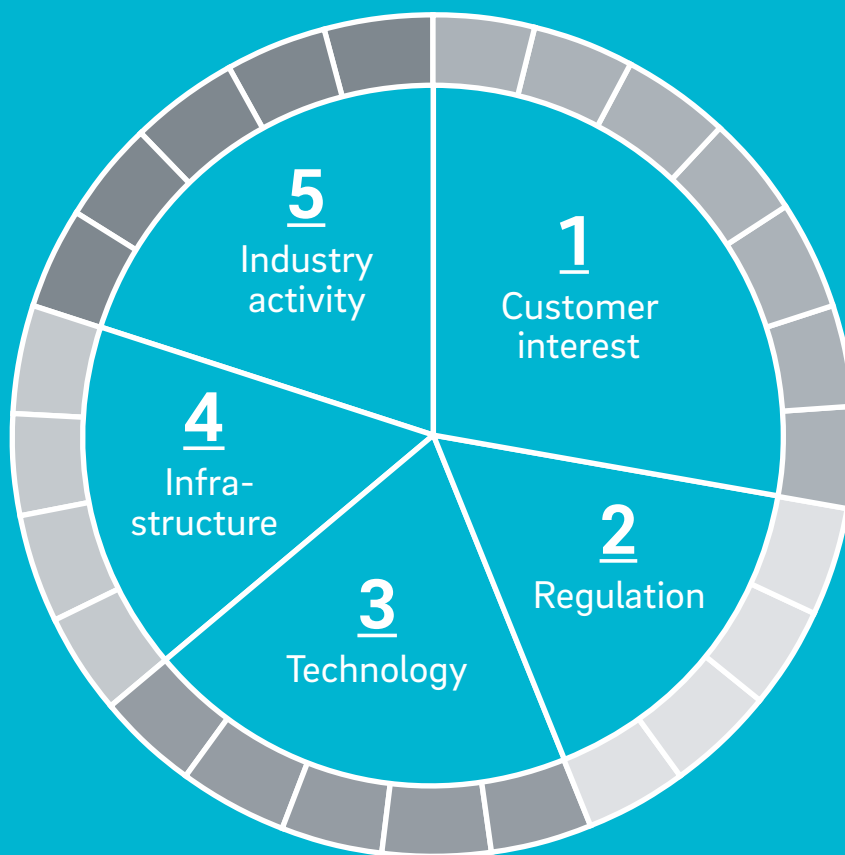


Automotive Disruption Radar Issue #1



Tracking disruption signals in the automotive industry
April 2017

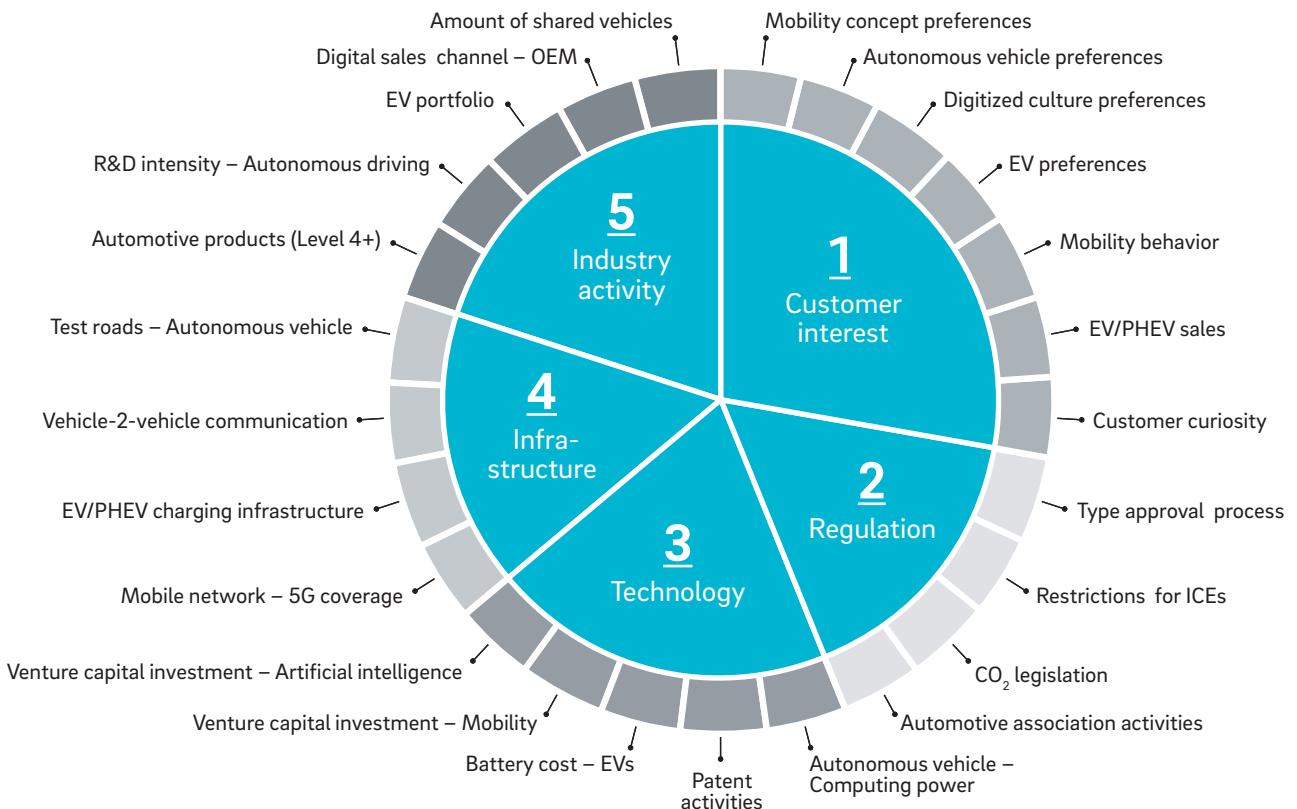


Monitoring evolutions in the global automotive industry

- Which factors are driving the change in the automotive ecosystem? How do they evolve over time?
- Which markets provide the best conditions for a smooth transformation towards the new automotive world?
- When do signals point to a more disruptive change?

THE AUTOMOTIVE DISRUPTION RADAR

A constant screening of 25 indicators along five dimensions



The Automotive Disruption Radar

supports decision making in a highly uncertain and thus complex environment

THE AUTOMOTIVE INDUSTRY IS SUBJECT TO "REAL" DISRUPTION

- Over the past 130 years, the automotive industry has followed a very "linear" development path. But due to the parallel emergence of four megatrends in the last 2 years (MADE – Mobility, Automated driving, Digital experience, Electrification), the industry is likely to be reshaped in the next 10 to 15 years."

MAKING THE "RIGHT" DECISIONS IS A HIGHLY COMPLEX TASK

- Despite the increased level of uncertainty, executives have to decide on long-term capital allocation
- Market dynamics should be monitored and analyzed permanently, with a strong focus on major tipping points

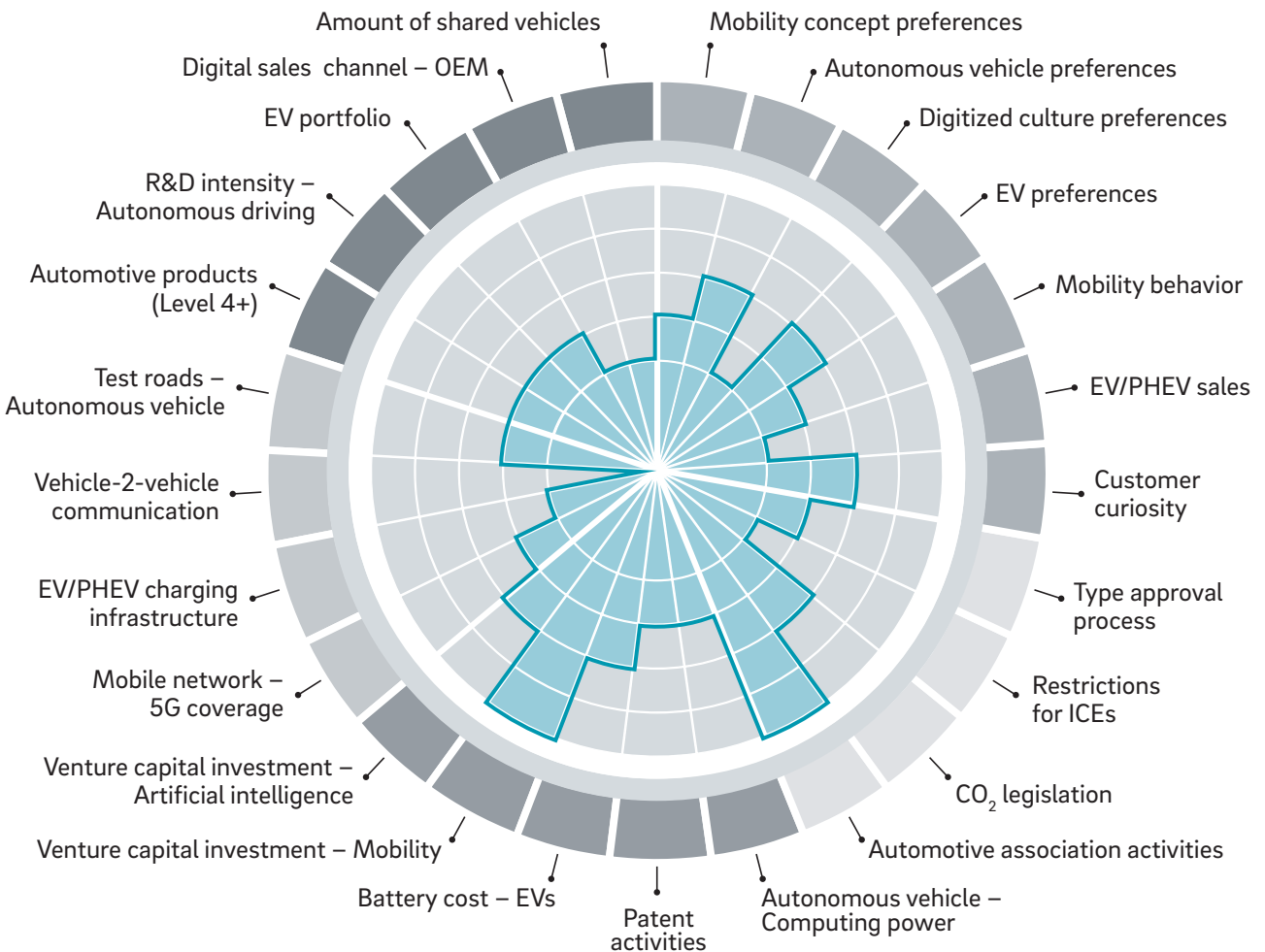
OUR "AUTOMOTIVE DISRUPTION RADAR" PROVIDES GUIDANCE

- The Radar monitors the automotive environment to provide support for decision making
- The Radar analyzes the transformation via 25 selected indicators in five dimensions: Customer interest (e.g. via >10,000 end user interviews), regulation, technology, infrastructure, industry activity
- All indicators are analyzed for 10 different countries and will be updated on a regular basis

Automotive Disruption Radar globally

Customers show interest in autonomous vehicles and start to accept electrical vehicles as an alternative, but regulation enabling disruption not yet in place

Insights are based on a customized survey of more than 10,000 car users, interviews with leading industry experts and comprehensive research using the latest available sources.



Global average

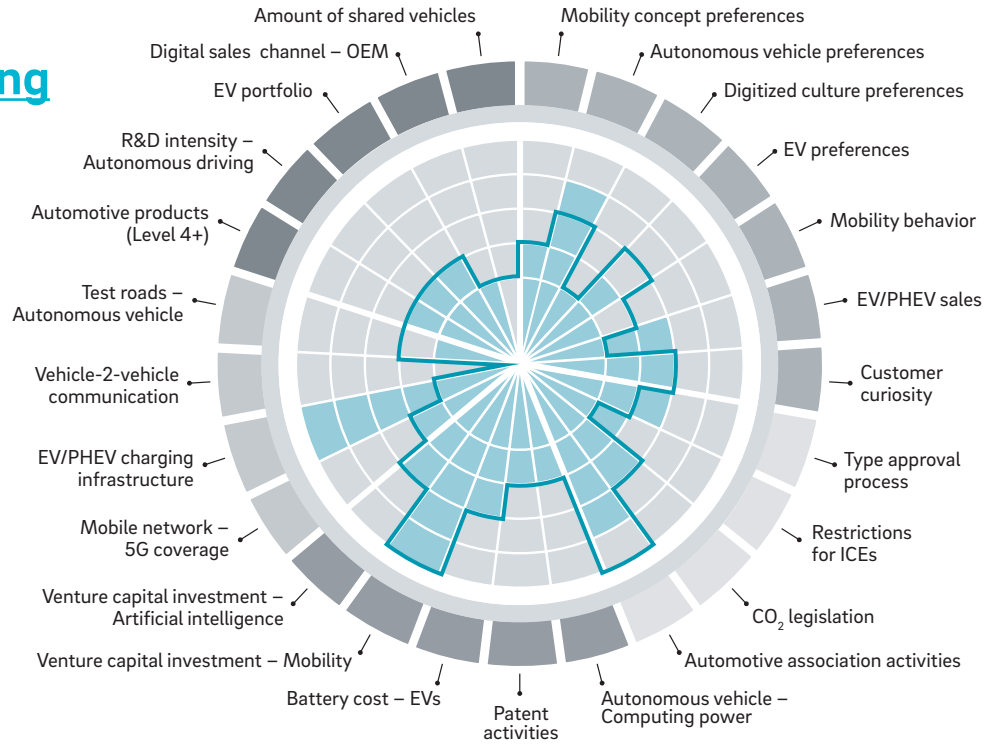
Source: Roland Berger

Country ranking

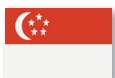


#1 The Netherlands

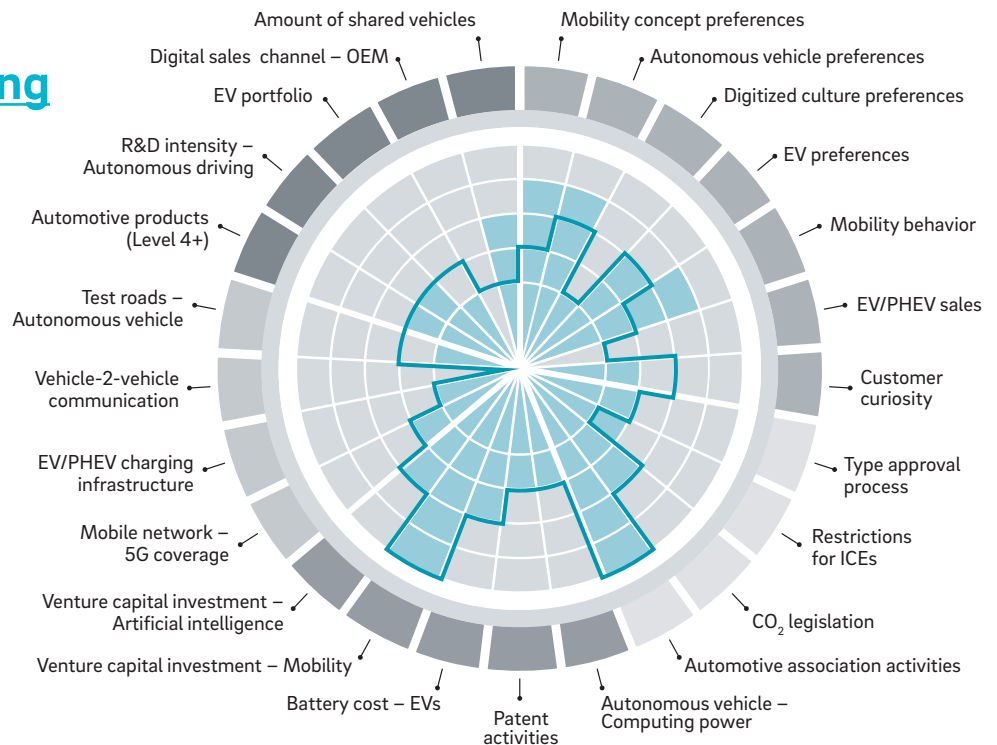
A winning combination: The Netherlands has comparatively high electronic vehicle sales, a very good EV charging infrastructure and a strong interest in autonomous driving.



Country ranking



#2 Singapore

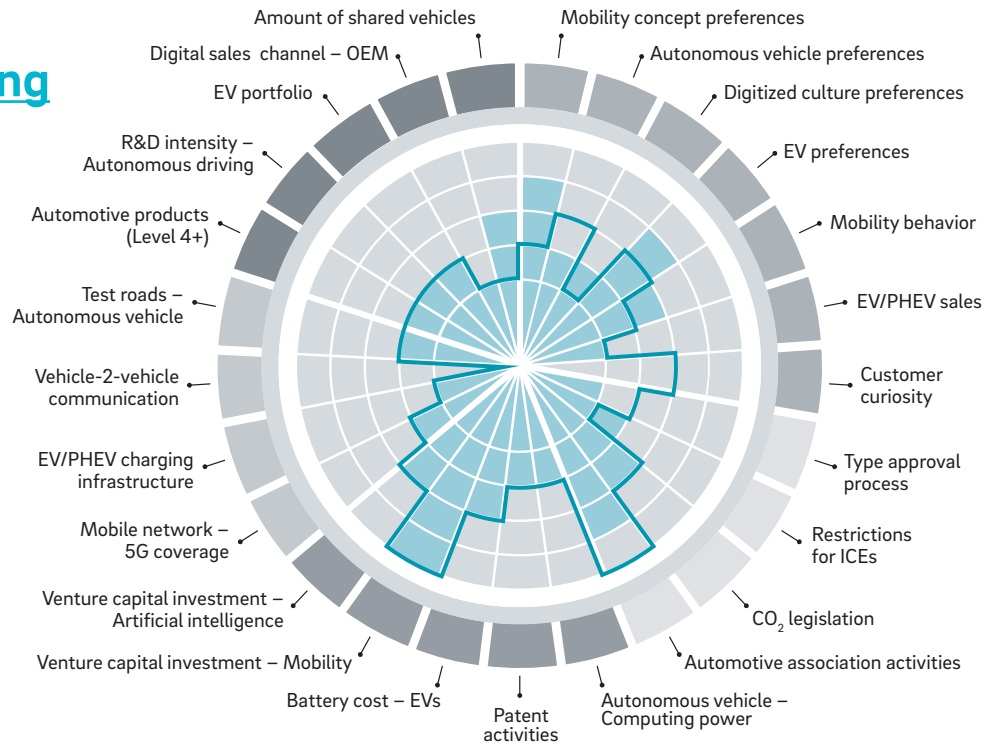


— Global average ■ Country scoring

Country ranking



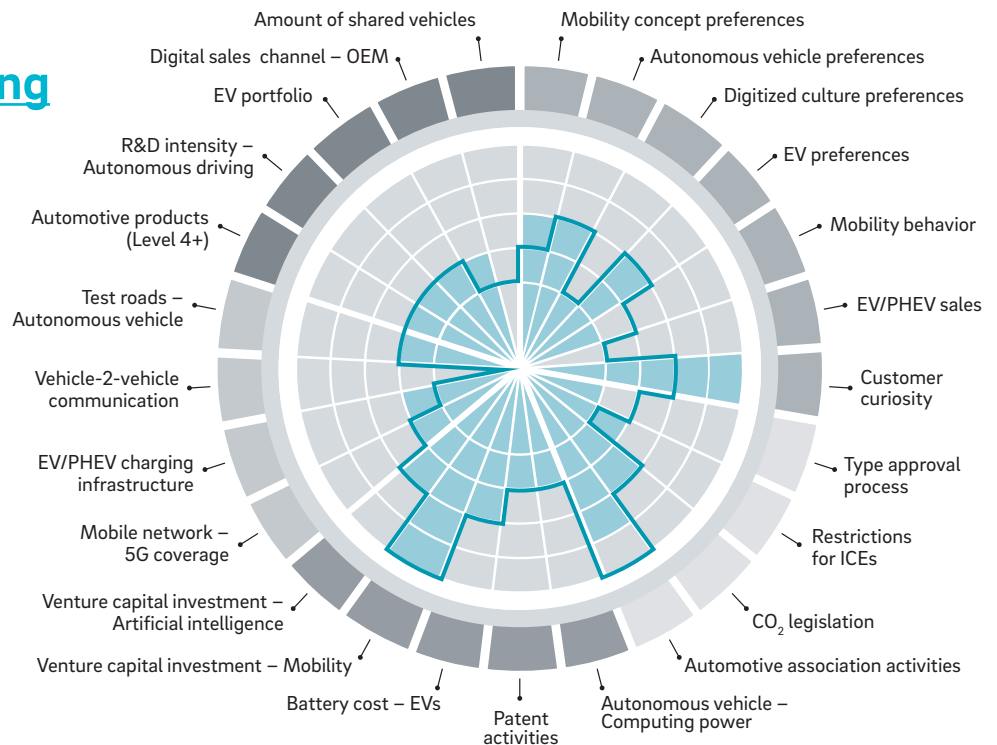
#3
China



Country ranking



#4
Germany

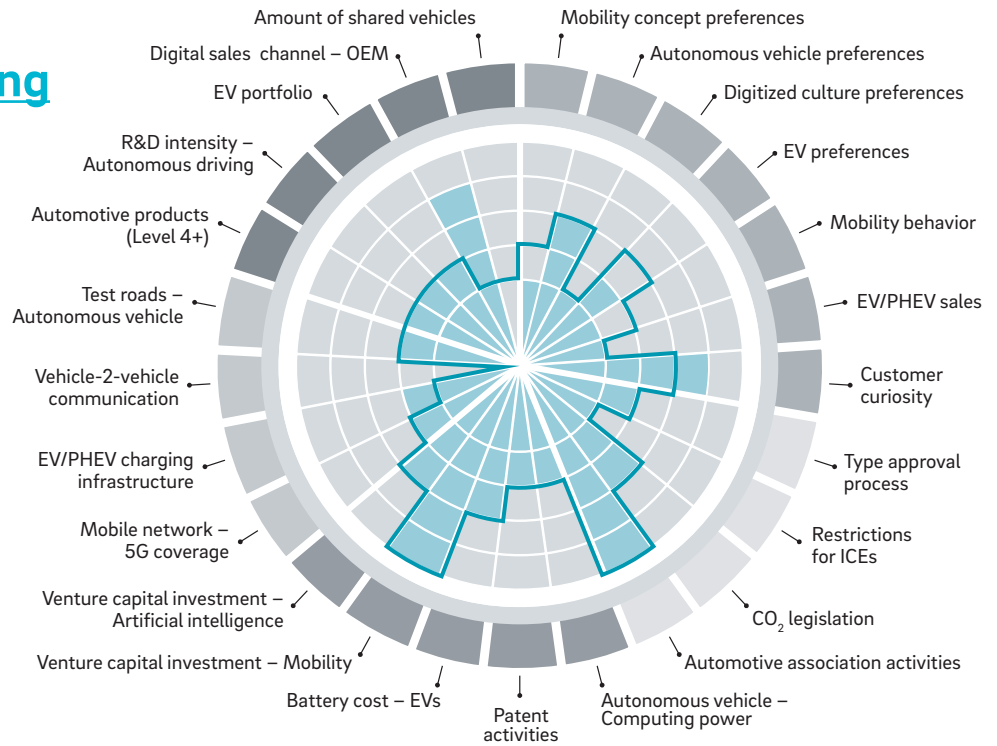


— Global average ■ Country scoring

Country ranking



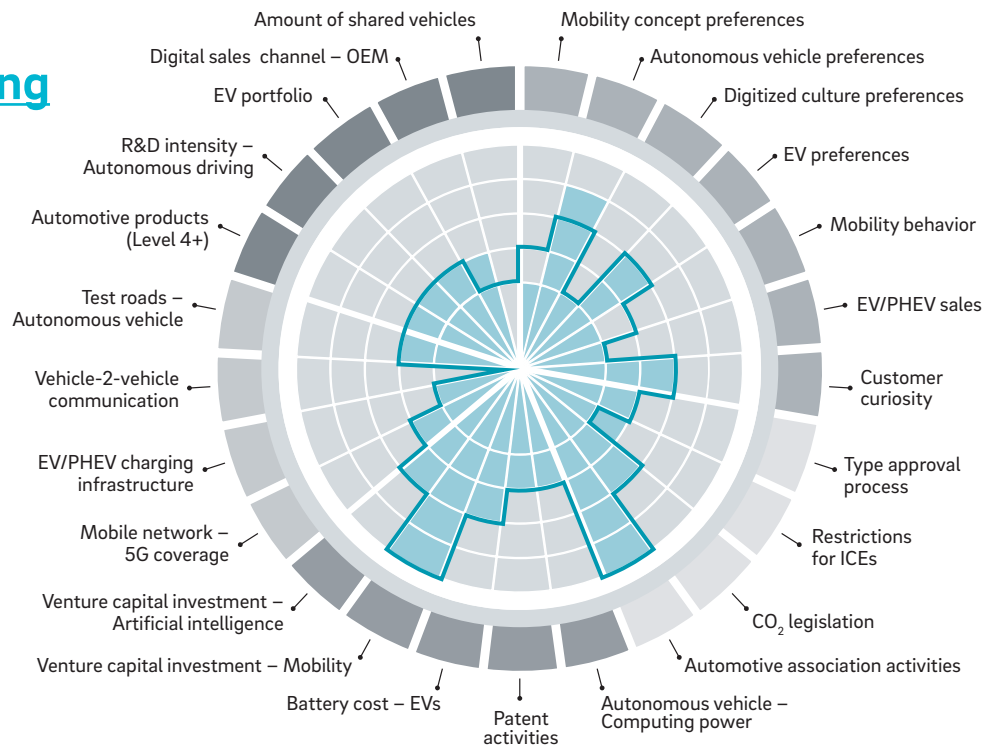
#4
UK



Country ranking



#6
France

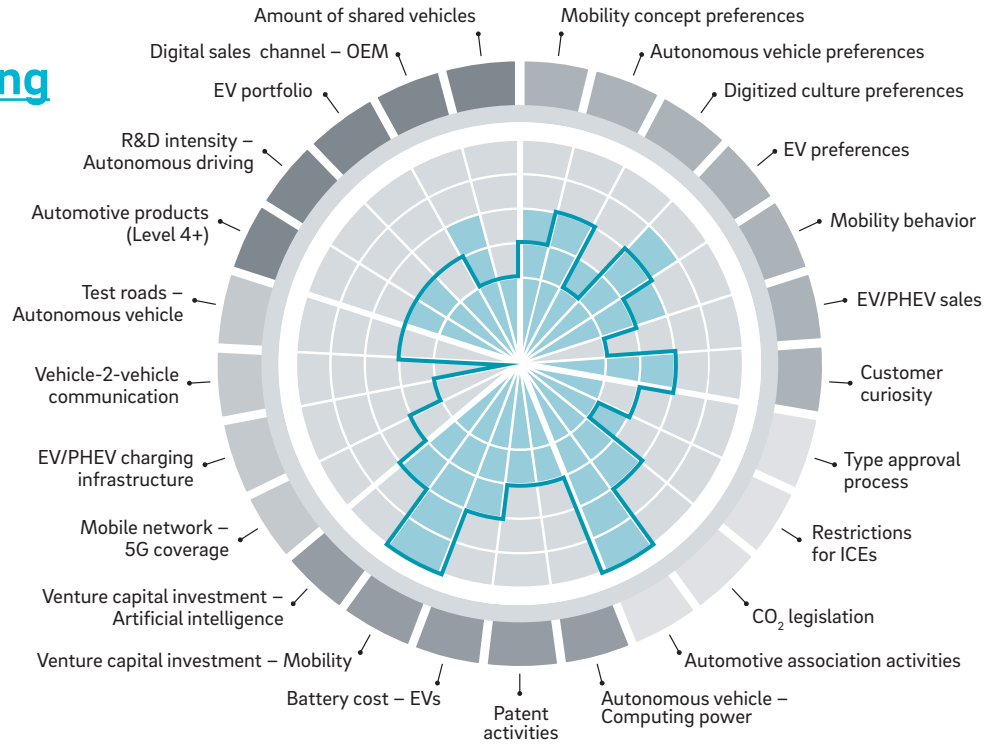


— Global average ■ Country scoring

Country ranking



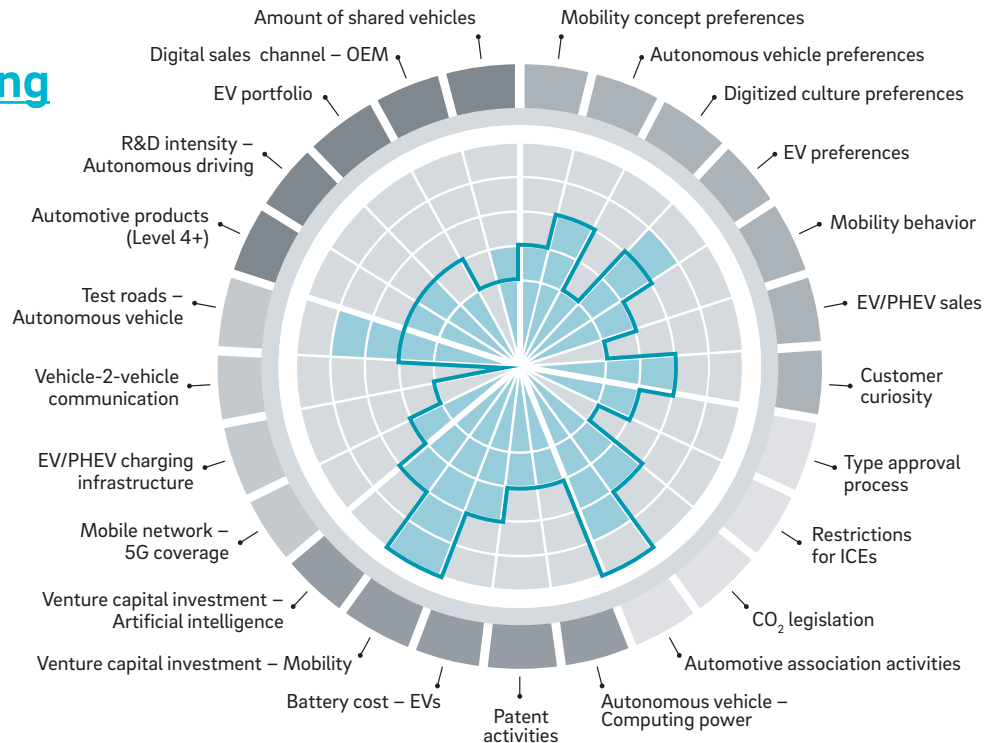
#7
India



Country ranking



#8
South Korea

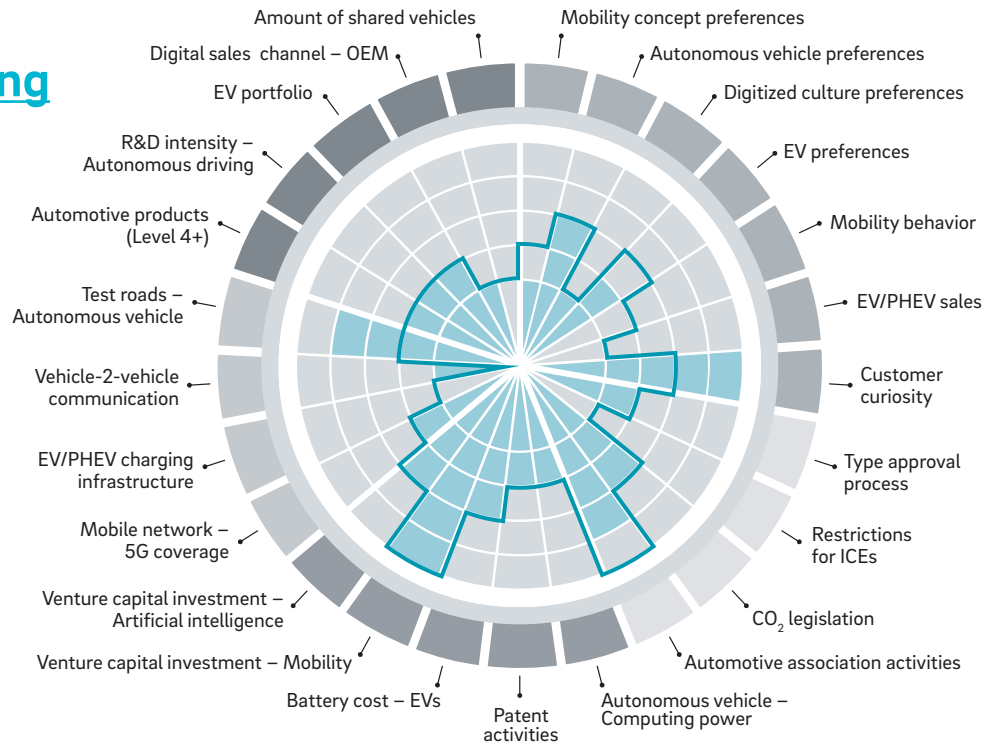


— Global average ■ Country scoring

Country ranking



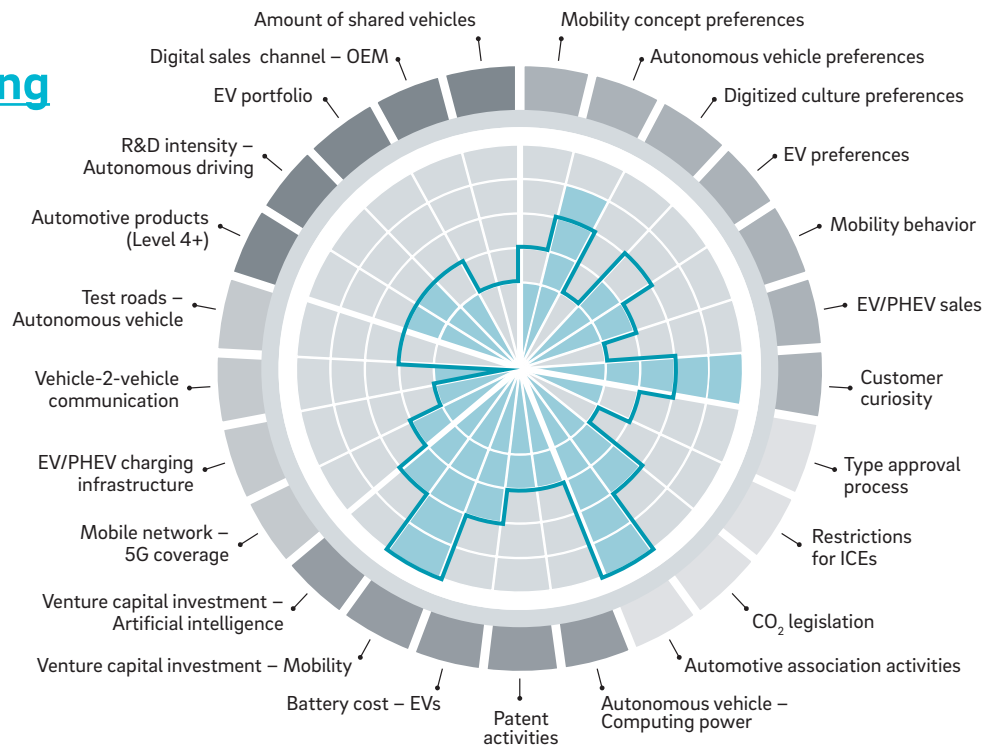
#9
USA



Country ranking



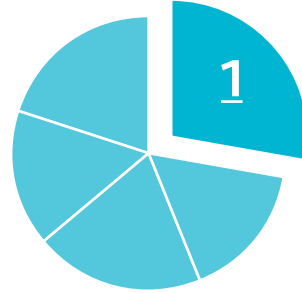
#10
Japan



— Global average ■ Country scoring

1. Customer interest

China and emerging Asian markets show highest customer demand for electric and autonomous vehicles



M

MOBILITY

Asian countries are leading in the usage of mobility concepts

→ Customers in Singapore, China and India are leading in mobility concept usage – moving away from car ownership. In developed countries, the adoption of mobility concepts is highest by far in cities and by young people

A

AUTONOMOUS DRIVING

Autonomous robocabs could reduce car ownership by almost half

→ Globally, 46% of customers would not buy a car again if fully autonomous robocabs could be used at lower cost per trip compared to their own car – Highest ratings in countries with high population density while people in large countries where travel distances tend to be long are less interested

D

DIGITIZED CULTURE

Significant share of customers are interested in buying their vehicle online

→ 11% of customers are interested in buying a vehicle on the internet

E

ELECTRIC VEHICLES

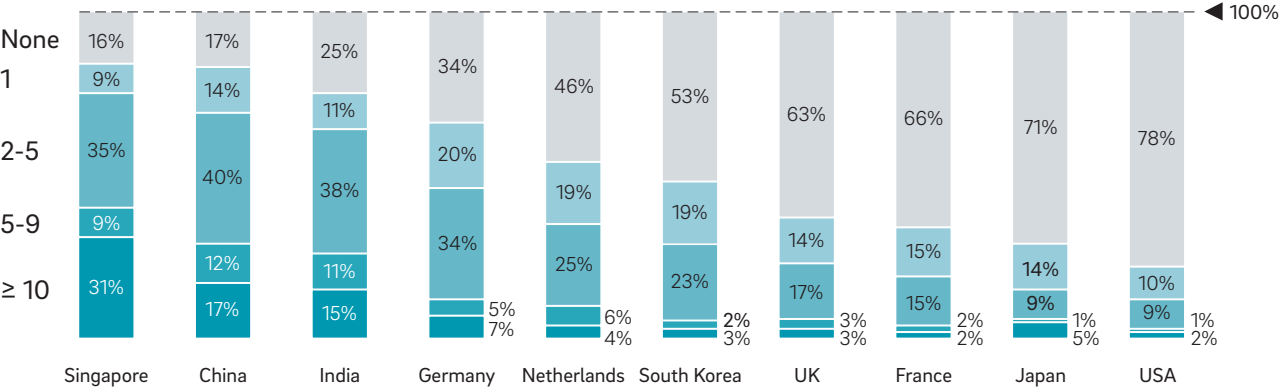
Electric vehicles are becoming an attractive alternative, especially in Asia

→ 37% of all customers are considering buying an EV as their next vehicle – in China even 60%. In emerging markets, the lack of charging infrastructure is cited as the key reason for not buying an EV while high prices are the main hurdle in mature automotive markets

M MOBILITY CONCEPTS: USE OF MOBILITY CONCEPTS

Asian countries show highest interest in mobility concepts, while mature Western markets are less keen

"How many people do you know who don't or did not want to buy a car because they exclusively use other mobility concepts?"

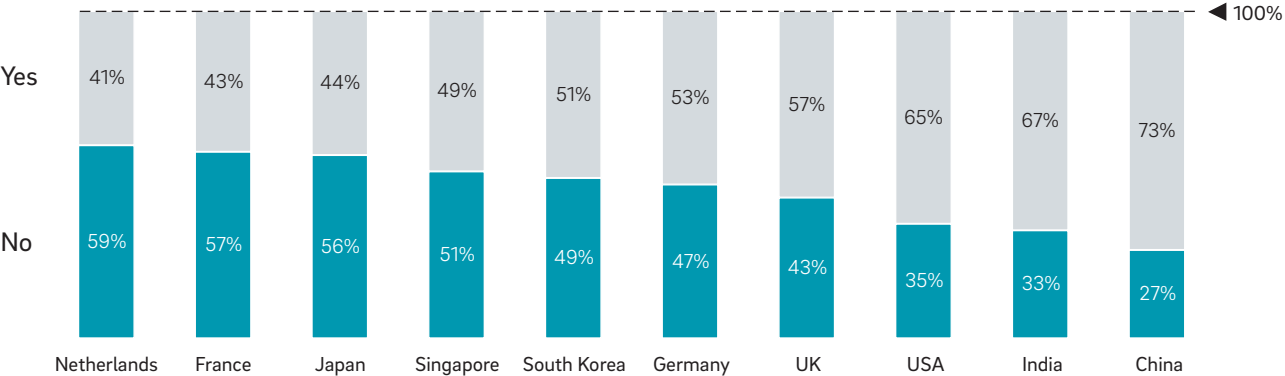


Source: RB online survey February 2017: 10,253 participants (China 1002, France 1007, Germany 1008, India 1011, Japan 1002, NL 1039, SGP 1047, UK 1004, USA 1001)

A AUTONOMOUS VEHICLES: SHARE OF POTENTIAL CUSTOMERS

Countries with high population density are especially interested in autonomous vehicles

"Would you still buy a car again if fully autonomous robocabs¹ could be used at lower cost per trip compared to your own car?"

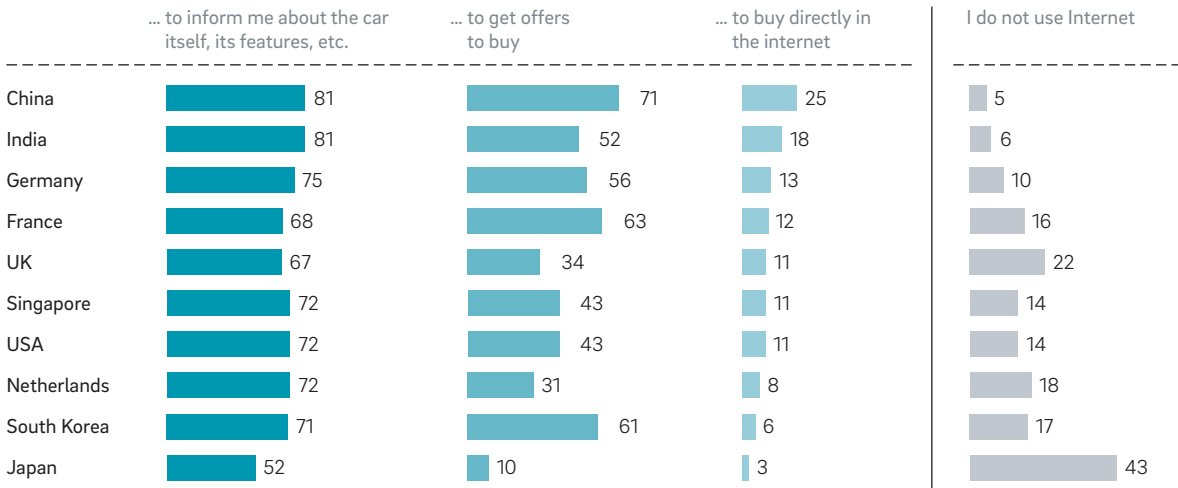


¹) Robocabs are defined as autonomous taxis without a driver in the vehicle
 Source: RB online survey February 2017: 10,253 participants (China 1002, France 1007, Germany 1008, India 1011, Japan 1002, NL 1039, SGP 1047, UK 1004, USA 1001)

D DIGITIZED CULTURE: USAGE OF INTERNET FOR VEHICLE PURCHASING

High acceptance of digital sales channels, esp. in developing countries, less so in Japan, the UK and the US

"Usage of internet in vehicle purchasing – to what extent will you use the internet?"

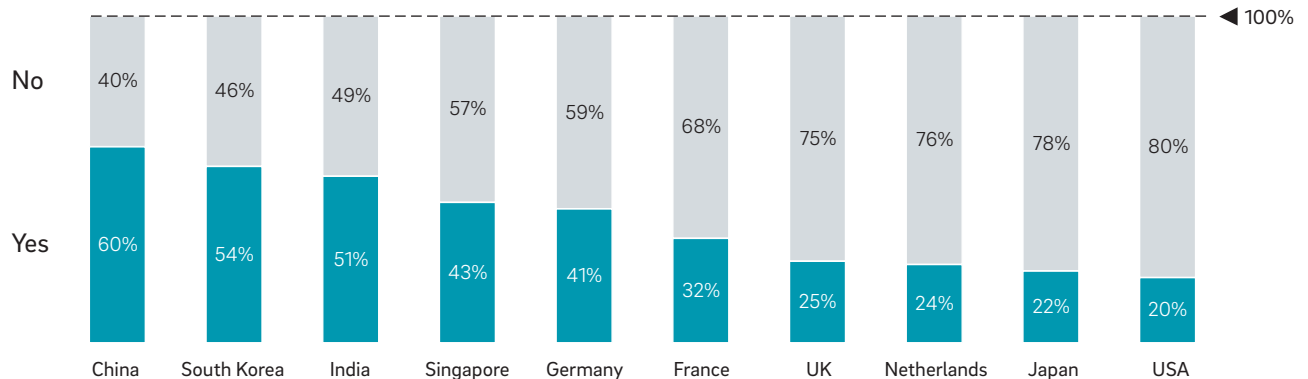


Source: RB online survey February 2017: 10,253 participants (China 1002, France 1007, Germany 1008, India 1011, Japan 1002, NL 1039, SGP 1047, UK 1004, USA 1001)

E EVS: SHARE OF POTENTIAL BUYERS

A significant share of customers are considering buying a BEV as their next car – Lower acceptance rates in the US, Japan, NL and the UK

"Are you considering buying a battery electric vehicle as your next car?"



Source: RB online survey February 2017: 10,253 participants (China 1002, France 1007, Germany 1008, India 1011, Japan 1002, NL 1039, SGP 1047, UK 1004, USA 1001)

2. Regulation

Netherlands leads in defining a type approval process for autonomous vehicles – ICE* restrictions globally rather low



TYPE APPROVAL PROCEDURE

Type approval procedures not yet in place

- Type approval procedures still critical to enable market launch of autonomous vehicles – The Netherlands shows the most advanced approach for developing type approval procedures by embedding lessons learned from test fleets into legislative process

RESTRICTIONS FOR INTERNAL COMBUSTION ENGINES (ICES)

Most effective restriction method is EV support in vehicle registration

- Only limited driving restrictions for ICEs today, mainly focusing on replacing old (diesel) vehicles with new ones. Strongest restrictions in the Chinese megacities of Beijing and Shanghai through supporting the EV registration process

CO₂ EMISSIONS

CO₂ targets for 2025 not finalized yet, thereby driving uncertainty surrounding EV success

- Expected CO₂ emissions targets for 2025 would further push powertrain electrification. However, the targets are not finalized yet – there is significant uncertainty around the outlook for e-mobility

AUTOMOTIVE ASSOCIATIONS

Automotive associations highlighting the chances for electrified, autonomous driving

- Overall the leading political, customer orientated and environmental orientated associations state a positive attitude towards the potential impact of mobility services, autonomous driving, digitization and electrified powertrains. We observe lowest satisfaction rate in Germany (76%), Netherlands (78%) and South Korea (82%)

*ICE: Internal Combustion Engine, traditional powertrains

3. Technology

Roadmaps and announcements indicate technology and cost readiness for autonomous electric vehicles by 2021



TECHNICAL FEASIBILITY OF AUTONOMOUS DRIVING

Technological feasibility is proven and commercialization expected by 2021

- Today's E/E architectures are expected to increase from ~20,000 DMIPs* to ~100,000 for Level 4 vehicles and to ~1,000,000 DMIPs for Level 5 vehicles – Roadmaps and announcements from leading CPU manufacturers indicate technological readiness for Level 4 vehicles in 2021
- Current test fleet already delivering 30-50 million km of video data for training modules
- In 2016 ~1.7% of relevant patents across 21 IPC codes were related to autonomous functions in vehicles (1,264 patents in total)

BATTERY COST

Battery cell cost expected to come down from ~200 USD/kWh to ~120 USD/kWh by 2020

- Battery cell chemistries will focus on Ni-rich NCM- and NCA-based cathodes, causing a significant decrease in manufacturing costs – On cell level, battery costs are expected to decrease to 120 USD/kWh by 2020

TECHNOLOGY FINANCING

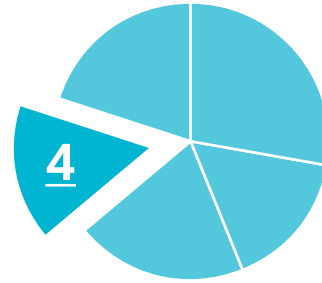
More than USD 9 bn in venture capital invested in mobility services in 2016

- In 2016 USD 9.3 bn in VC investments were made in mobility services, leading to a y-o-y decrease of ~9% compared to USD 10.2 bn in 2015. The top ten investments accounted for more than USD 7.5 bn, led by Didi (USD 4.5 bn), Lyft (USD 1.0 bn) and Grab (USD 0.75 bn)
- Significant increase of VC investments in artificial intelligence, rising from USD 0.7 bn in 2015 to USD 1.6 bn in 2016, reflecting a year-on-year increase of 139%

*DMIP: General processor (CPU) performance measure

4. Infrastructure

Netherlands shows a sufficient EV charging infrastructure – Korea and USA leading in autonomous testing



MOBILE NETWORK

Required commercialization of 5G mobile network is expected by end of this decade

- Next generation (5G) of mobile network seen as crucial for enabling V2X communication, which is required for autonomous and highly automated vehicles
- In all mature markets technology roadmaps for establishing 5G are in place, e.g. first commercialization in 2017 in USA, 2018-2020 test phase in France, first rollout for Olympic Games in South Korea (2018) and Japan (2020) announced

EV CHARGING INFRASTRUCTURE

Netherlands clearly leading in EV infrastructure

- The Netherlands has the highest relative amount of charging stations (charging stations per km of roadway), China takes the lead in absolute terms

VEHICLE-TO-VEHICLE COMMUNICATION (V2V)

First vehicles with V2V functionality launched in USA and Japan

- GM, Mercedes and Toyota introduced first models with V2V functionality. However, no significant market share yet

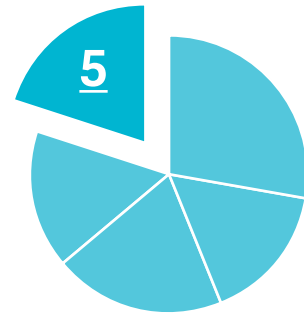
TEST ROADS FOR AUTONOMOUS VEHICLES

Korea and parts of the USA declared almost all roadways as test roads for autonomous vehicles

- Korea and USA are the leading nations when it comes to allowing testing of autonomous vehicles:
 - Korea defined all roads as potential test roads (except school zones and disabled person protection zones)
 - In several US states, the testing of autonomous functions is allowed state-wide under specific conditions

5. Industry activity

Commercialized Level 4 vehicles expected by 2021 – First fully autonomous "people movers" already in operation



AUTONOMOUS VEHICLES

While "people movers" already exist, automotive OEMs expect to launch products by 2021

- Small fleet of commercialized, driverless "last mile" people movers already launched in the market, e.g. Auro, EasyMile or Navya (in Singapore)
- OEMs announced roadmaps for Level 4 vehicles: Large test fleets by 2018 (GM), or first series models (BMW, Ford, Mercedes, Audi)
- All major OEMs and suppliers exhibit a high level of activity, more than 40,000 FTEs are working on mobility services and autonomous driving

ELECTRIC VEHICLES

Share of EV models in portfolio increased in 2016 to as much as 12% – Further rise expected

- Share of BEV/PHEV models in OEM product portfolio increased within last 12 months – Germany leading with a share of 12% (vs. 9% in 2015), significant increase also seen in China (10% in 2016 vs. 7% in 2015).

DIGITAL SALES

UK leading in OEM driven online vehicle sales channels

- 6 OEMs offer a direct vehicle sales channel on their website in the UK, by far the highest rate across all countries

AMOUNT OF SHARED VEHICLES

Asia leading in shared vehicle car parc

- China, South Korea and Singapore are leading in the proportion of shared vehicles in the vehicle car parc – While ride sharing is the major driver in China, car rental business and taxi fleet are core drivers in South Korea and Singapore

Ten countries in transition at a glance

Each of the 10 countries in scope show advancements towards the new automotive economy

<u>DIMENSION</u>	<u>ELEMENT</u>	<u>LEADER</u>	<u>FAST FOLLOWER</u>	<u>FOLLOWER</u>
1 Customer interest	Mobility concepts	Singapore, China	Germany, India	Netherlands, South Korea, France, Japan, UK, USA
	Autonomous vehicles	France, Japan, Netherlands, Singapore	Germany, UK, India, USA, South Korea	China
	EV/PHEV	China, Netherlands	India, France, South Korea	Germany, Singapore, UK, Japan, USA
2 Regulation	Type approval process	Netherlands	Singapore, USA, UK, South Korea, France	Germany, Japan, India, China
	Restrictions for ICEs	China	India, France, UK, Singapore, Netherlands, Germany	South Korea, Japan, USA
3 Technology	All technology elements	Elements driven globally and therefore no country comparison		
4 Infra-structure	5G network	Germany, UK, Singapore, France, Japan, USA, China, Netherlands		India
	V2V functionality	Japan, USA		China, Netherlands, India, France, UK, South Korea, Germany, Singapore
	Test roads	USA, South Korea	China, Germany, UK, France	Netherlands, Japan, Singapore, India
5 Industry activity	Share of EV/PHEV models in product portfolio	Netherlands, China, Germany, UK, France, USA	Singapore, India, South Korea, Japan	
	Amount of shared vehicles	Singapore, China	South Korea, India	Germany, Netherlands, France, Japan, UK, USA

Imprint

WE WELCOME YOUR QUESTIONS, COMMENTS AND SUGGESTIONS

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Automotive Disruption MADE by RB

We believe that the combination of 4 dimensions (Mobility, Autonomous driving, Digital and Electrification) is likely to trigger a major disruption in the next 15 years in the Automotive industry. In 2017 we have brought together our experts from all around the world to try to make this new future and its implications more concrete, and to best support the key decision makers of the Automotive industry.

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