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MCKINSEY CENTER FOR FUTURE MOBILITY

An automotive metamorphosis? Adaptation, adoption and autonomy

Singapore | November 2018

www.mckinsey.com/mcfm

Key messages

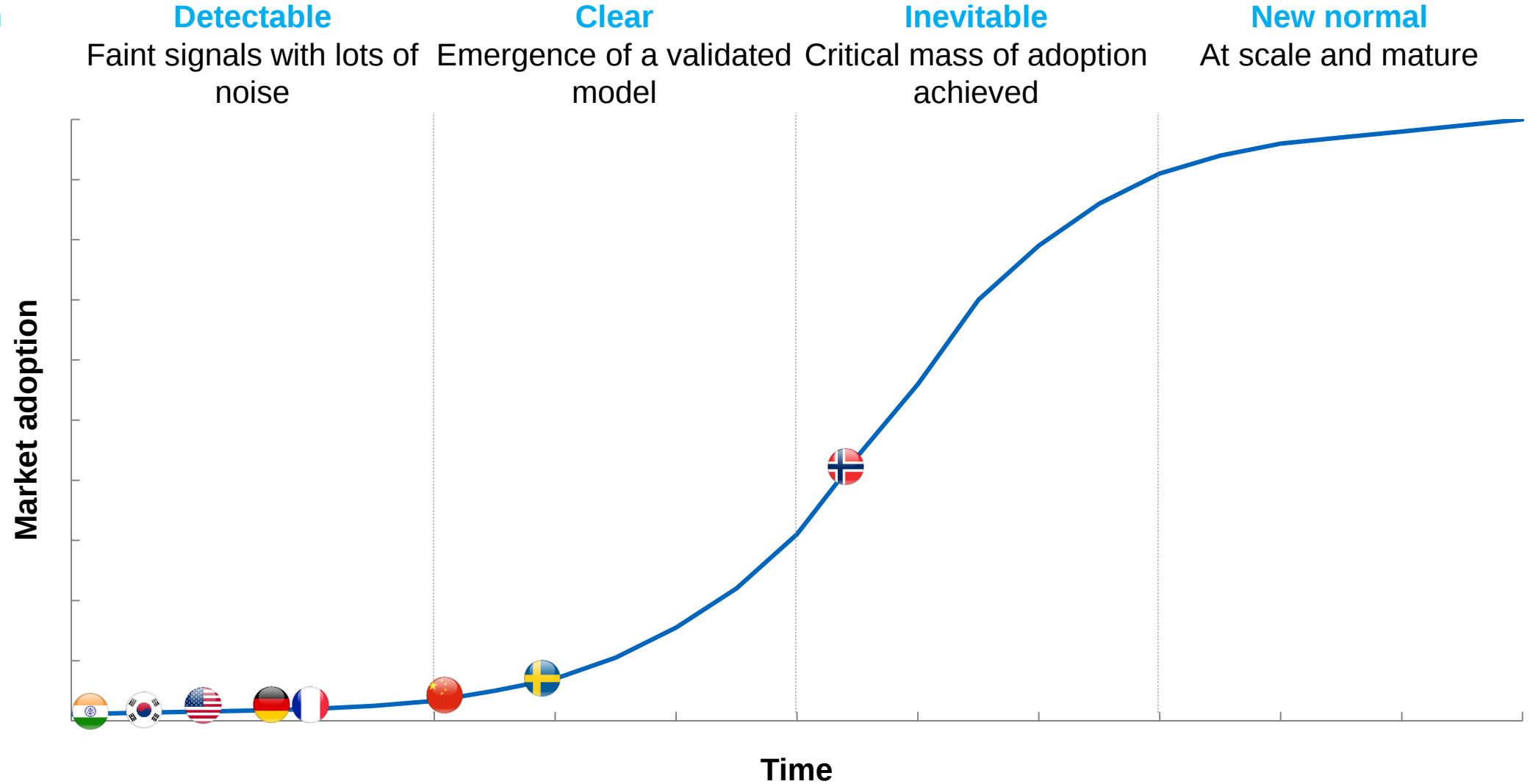
- 1** It is economic story, not environmental – markets in the money today enough to drive the S-curve
- 2** EVs are not a trend in isolation, they are in combination with AVs and Shared vehicles
- 3** Charging infrastructure is the main reason why people are not buying – “chicken and egg”.
- 4** The new business model – selling a “system” not a car, in the future selling mobility
- 5** Asia can lead the revolution – China, penetration in three wheelers etc. in developing countries

1 Electric vehicle sales are increasing at very different speeds around the world

ILLUSTRATIVE

The 4 stages of a disruptive trend – focus on EV market adoption

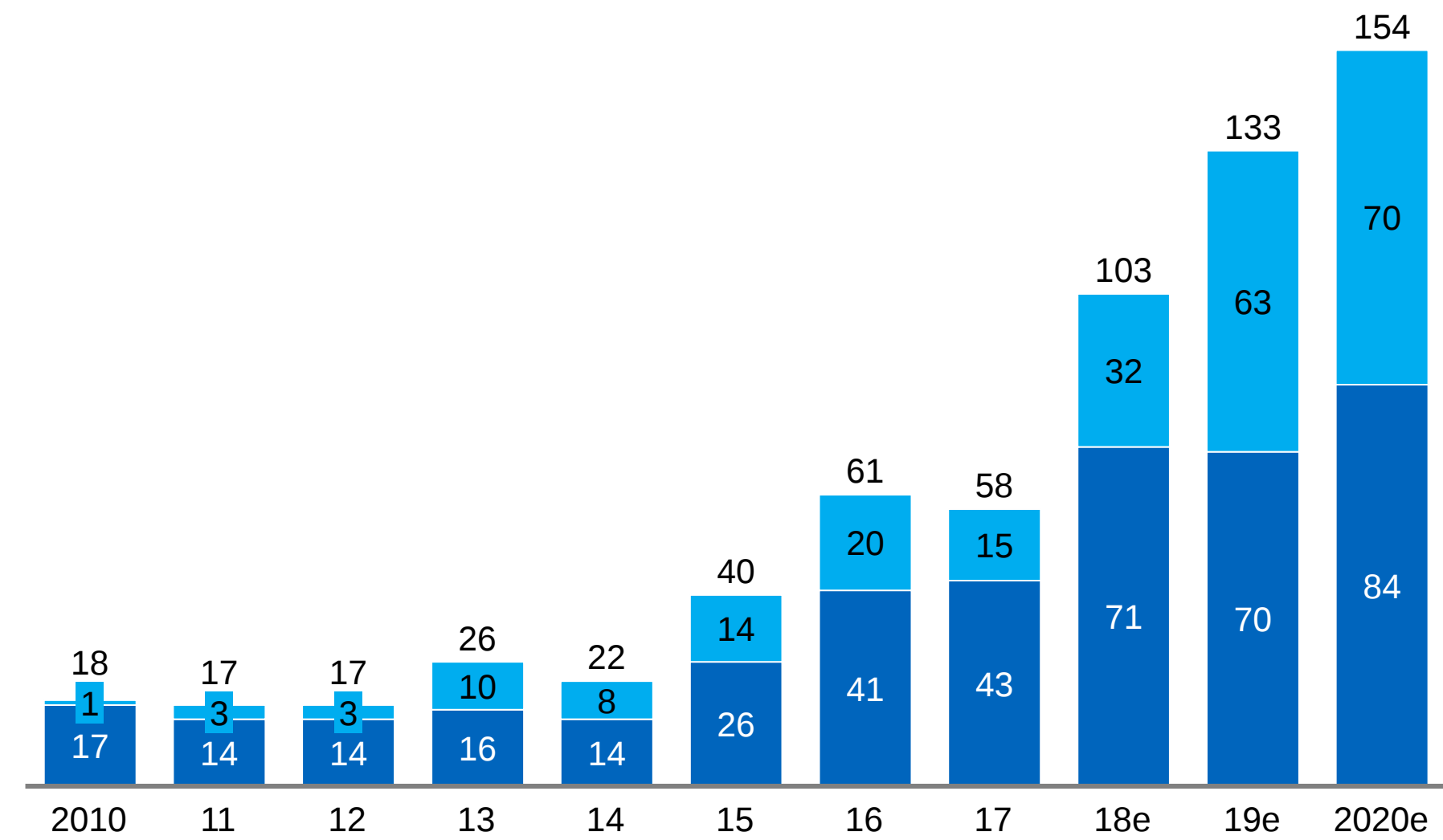
Disruption
is...



1 Electric vehicle launches keep on increasing with almost 300 new models being introduced in the next two years worldwide

■ PHEV ■ BEV

Number of new BEV and PHEV model launches worldwide



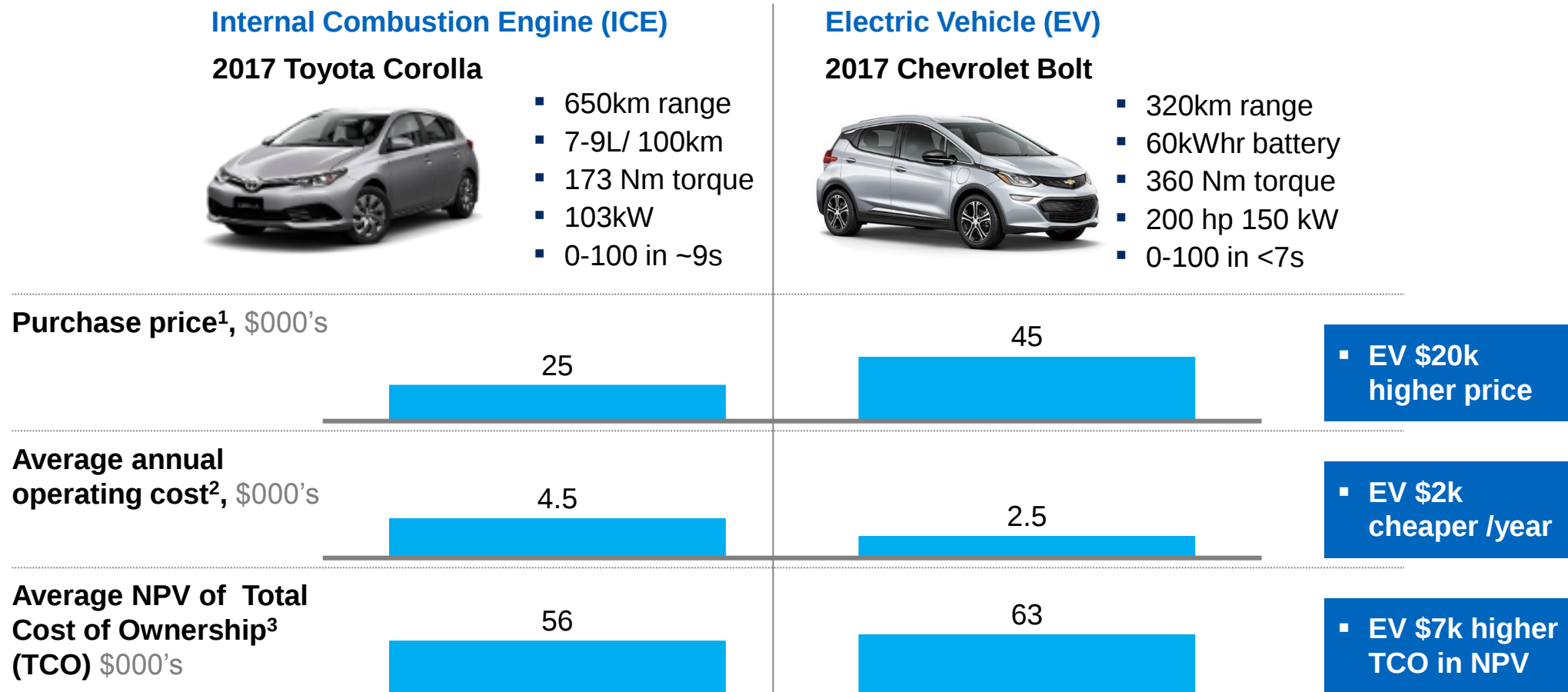
Implications

- Compared to the past few years, significantly more launches of electric vehicles are planned by various manufacturers
- Full-battery EV launches still outnumber plug-in hybrid EVs, though the latter are gaining importance
- Limitations on the supply side are likely to not be an issue anymore in the mid term

1

Let's talk economics – although the average consumer does not yet have a TCO benefit from an EV...

EXAMPLE AUSTRALIA



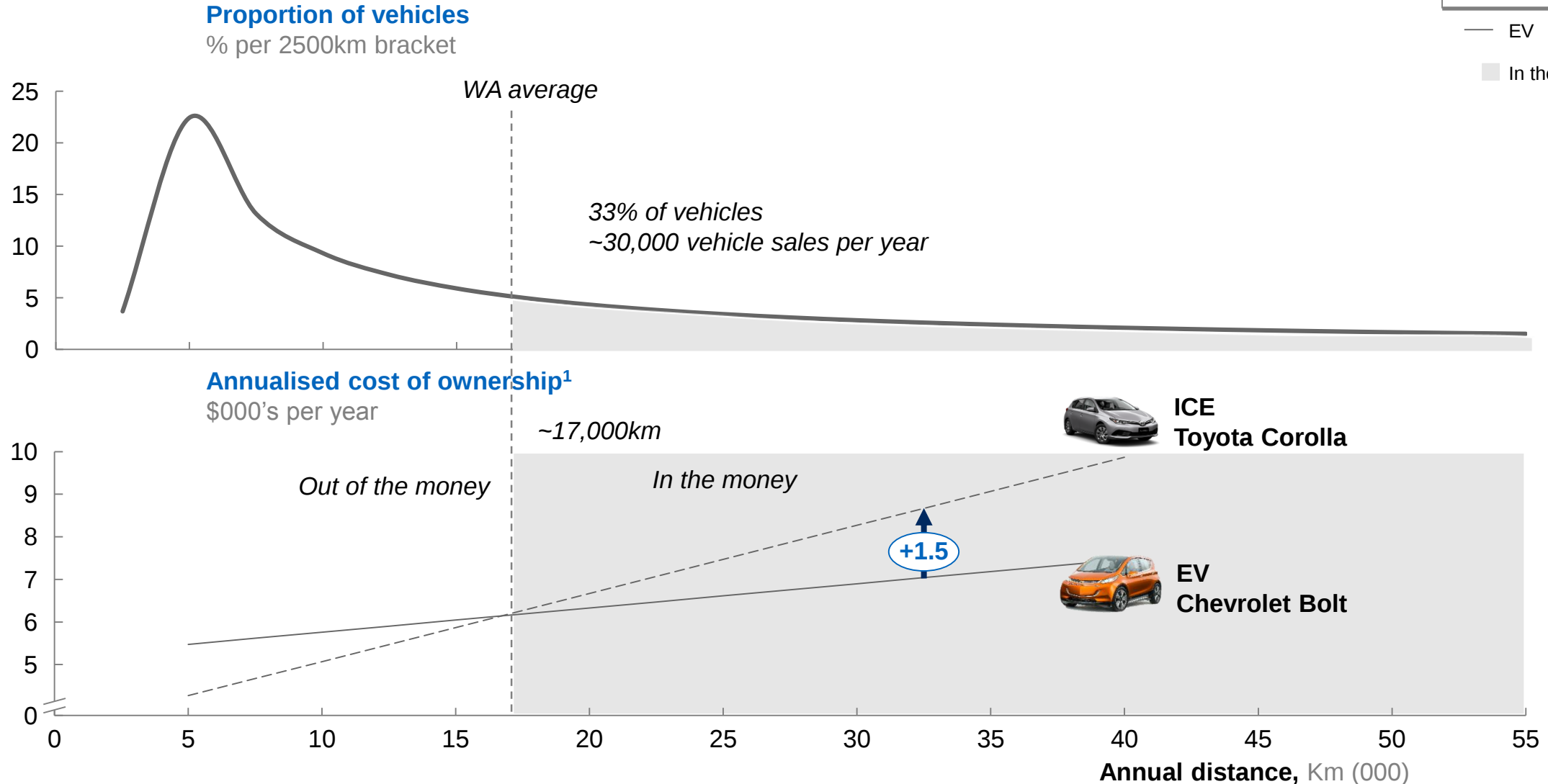
¹ US prices scaled to Australian dollars; ² Assumptions of \$1.35/L for unleaded petrol, 20c/kwh for grid electricity (25% coming from decentralised solar @7c/kwh and 75% from the grid at 25c/kwh); ³ 10 year life span, residual value based on Redbook, 7% finance rate

SOURCE: <http://gmauthority.com/blog/gm/chevrolet/chevrolet-bolt-ev/2017-bolt/>
<http://www.zeroto60times.com/vehicle-make/toyota-0-60-mph-times/> <http://www3.toyota.com.au/corolla/specifications/ascent-sedan-manual>

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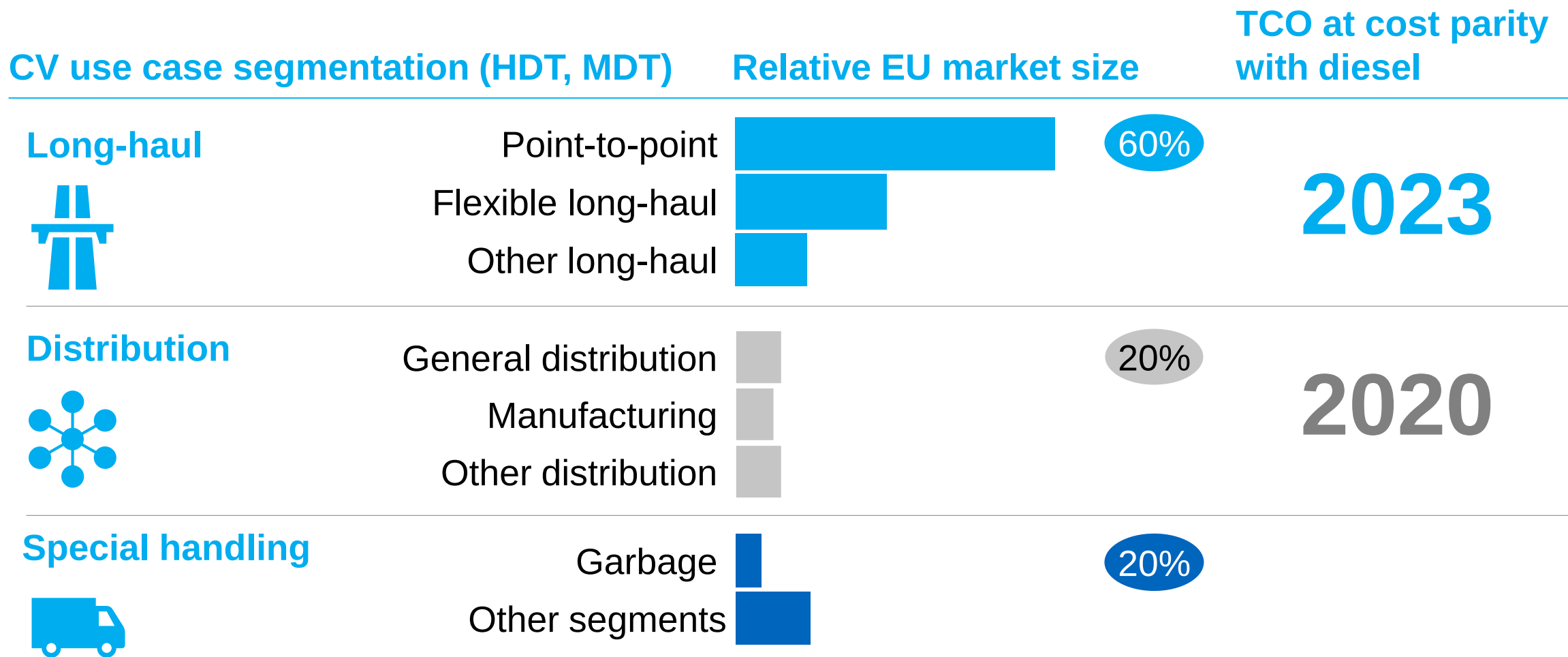
It's not the average consumer that counts - in this case, 30% of consumers are already be in the money buying an EV, the average EV driver would save annualised \$1.5k/year

EXAMPLE AUSTRALIA



1 Central assumptions of \$1.35/L for unleaded petrol, 20c/kwh for grid electricity (25% coming from decentralised solar @7c/kwh and 75% from the grid at 25c/kwh), 10 year life span, residual value based on Redbook, 7% finance rate; 2 ICE models chosen as close performance and segment substitutes; 3 WA car sales in 2015

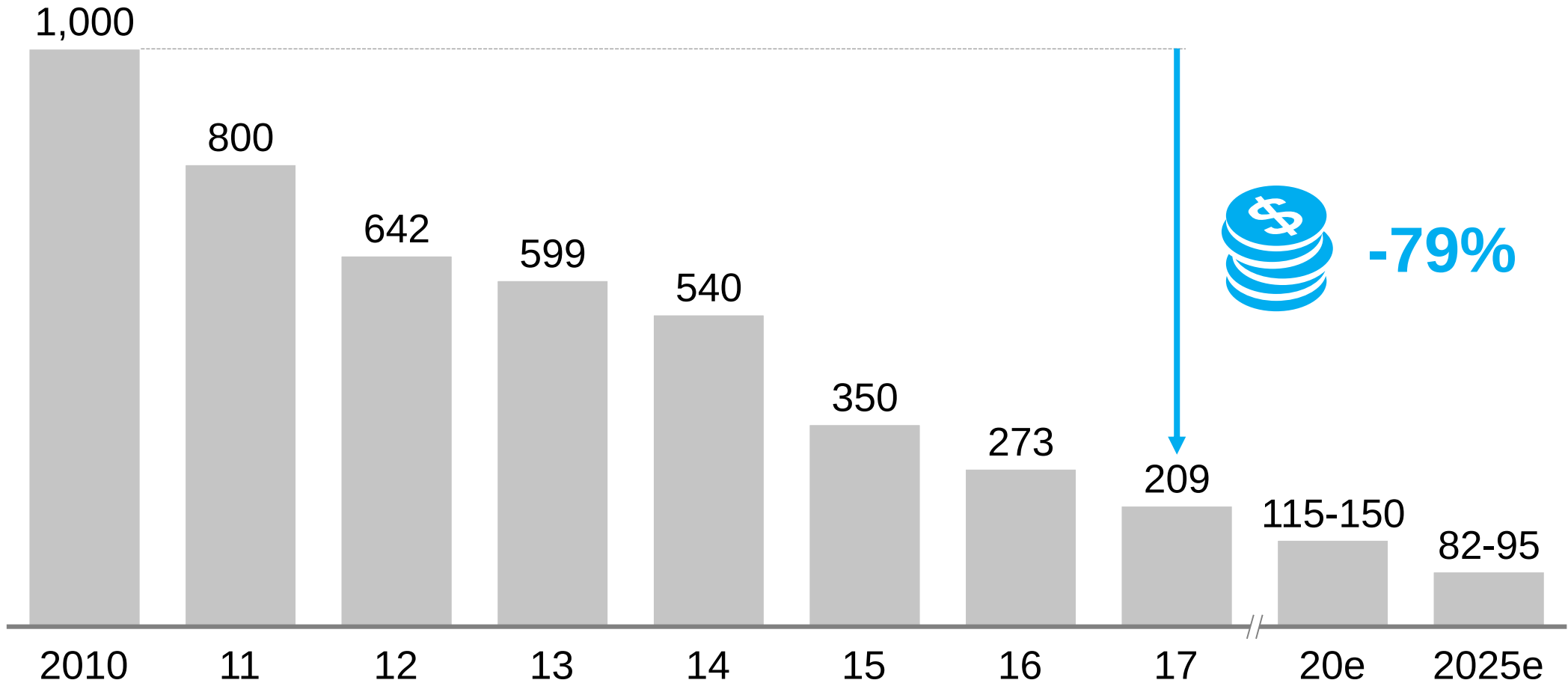
1 Electrification for commercial vehicles is approaching a clear tipping point with specific use cases breaking even with diesel over the next years



Trigger points: regulation, toll, battery technology, TCO, charging infrastructure, NLR

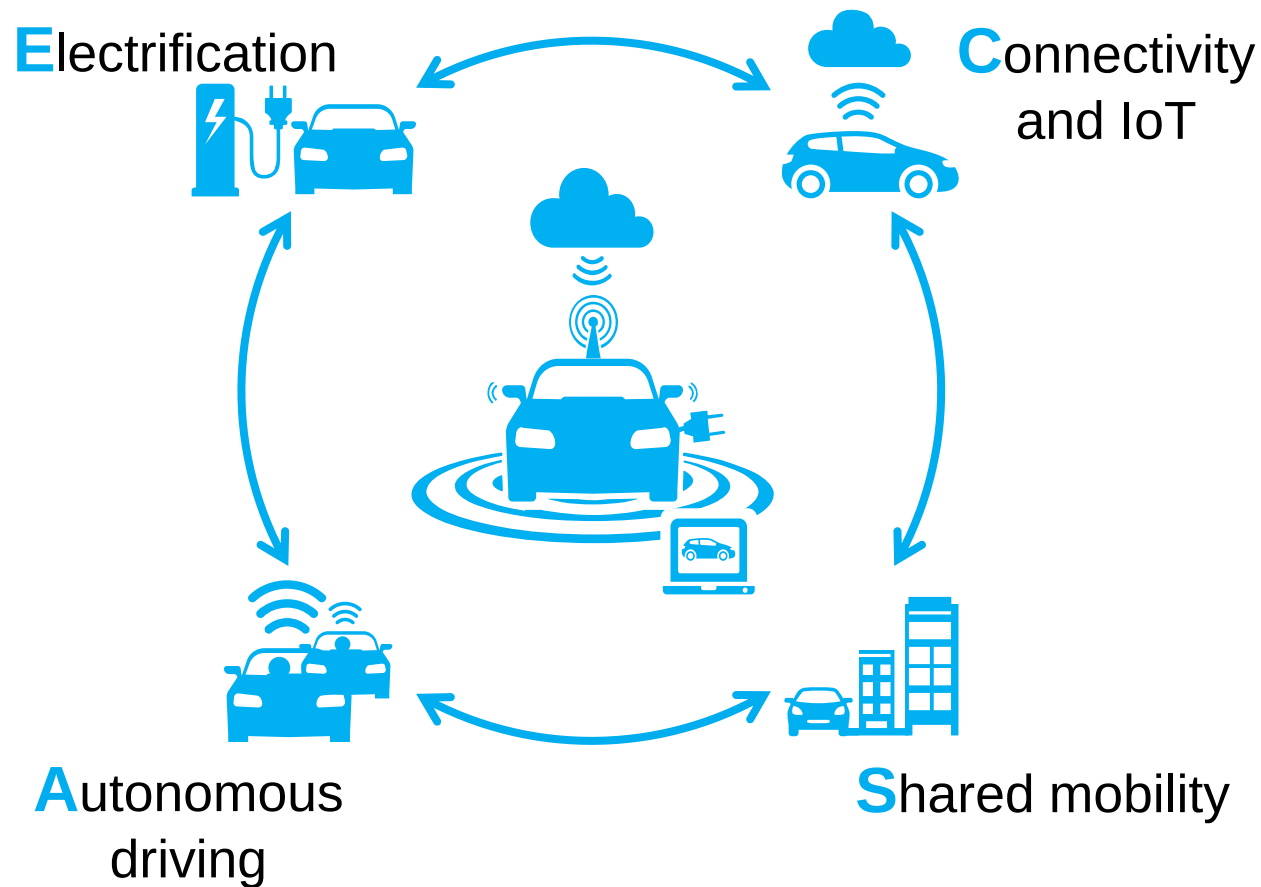
1 Lithium-ion battery pack prices keep on decreasing

Lithium-ion battery pack price development, USD/kWh



2

Four disruptive technology-driven trends...



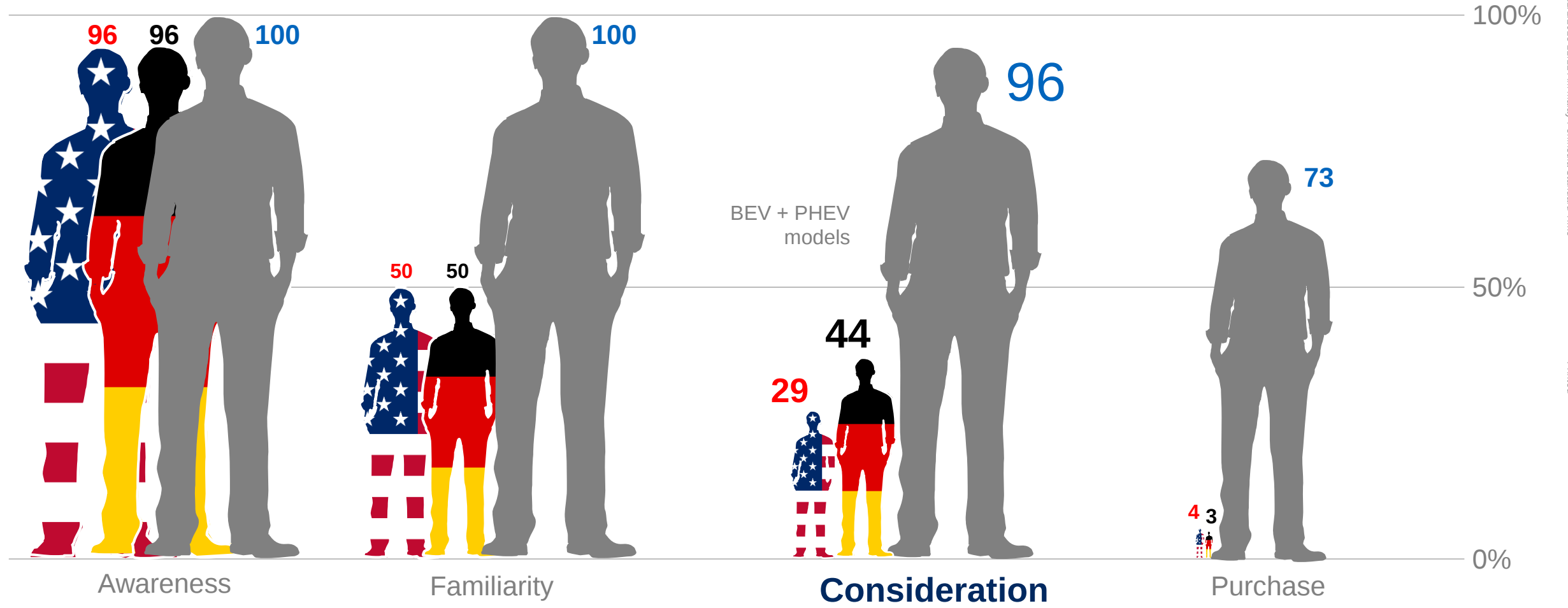
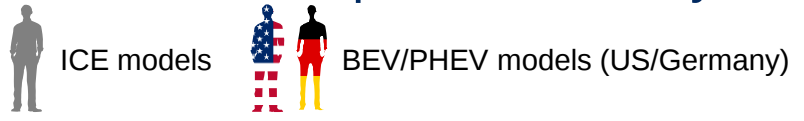
... radically changing the mobility industry

- Changes in mobility behavior
- Shifting markets and revenue pools
- Diffusion of advanced technology
- New competition and cooperation

39% of Chinese consumers do not think it is necessary anymore to own a car given the alternatives

3 Between 30 and 45% of vehicle buyers in the US and Germany consider an EV purchase today

Percentage of responses US and Germany, 2016

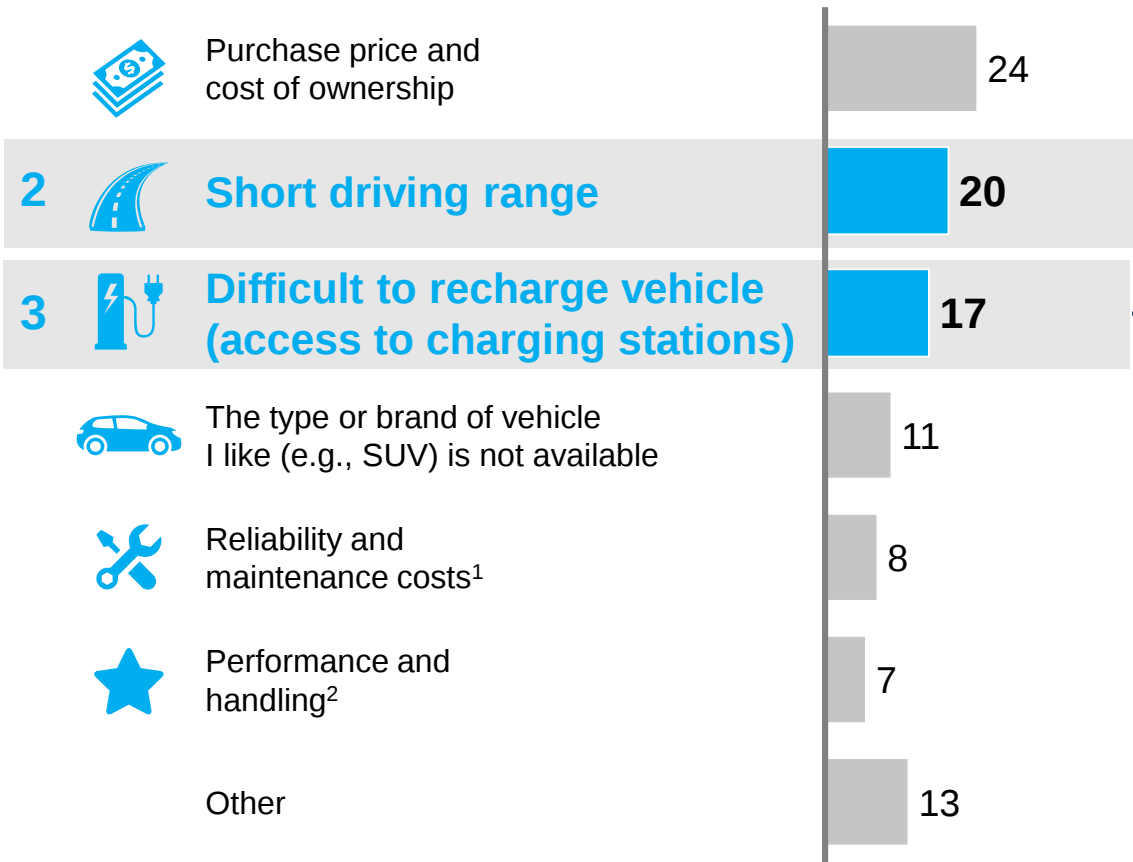


3 Some perceived customer concerns of electric vehicles are not issues during ownership

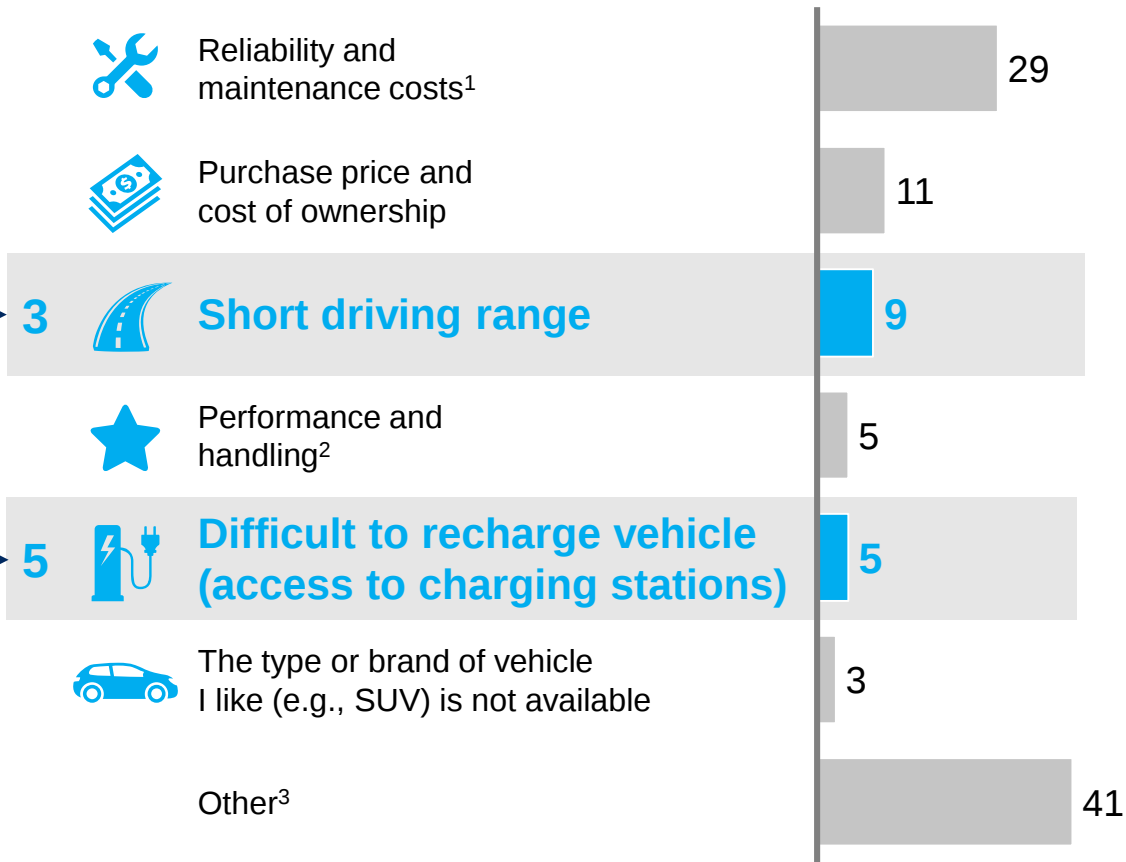
% of survey respondents



Top purchase barriers for BEV considerers...



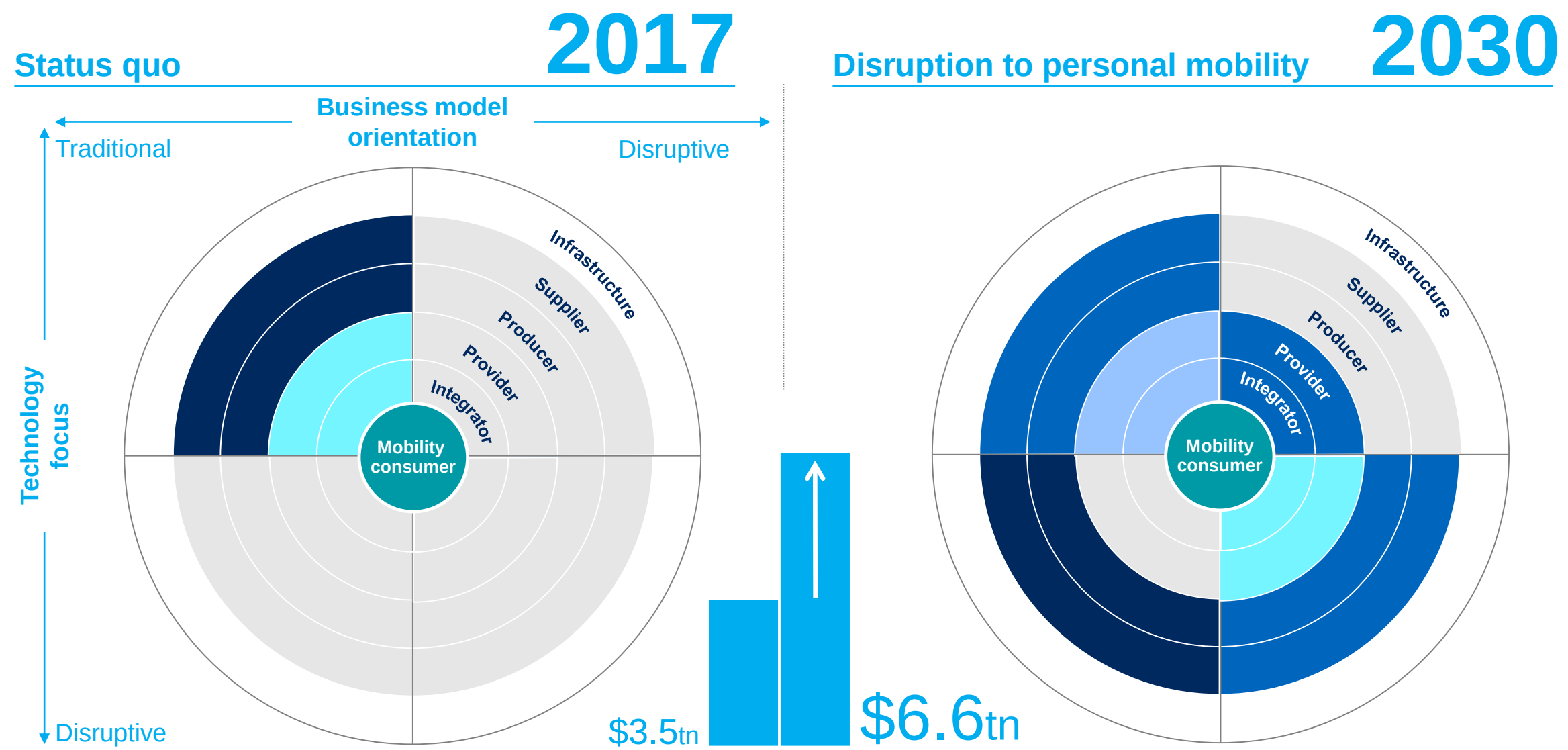
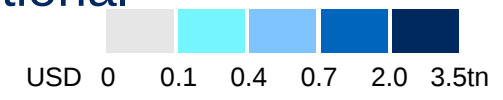
... are not aligned with concerns of BEV owners



1 Includes "maintenance cost" and "battery pack reliability"
2 Includes "poor power/acceleration performance" and "not fun to drive"

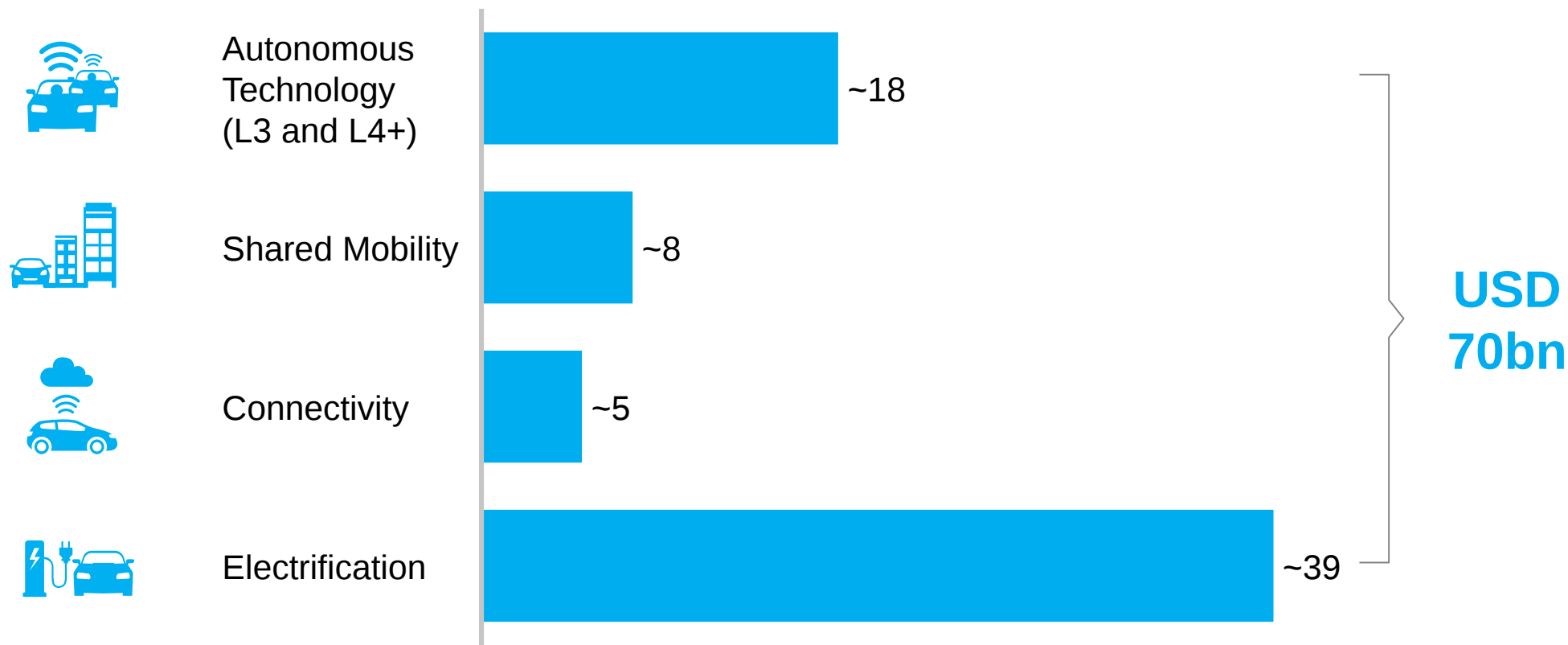
3 Price of electricity (11%), reduced range when running accessories (8%), time to charge battery (8%), service availability (7%), I don't understand/trust the technology (5%)

4 Today, the industry revenue comes from traditional business models and traditional technology while by 2030 it will be divided across many more areas



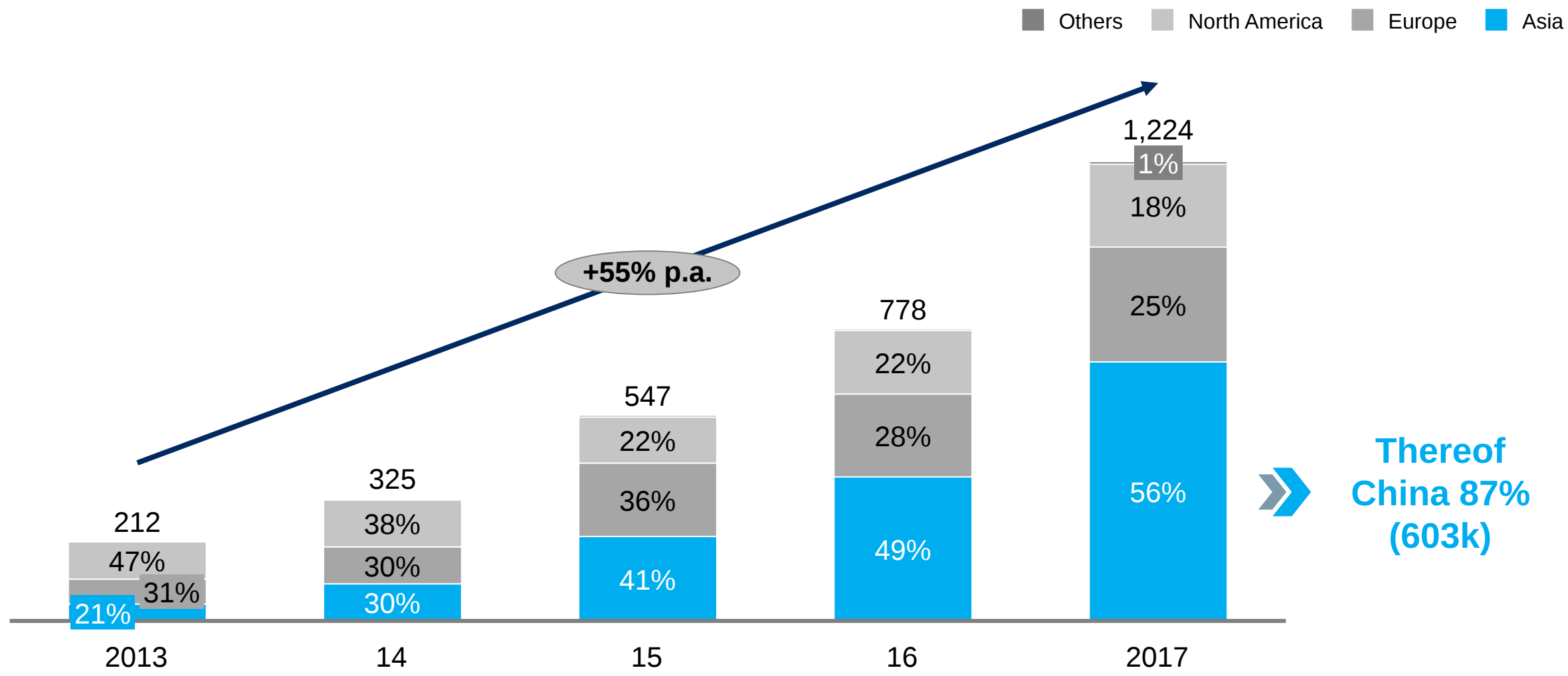
4 To participate across all new technologies, individual players will struggle to invest a required USD 70 bn over the next 10 years

Expected investment volume required for a “fully integrated mobility player”, USD bn



5 Asia continues to expand its global market share in EV sales now combining 690,000 units

Global light electric vehicle sales by region, 2010-2017 in thousand units



1 China, Japan, South Korea, Hong Kong, Taiwan, Malaysia, Sri Lanka, Thailand, Indonesia, Singapore, India, Philippines 2 EU28 + Norway and Switzerland 3 USA and Canada

5 China is positioning itself as a lead market for e-mobility



61

Chinese brands selling EVs in 2018 in China

5mn

Charging poles by 2020

5.5bn

government subsidies in China on EV in 2017 in USD

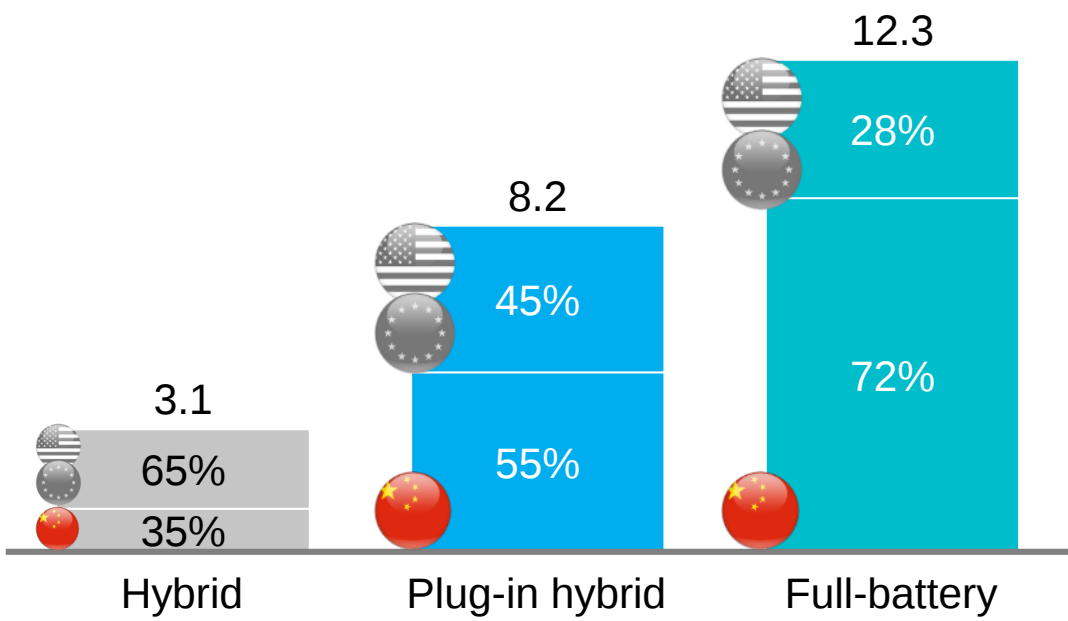
68%

China share of global refined Cobalt production in 2017

>60%

China share of global Li-Ion capacities in 2028

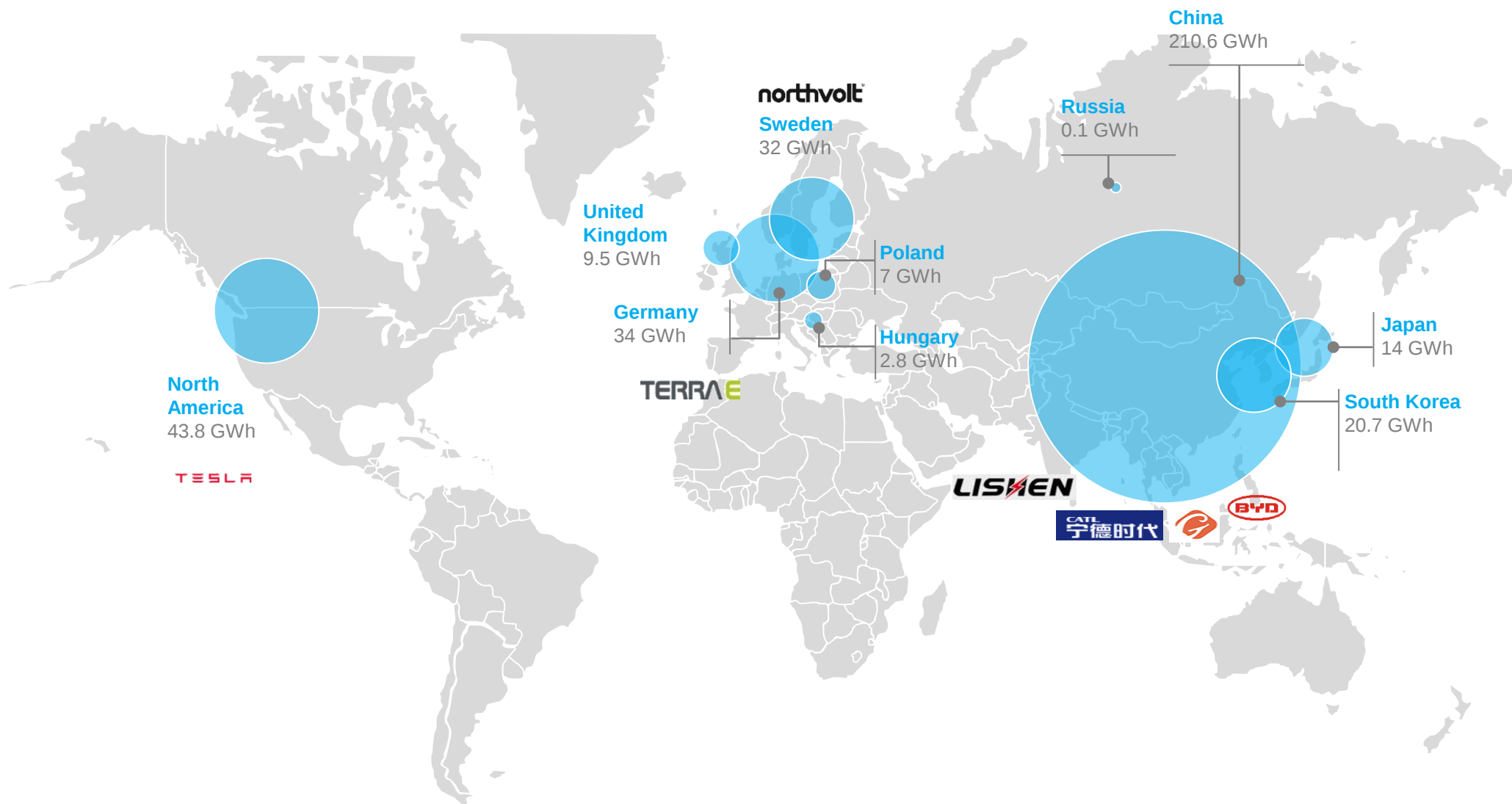
New vehicle sales by powertrain type
K units, Base case 2030, Europe, US, China combined



~60%

China share of global EV sales across all 3 categories

5 Battery manufacturing capacity is expected to reach ~370 GWh by 2028, mostly driven by China



Notes: Benchmark estimates; not all data disclosed by companies; 2 GWh production capacity for rest of world

SOURCE: Visual Capitalist; Benchmark Mineral Intelligence; press search

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The background of the slide is a dark blue gradient with a faint, semi-transparent image of a speedometer. The speedometer has a needle pointing towards the 200 mark, and the numbers 160, 200, and 240 are visible on the dial. The overall aesthetic is technical and modern.

Back-ups

Over the past 2 years, significant additional momentum has been built along all four disruptive trends

Autonomous driving



80% of the top 10 OEMs plan to have **highly autonomous technology** by 2025

Connectivity



40% of consumers would **change** the **car brand** for better connectivity (+20 pp vs 2014)

Electrification



>40% of models announced **until 2021** will have **xEV** powertrains

Shared mobility

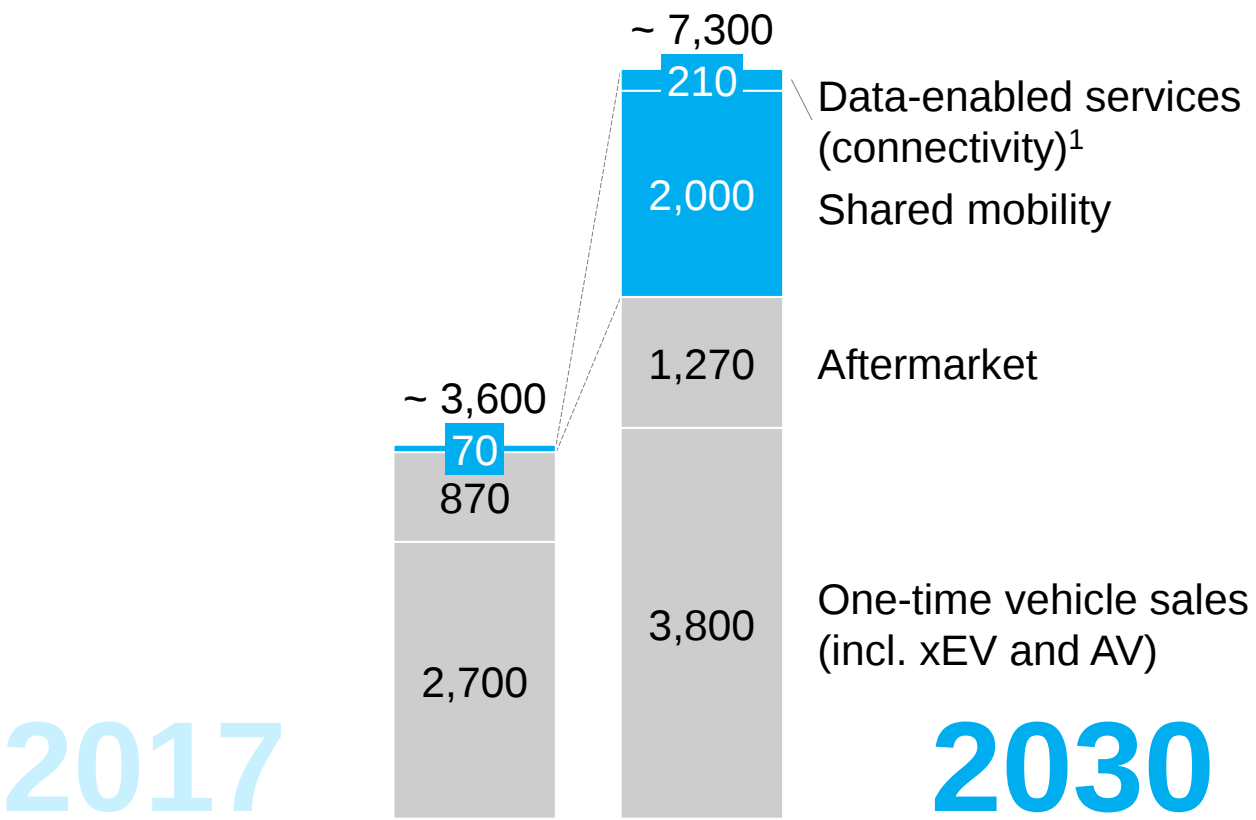


At least **\$32 billion** have been invested in **ridesharing start-ups**

With disruptive scenarios becoming more likely, the share of revenues from disruptive business models could increase to 20-25% by 2030

Automotive revenues based on consumer spend in 2017 and 2030

"Disruption to personal mobility" scenario, \$ bn



The world we have to believe in for this scenario

Examples

80-90% ridesharing mobile app adoption on smartphones globally

10x growth in rideshare vehicle miles travelled, with shared mobility accounting for **up to 20% in dense cities**

100% connectivity saturation by 2021 and **robotaxis covering 6%** of passenger miles travelled by 2030

~50% of vehicles sold are electrified and many regulators only allow PHEV/BEV in new cars

¹ Revenues only, not comprising cost saving potentials
SOURCE: McKinsey Center for Future Mobility

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① Macroeconomics



③ Regulation and incentives



② Technology

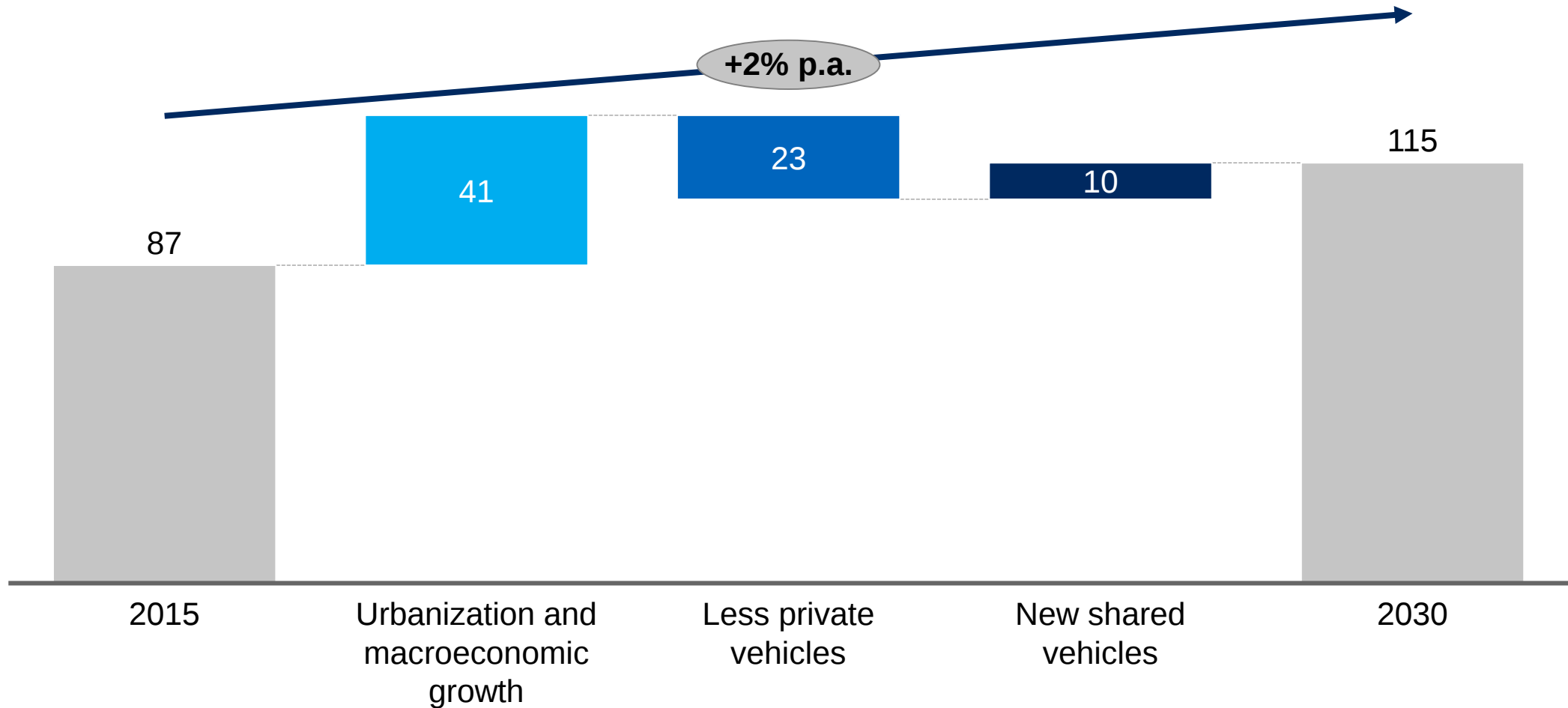


④ Customer demand



1 Vehicle growth until 2030 is driven by urbanization and shared mobility, which favor the roll-out of electric vehicles

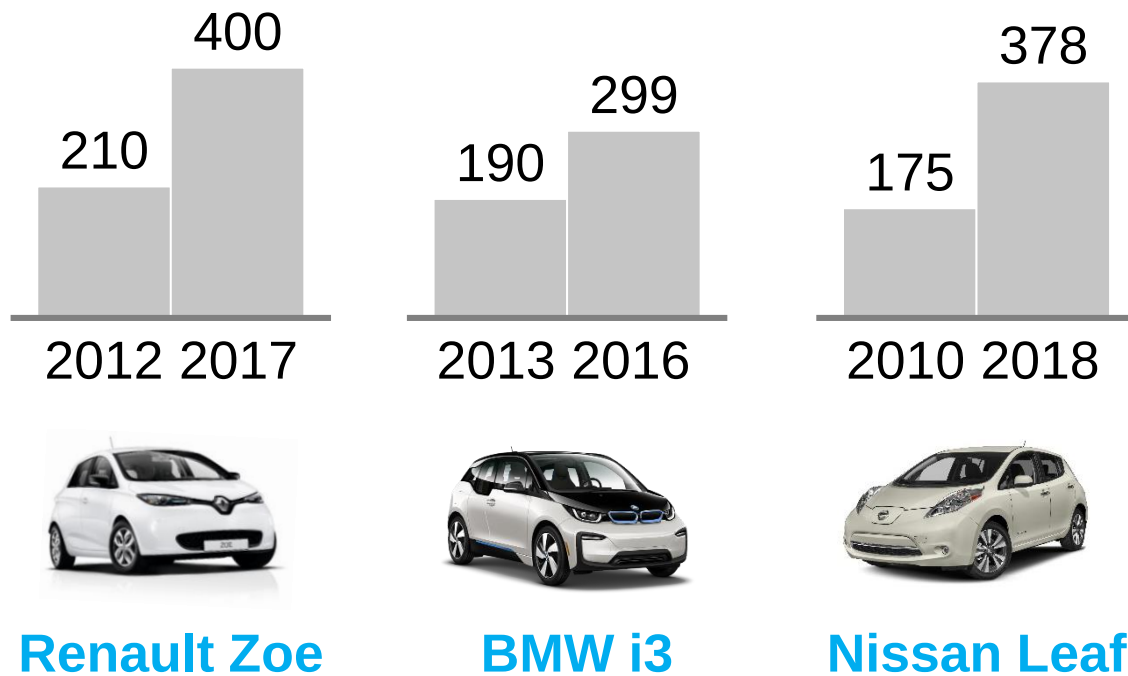
Current and future annual global vehicle sales, millions



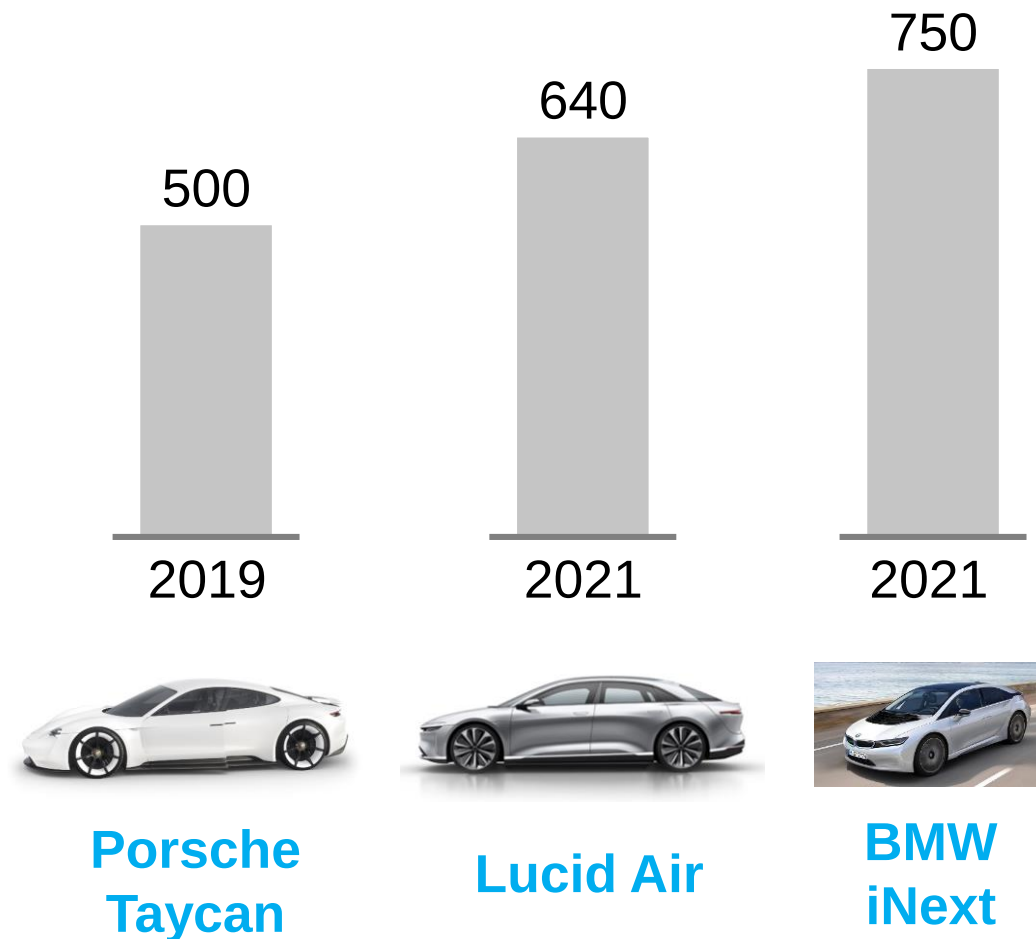
2 Advances in battery technology go in line with a range increase

Electric driving range by model year in km (NEDC)

Updated models



New launches



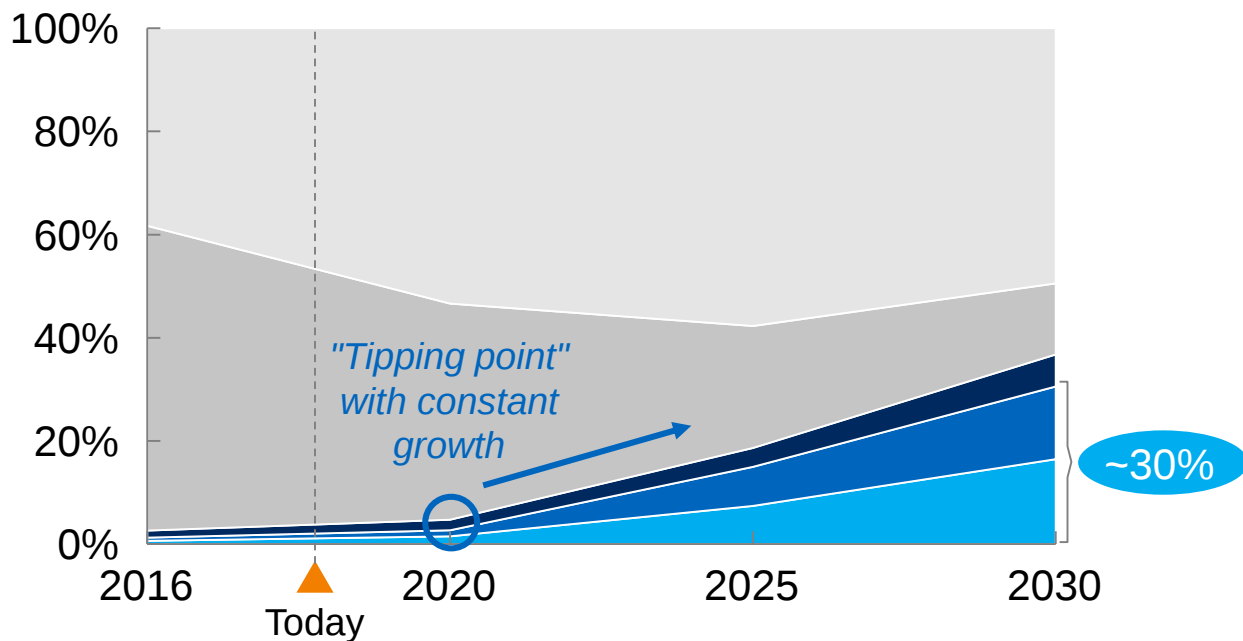
xEV market scenarios – BEVs reaching up to ~30 percent market share in Europe by 2030



Share of new light vehicles sold in percent

Gasoline¹ Diesel¹ BEV/FCEV PHEV HEV

Base case



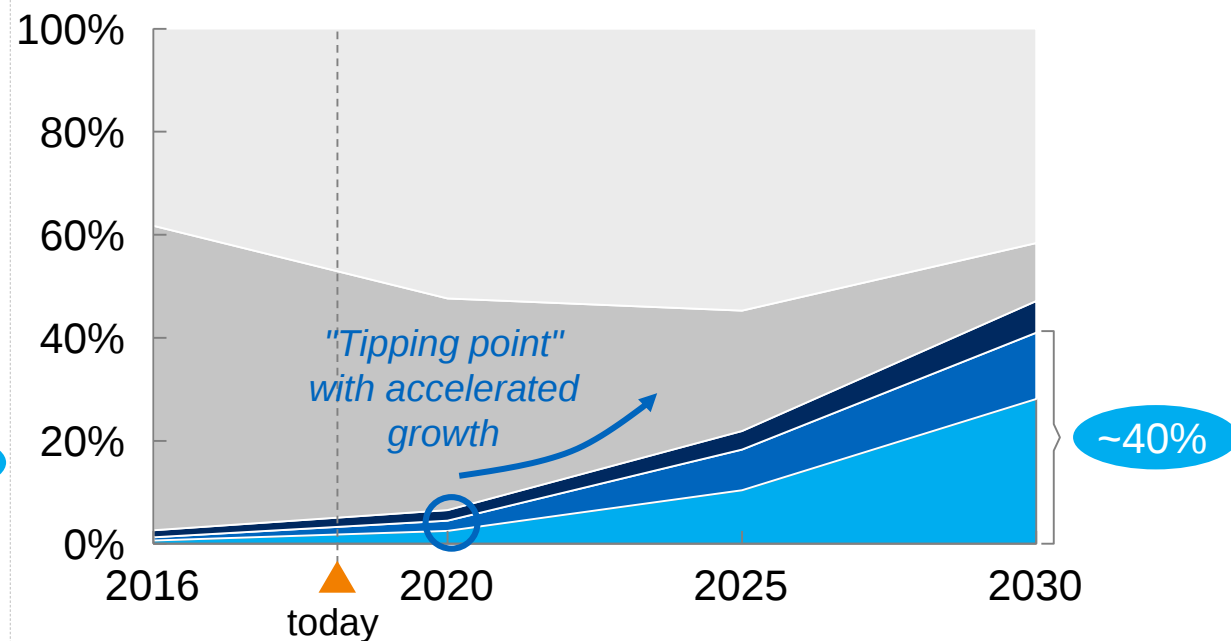
Base case scenario assumptions 2030

~90 USD/kWh (pack level)

67 g/km CO₂

~10% shared vehicle sales

Breakthrough scenario



Breakthrough scenario assumptions 2030

~55 USD/kWh (pack level)

57 g/km CO₂

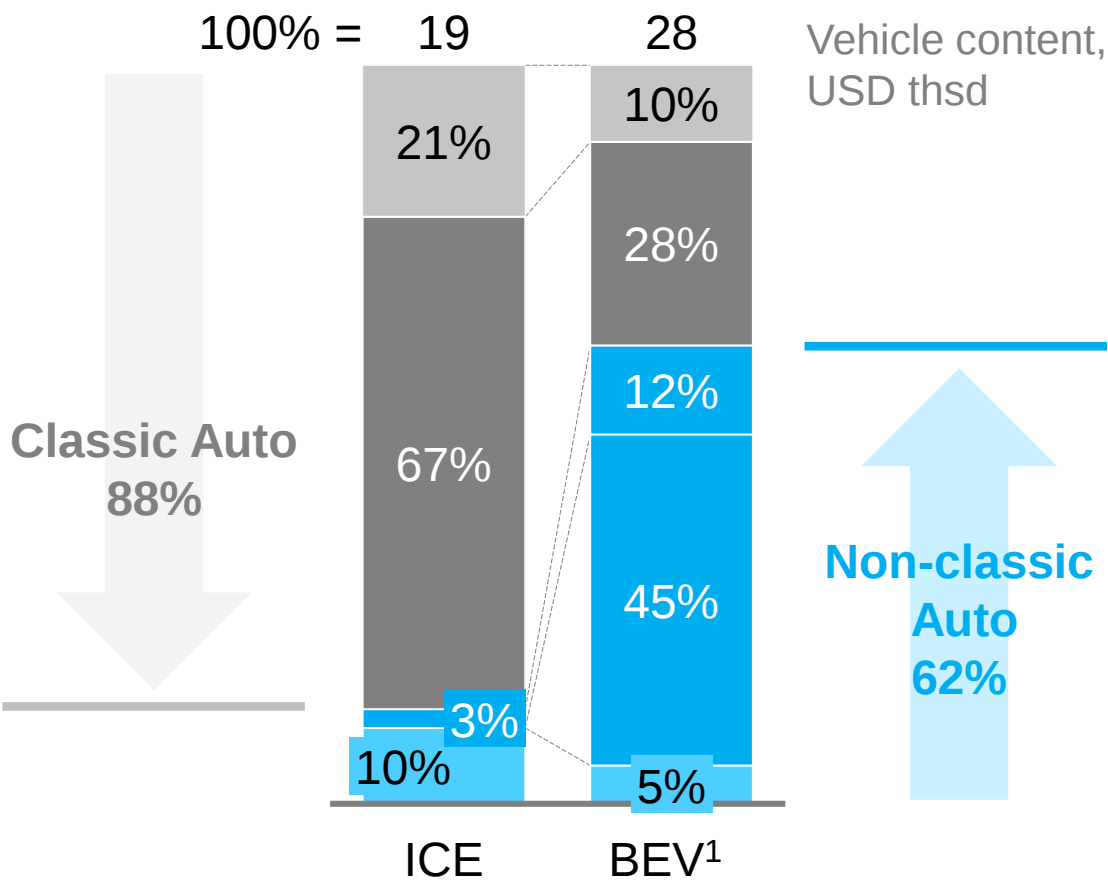
~15% shared vehicle sales

¹ incl. 48V MHEV and alternative/ biofuels
SOURCE: McKinsey, ICCT, IHS Automotive

The example on electrification shows how supply is shifting from traditional to non-traditional suppliers and how business models are changing and expanding to adjacent areas

■ OEM value add ■ Classic tier 1 ■ Powertrain electronics suppliers ■ Battery suppliers ■ Raw materials

New technology focus



1 Chevy Bolt example
SOURCE: UBS estimates, McKinsey

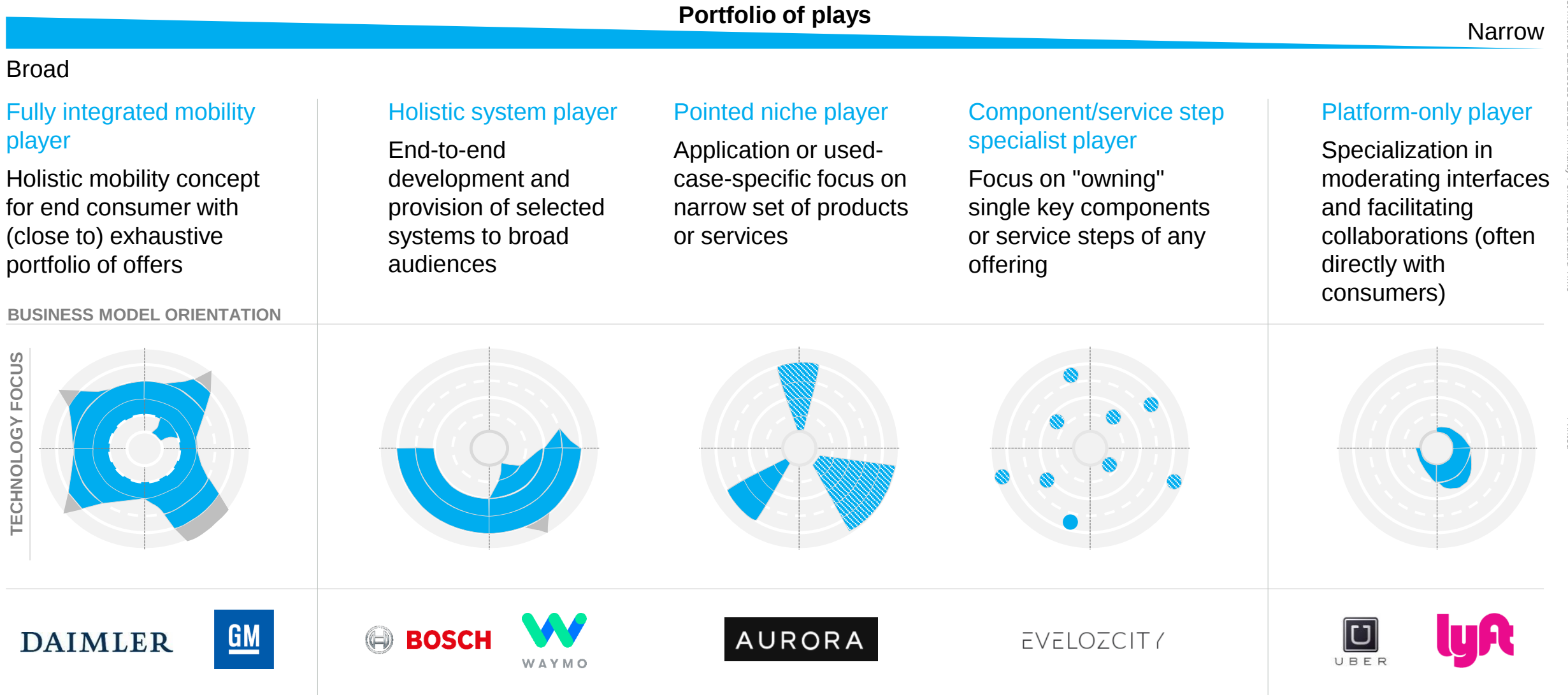
New business models

- Greencarreports - Nov 6, 2017
BMW, Mercedes, Ford, VW, Audi launch Iony high-power fast charging across EU
- Electrek - May 2, 2018
Ford to launch new all-electric vehicles for ride-hailing services in China
- Chicago Tribune - Mar 30, 2017
Would you buy a new car online? Lynk & Co is betting on it



We identified 5 strategic archetypes along the breadth of their "portfolio of plays"; each can vary in shape depending on individual player choices

Defined play field Alternate positioning



Players can manage their reach across technologies and business models through partnerships and strategic investments as the example of electric vehicle startup NIO shows

Nio's ecosystem with a mix of partnerships and investments along the value chain

