiener Motorensymposium 2018

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Way towards zero net-impact emissions of Passenger cars and commercial vehicles.

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2030 — Reduced local emissions

Tank-to-wheel
CO_2-emissions reduction

Reduction of real-world emissions of passenger- and commercial-vehicle fleets

~2040 — Zero local emissions in cities

Emission-free cities[1]

Zero local emissions in urban areas, use-case-based application of combustion motors in suburban and rural areas

2050+ — Zero net-impact emissions

Well-to-wheel
CO_2-emissions reduction[1]

Zero local and zero well-to-wheel emissions through renewable energies for electricity/hydrogen and alternative fuels[2]

[1]Battery electric vehicle, plug-in-hybrid electric vehicle, and fuel-cell electric vehicle as predominant powertrain technologies for cities and urban areas.
[2]For example, synthetic fuels and biofuels.

McKinsey&Company | **Source:** McKinsey Center for Future Mobility analysis

Architecture complexity: consequence of digitalization

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Lines of code

- 2M Hubble Space Telescope
- 5M Mars Curiosity Rover
- 12M Smartphone OS
- 25M F-35 Fighter Jet
- Luxury car software 100M

Traffic deaths worldwide
1.35 million / a
Asia 770
Europe 75
Central / North America 66

- 6 radar beams
- 8 cameras
- 12 parking sensors
- 100+ electrical motors
- 144 electronic control units
- 500 LEDs
- 734 wire harnesses
- 2.400 wires
- 5.000 meters of cables

Cars are more and more developing towards software products, containing already more lines of code than Windows 8 and Mac OS X …

Source: Roland Berger, CarsGuide, High volume global automotive platform

The 2050 Vision

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The 2050 vision includes innovations across powertrain portfolio, business models, technologies, and mobility-type-specific solutions.

Selected examples, by dimension

Sustainable mobility portfolio

We consider multiple power-train solutions, energy supply chains, and ecosystems

- Electric
- Advanced ICE[1]
- Hydrogen
- LNG/CNG[2]

Business-model innovation

We create a framework for offering innovative business models that benefit mobility consumers

- Data driven
- Pay per use
- Carsharing

New technology innovation

We build an ecosystem for leading development and rollout of future high-tech solutions

- Connected cars
- Autonomous driving
- Truck platooning

Targeted solutions for each mobility scenario

We promote development of different mobility and transport solutions and ecosystems for individual requirements

- Seamless and multimodal
- Private autonomy
- Last-mile delivery

[1]Internal-combustion engine.
[2]Liquefied natural gas/compressed natural gas.

McKinsey&Company | **Source:** McKinsey Center for Future Mobility analysis

The 2050 vision for the European mobility Industry.

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Benefits for the mobility customer of 2050

People

- Zero fatalities and accidents
- Individual mobility accessible to up to ~90% of population
- Shift of 50% of commuting time to value-add time
- Mobility companies as best places to work for

Planet

- Zero emissions in cities
- Zero net well-to-wheel emissions
- 20–30% of traffic space transferred into livable spaces
- Optimized traffic flow and 20% less congestion

Profit

- Mobility costs might decrease down to ~€0.10 per km
- Transportation costs could decrease 40% per km due to autonomous vehicles
- Attractive job opportunities with above-average salaries

McKinsey&Company | **Source:** McKinsey Center for Future Mobility analysis

Global Growth of Asian OEMs

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1970's 1980's 1990's 2000's 2010's 2020's

Toyota Crown

Toyota Corolla

Honda Accord

Lexus RX

Toyota Prius

Toyota Corolla

Hyundai Excel

Hyundai Accent

Hyundai Tucson

Kia Cee'd

Hundai Tuscun

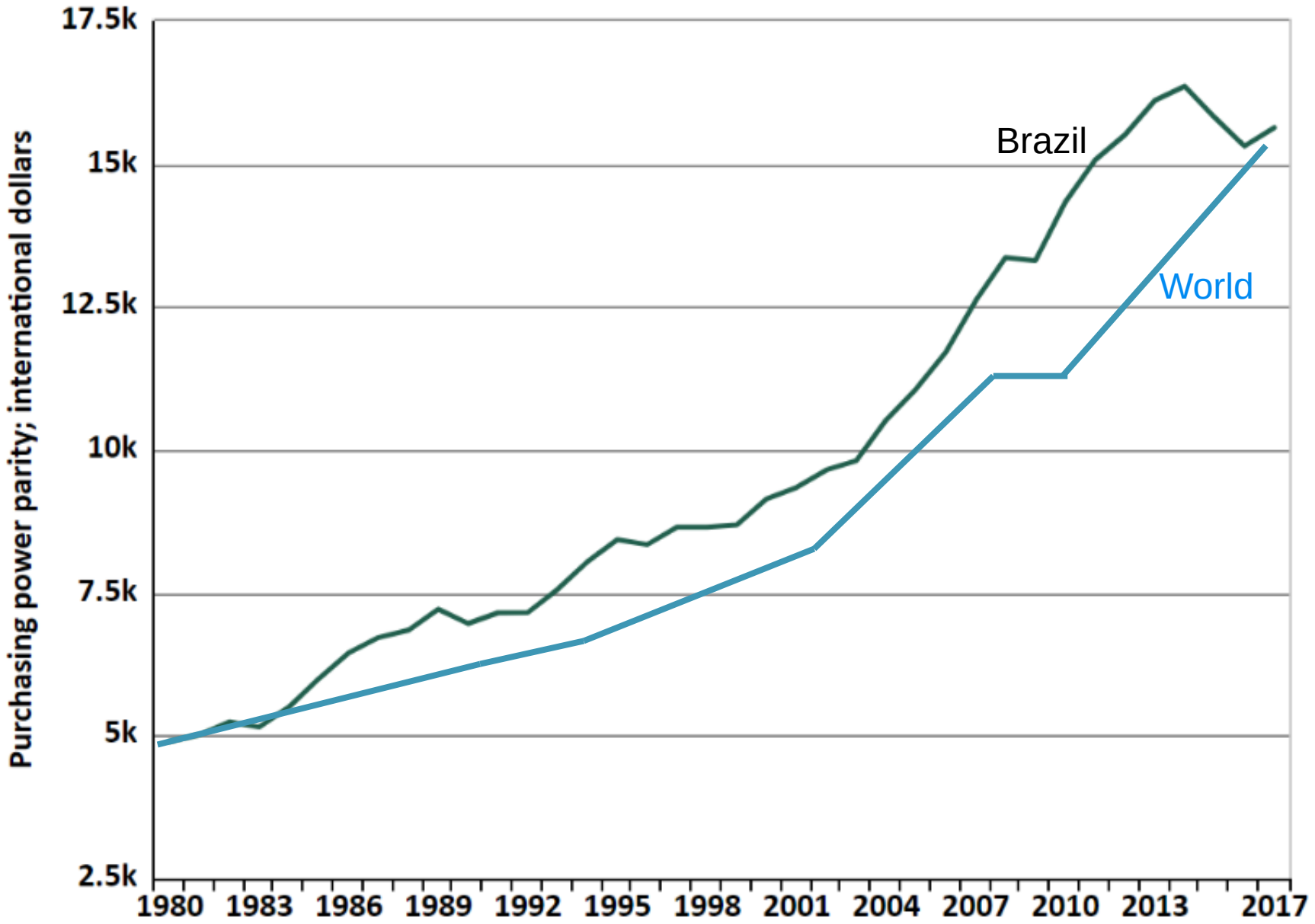
Chery M1 Brazil

Volvo S60

Great Wall Haval H6

Great Wall Deer Mid/East

GDP per capita based on PPP?



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What does that mean for you?

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- Brasil fits perfectly into the environmental trends that will gain even more priority in the next decades (from alcohol as fuel via natural fibers to the general CO2 footprint). Brasil could be a world leader in „green technology“ which will grow and florish and will be a good business. Learn to export it!

- Brasil will be a follower in electrification and automated driving. Just copy.

- Brasil will remain an emerging country that does not allow to successfully copy products developped for the „rich world“ for the local mainstream market.

- There are suppliers in Brasil that earn really good money since the Brasilians are – under good leadership – adopting change faster than most of the world.

- Cooperations will be crucial for the future success of the automotive industry! Be a frontrunner in bundling forces with frienimies. The brasilian cultural openness and moderate pride are key ingredients for success. Demonstrate to your mother companies that it works!!

- Perceived corruption in Brasil is bigger than real corruption. Just continue to act! Off course there are many duties remaining for the „political Brasil“ from pension- to tax- to education reforms, but who is perfect in our world.