OLIVER WYMAN

VDA | Verband der Automobilindustrie

FAST 2030

FUTURE AUTOMOTIVE INDUSTRY STRUCTURE UNTIL 2030

THE IMPACT OF CURRENT TRENDS ON VALUE CREATION AND THEIR IMPLICATIONS

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Prepared for: Cluster de Automoción de Navarra

MARSH & McLENNAN COMPANIES

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- Over 30 years of consulting experience in the Energy and Transportation sectors
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Section 0 | Introduction to Oliver Wyman

Introduction to Oliver Wyman

Oliver Wyman Group is a Marsh & McLennan company, one of the leading global professional services firms

MARSH & McLENNAN COMPANIES

- **2017 Revenue: US$14 BN**
- **Staff: 65,000+**
- **Clients in more than 130 countries**
- **New York Stock Exchange (MMC)**

OLIVER WYMAN GROUP

Management, economic and brand strategy consulting

- **Strategy**
- **Organization**
- **Operations**
- **Risk management**
- **Transformation management**

- **1984 year founded**
- **4,700 colleagues**
- **60+ offices worldwide**
- **$1.9 BN 2017 revenue**

GUY CARPENTER

Risk and reinsurance specialist

- Reinsurance and risk management
- Contract management, claims handling, and fiduciary accounting

- **1922** year founded
- **2,300** colleagues
- **50+** offices worldwide
- **$1.2 BN** 2017 revenue

MERCER

Talent, health, retirement and investment consulting

- Personnel strategy
- HR systems
- Compensation
- Incentive systems
- Communication

- **1937** year founded
- **22,600** colleagues
- **170+** offices worldwide
- **$4.5 BN** 2017 revenue

MARSH

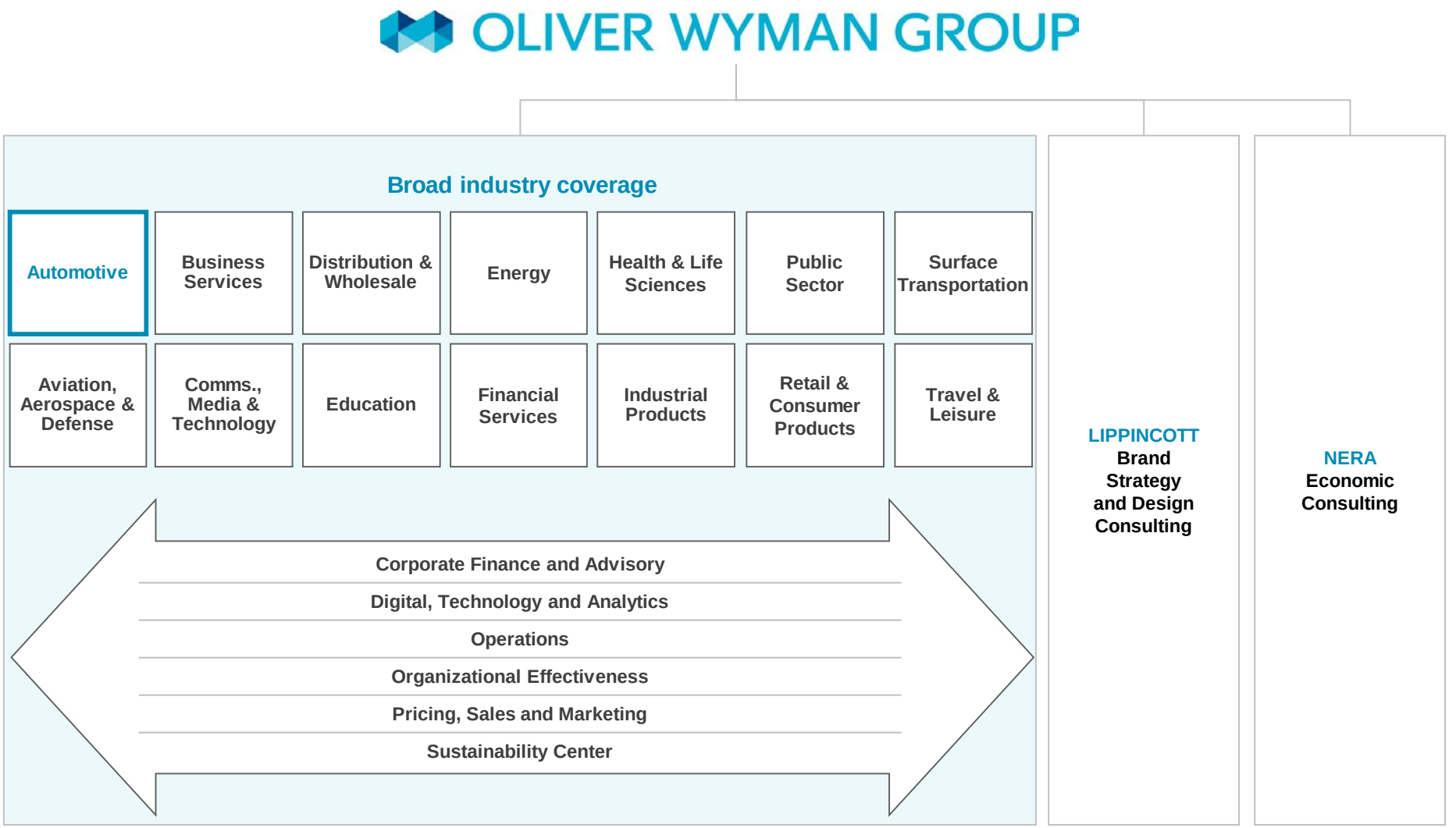
Insurance broker and risk advisor

- Risk management, consulting, and transfer
- Financial solutions and insurance program management services

- **1871** year founded
- **32,700** colleagues
- **500** offices worldwide
- **$6.4 BN** 2017 revenue

Oliver Wyman Group overview

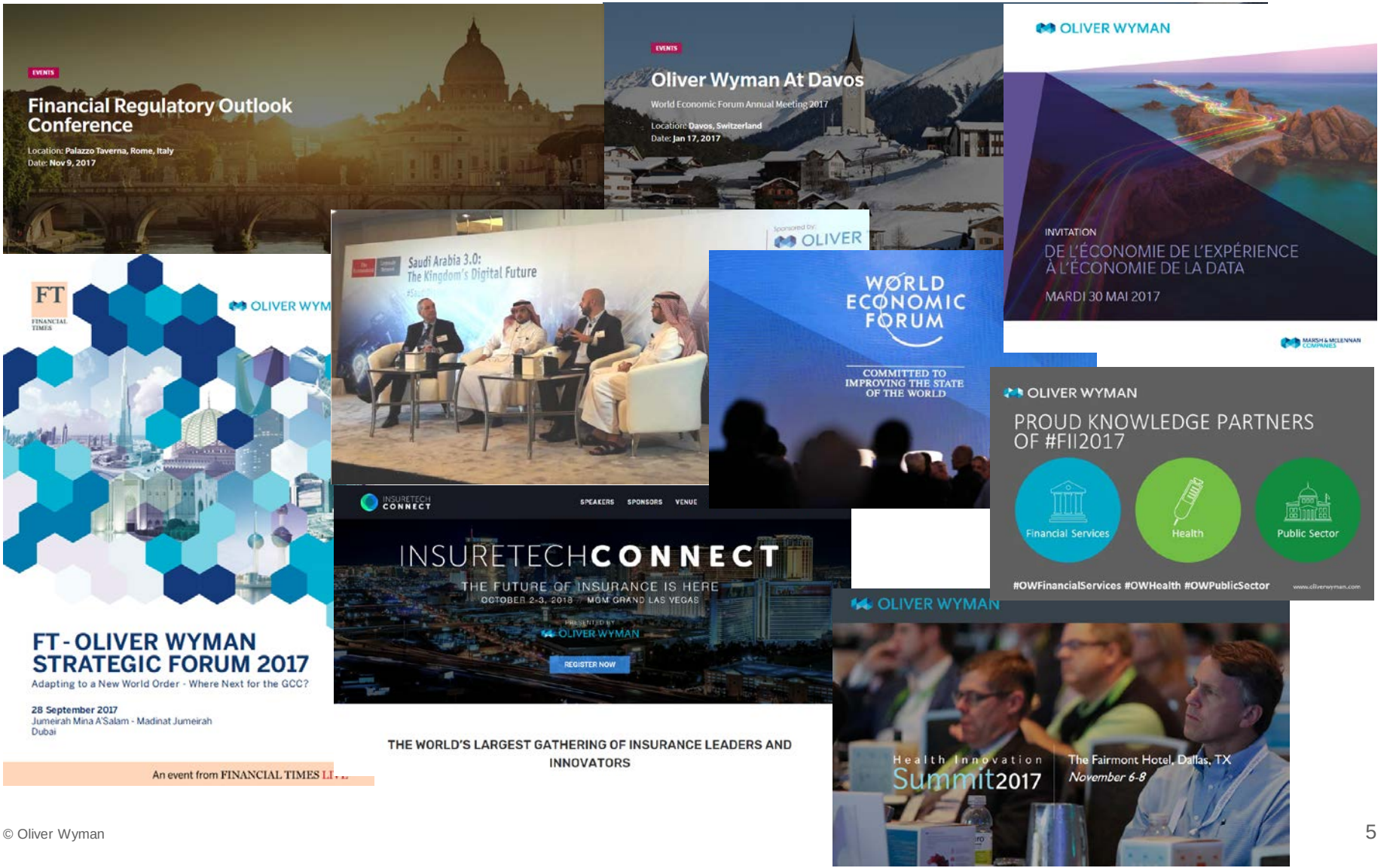
Oliver Wyman Group has ~4,700 colleagues with expertise across a range of industries to help our clients address their greatest challenges



Example

Presence at international forums

We lead international discussions on key topics at game-changing events and international forums



Oliver Wyman's Global Automotive Practice

Oliver Wyman is working for the world´s leading car manufacturers and suppliers on a broad range of topics

Excerpt from client list

Automotive manufacturers
(passenger cars, commercial vehicles)

- Extensive project experience at leading global OEMs
  - BMW
  - Daimler
  - Volkswagen Group
  - Peugeot/Citroën
  - GM
  - Ford
  - Renault
  - …
- Intensive contacts with top management
- Broad coverage of topics:
  - Sourcing / product costs
  - R&D strategy / core competences
  - Assembly processes
  - Risk management
  - Customer satisfaction
  - Distribution network
  - Marketing
  - Brand management
  - Service strategy
  - Financial services
  - …

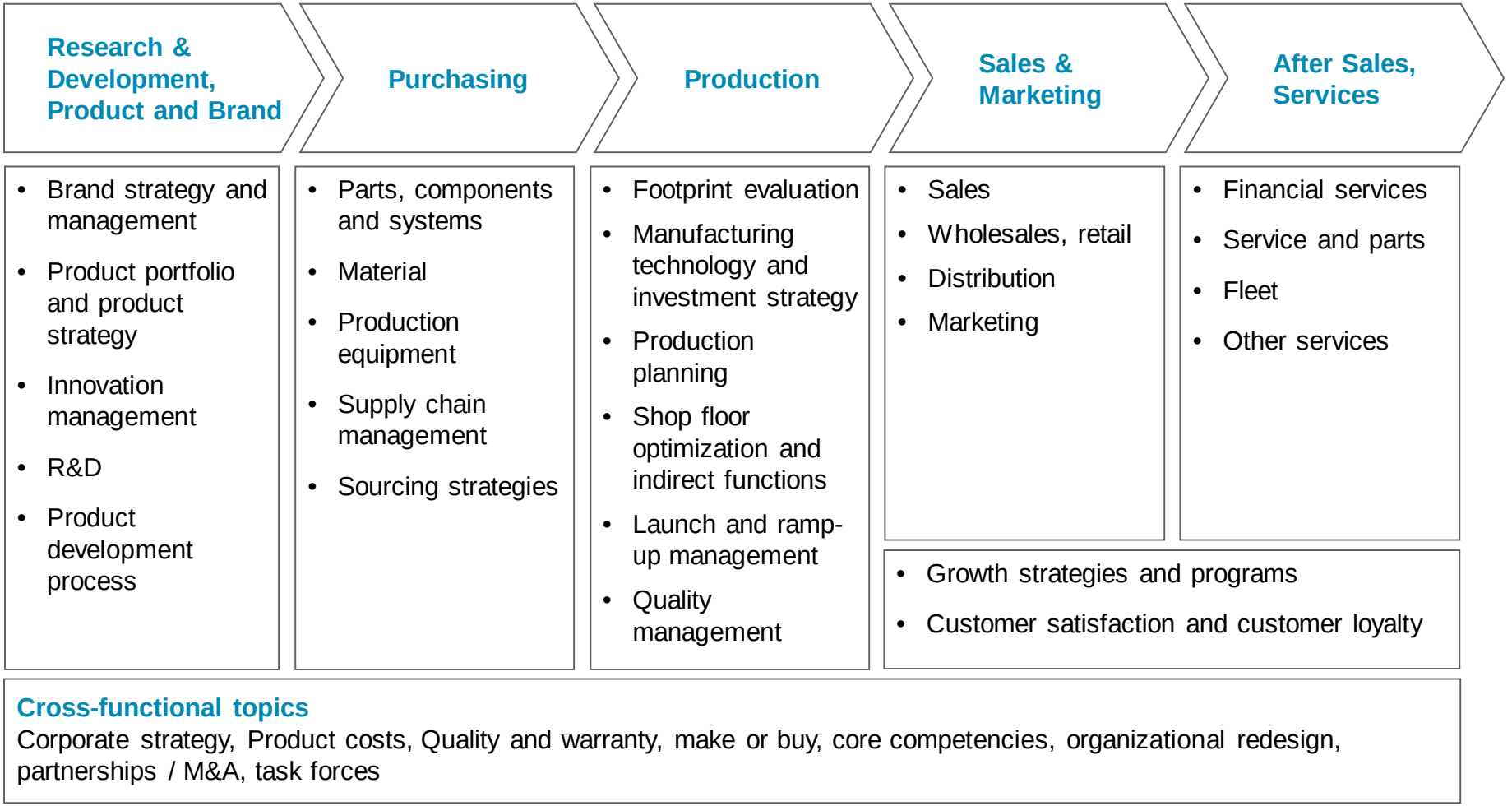
Source: Oliver Wyman

Automotive suppliers

- More than 200 projects since 2004 and more than 80 active clients:
  - Nine of the top 20 companies
  - Medium-sized & family companies
- Very good relations with top management and owners
- Broad coverage of topics and modules:
  - Strategy, market analyses & market entry, footprint optimization, product portfolio, M&A, brand management, sourcing, operational excellence, reorganization & restructuring, performance improvement, product cost reductions, supply chain optimization, benchmarking, ...
  - Engine, transmission, chassis, interior, body, exterior, electrical systems/ electronics, engineering services, ...

Oliver Wyman Automotive service offering

Together with our clients we develop innovative strategies and viable solutions for the main challenges of the automotive industry



Source: Oliver Wyman

Introduction to The Harbour Report® Automotive

The Harbour Report® is the leading global Automotive manufacturing benchmarking study

- Harbour Report® basics
- Guide to **competitive analysis in manufacturing performance based on ~ 400 plants globally**. Providing insights per shop, function and sourcing type by company, plant and product
- Benchmarking data enables participants to focus improvement activities in numerous areas with **highest potential** for savings (cost, product design, manufacturing performance, etc.)
- Over 30 years of **proven methodology** ensures comparability
  - **Detailed definitions**
  - Adjustments for **sourcing**
- The Harbour Report® team as a **trusted source** of information and as a **common platform** for Automotive manufactures

Source: Oliver Wyman

Proprietary Intellectual Capital

Oliver Wyman develops and applies innovative, leading-edge intellectual capital, especially in the area of value growth strategies

Excerpt from publication

Periodicals

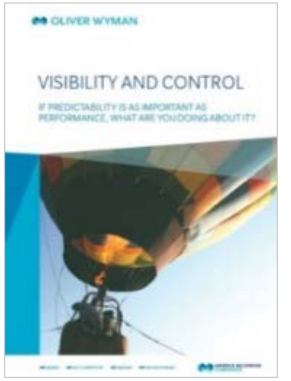
Automotive Manager 2017

Perspectives on Manufacturing industries 2017

Studies and Industry Reports

Digital Industry

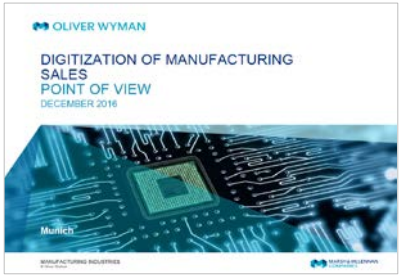
Mobility 2040



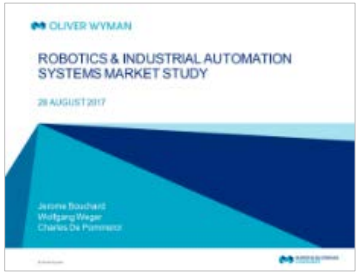
Visibility and Control

FAST 2030

Point of View

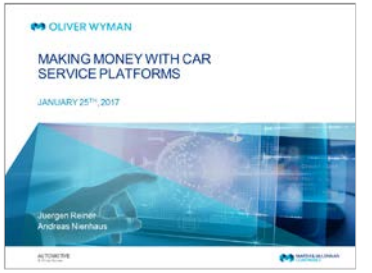


Digitization of Manufacturing Sales



Robotics and Industrial Automation Systems Market Study

E-Mobility 2035



Making money with car service platforms

Source: Oliver Wyman

Section 1 | Excerpt from FAST 2030 study for ACAN

FAST 2030
Study outline

Outline

- The automotive industry remains **on track for success** – **in continuation of the recent years**. After the crisis years 2008–10, both OEMs and suppliers have experienced a phase of prosperity
- However, this might turn out to be a short-lived chapter in light of the "**Mighty Seven Industry Trends"** – a perfect storm of transformative technologies and changing customer behavior – which challenge the core business pillars the industry is built on
- As a consequence, the shape of automotive **value creation is expected to simultaneously shift in three dimensions until 2030** – horizontally between vehicle systems, vertically between industry players, and regionally
- **Nine new business models** are emerging for auto suppliers creating a need to **re-define their role and operating model** in order to retain competitiveness
- In parallel, both suppliers and vehicle manufacturers will have to **foster holistic performance improvements** to offset the needed investments and absorb other looming externalities.

Sources

This is the **third edition** of the FAST study, created every five years in collaboration between Oliver Wyman and the German Automotive Association (VDA)

- **More than 100 expert interviews** with global top managers in the automotive industry as well as further external industry specialists
- Triangulation of a **vast set of market publications, industry reports, and other external sources** to gather additional both quantitative and qualitative insights on current and future developments
- Insights from **Oliver Wyman's global internal expert network, knowledge repository and recent intellectual proprietary** on industry dynamics and transformative trends (amongst others, "E-Mobility 2035 study", "Mobility 2040 study", "HMI point of view")

Agenda FAST 2030

1. **Status:** Current status of the automotive industry
2. **Trends:** Current and emerging trends changing the automotive industry
3. **Value:** Automotive value creation development until 2030
4. **Impact:** Areas of impact and strategic business model options for automotive suppliers

1

STATUS:
Current status of the automotive industry

Current status of the automotive industry – Overview

Overall, the automotive industry remains strong and continues to grow; suppliers are well positioned, but the road ahead is challenging

1 | Strong global growth of the automotive industry

Light vehicle production has grown to ~95 mn vehicles in 2017

+3%
CAGR (2010-2017)

2 | Regional value shifts in key markets

Emerging markets have been the key growth drivers with China leading at…

+15%
CAGR (2005-2017)

3 | Pressure both from need for increased customer value and on prices

Concurrently, products have become more complex at unchanged price levels

x1.6
PATENTS (2008-2016)

4 | Healthy profit margins for suppliers

Despite the tension, suppliers have shown sound financial performance

EBIT MARGIN
(average, 2015)

5 | …but increasing challenges for suppliers emerge

Disconnect between growth, new tech, and organizational readiness manifests in multiple issues such as quality

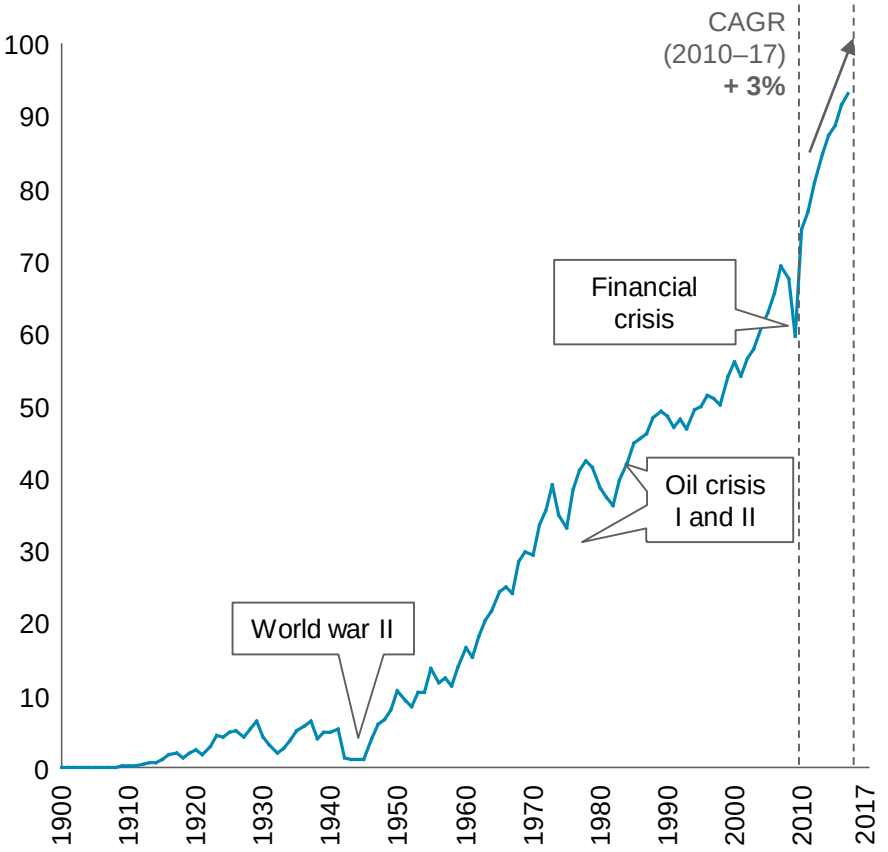
Source: Oliver Wyman analysis

1 The automotive industry – Historic trajectory

Despite some crises, the auto industry has been on a strong growth path for over 100 years with an especially strong recovery after the financial crisis...

Global light vehicle production development

In MM units, light vehicles, 1900–2017



Light vehicles incl. vehicles under 7t

Source: OICA, Ward's: World Motor Vehicle Data, LMC automotive, Oliver Wyman analysis

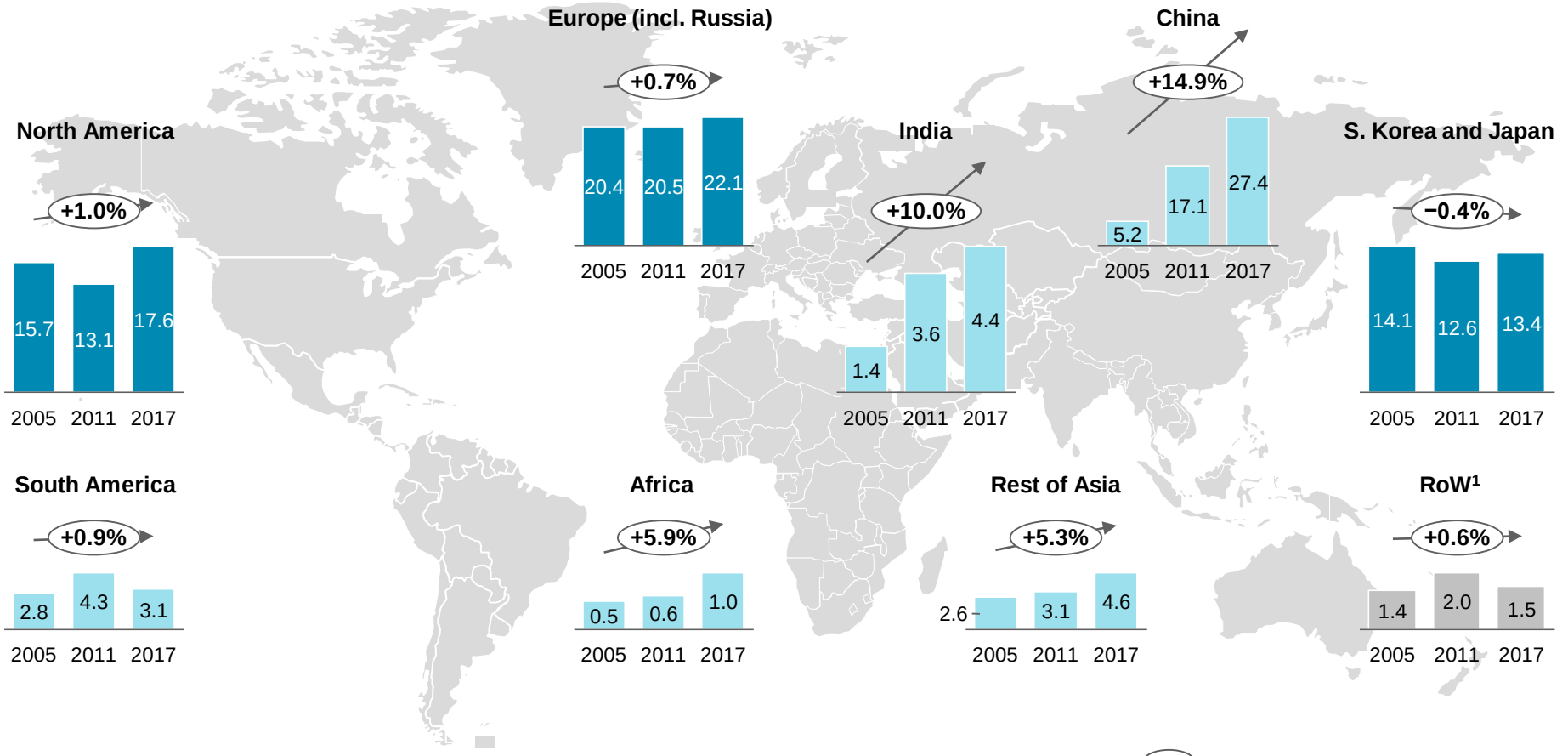
Comments

- Since 2012, the publish date of the FAST 2025 study, **market growth has persisted**
- In total, global light vehicle (LV) production grew steadily with a **CAGR of 3% between 2010 and 2017**
- **Largest** LV producers are **China, the United States, Japan, and Germany**, accounting for 59% of total vehicle production
- **Passenger cars** account for approx. **75%** of LV production, **commercial vehicles** for the remaining **25%**
- The **momentum of** automotive industry **growth** is expected **to continue** over the next years

2 Regional development

Key growth markets, especially China, are still the engines driving overall growth and the ongoing regional shift of the automotive industry

World light vehicle production
In MM vehicles



1. RoW includes Australia and Iran (amongst others)
Source: LMCA Q2/2017 and Q1/2012

Established markets | Emerging markets | Other | X.X% CAGR (Compound Annual Growth Rate)

2 Regional development – OEM production plants expansion in China

In China, the number of OEM production plants increased by more than a third since 2012, raising production capacity by about 50%

Overview of OEM production plants in China

production plants by region, 2012 vs. 2017

Central south [13%]

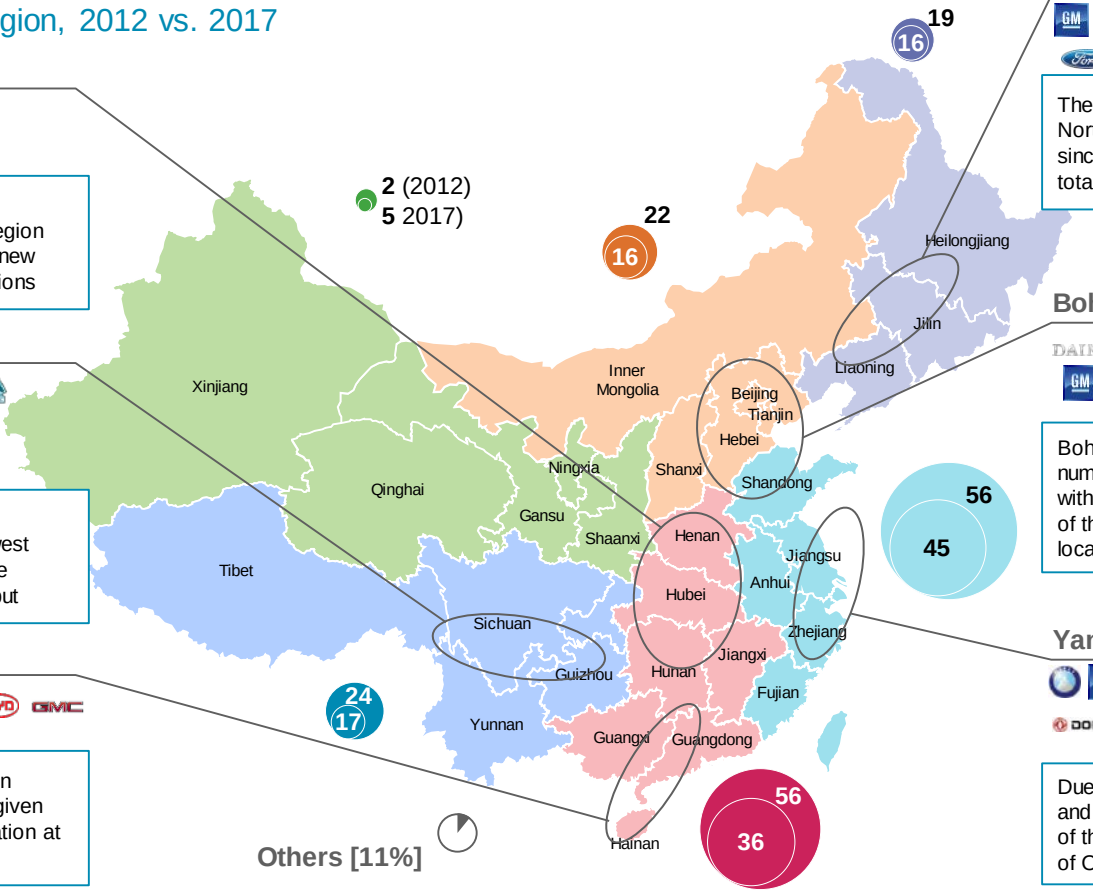
Central south remains important production location, although the region experienced relative low growth in new OEM plants compared to other regions

Southwest zone [21%]

With more than 15 individual car manufacturers located in in Southwest industrial zone, the cluster is in pole position in terms of production output

Pearl River delta [11%]

Very high growth in OEM production plants (almost 60%% since 2012) given highly beneficial infrastructural location at the South China Sea



Others [11%]

Northeast zone [10%]

The number of OEM production plants in Northeast China increased only slightly since 2012 (<20%), accounting for 10% of total Chinese vehicle production in 2017

Bohai zone [15%]

Bohai zone in North China with limited number OEM production plants – often with rather large volumes; More than 50% of the industrial clusters' plants are directly located either in Beijing or Tanjin

Yangtse delta [19%]

Due to its favorable location at the Yellow and East Chinese Sea, East China is one of the leading regions in terms of number of OEM production plants and output

% of total Chinese vehicle production 2017

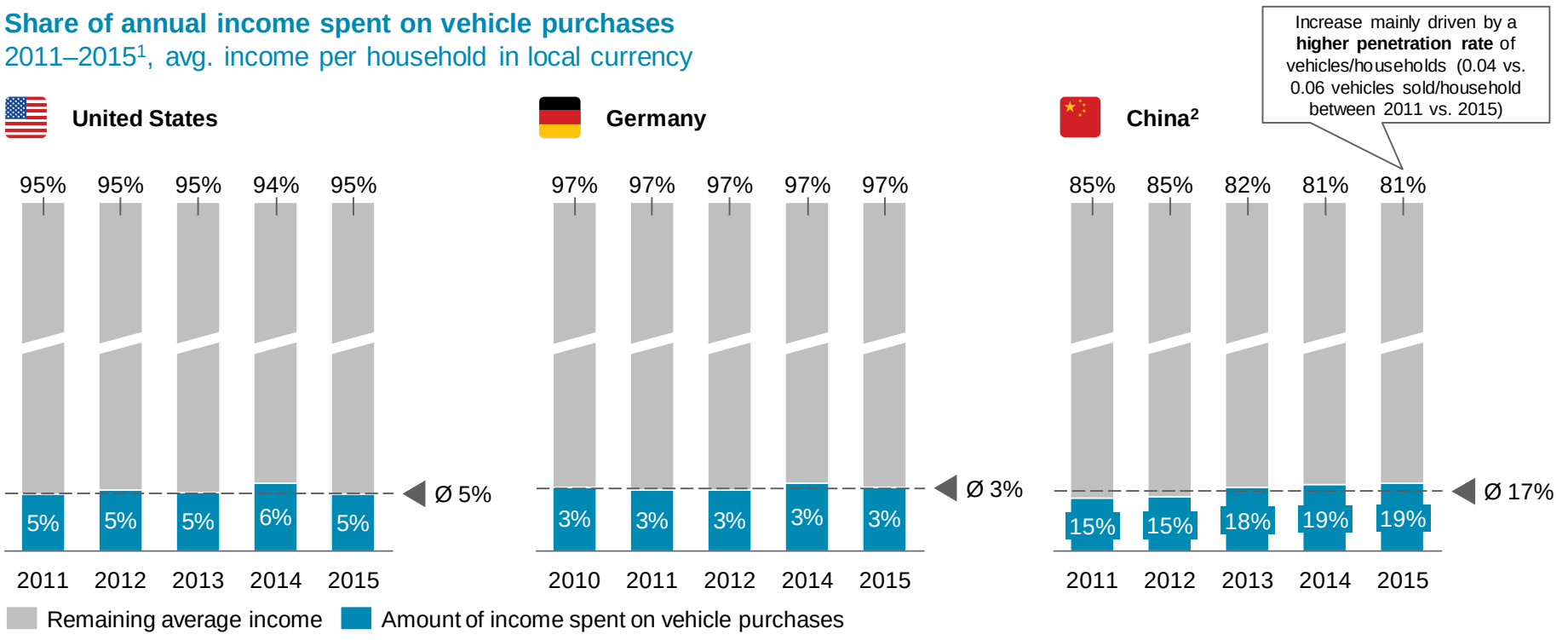
# of OEM production plants 2012 (inner circle) vs. 2017 (outer circle)

Source: Automobil Produktion, LMCA Q1/2018, Oliver Wyman analysis

Concentration and main expansion of OEM production plants in regional clusters along the coastline

3 Continuing crunch of increasing customer value vs. price pressure
Largely unchanged environment of customer spending

Share of annual income spent on vehicle purchases
2011–2015[1], avg. income per household in local currency



Despite increasing value of cars due to new technologies and functionalities as well as advanced electronics, households' spending behaviour for vehicle purchases has remained unchanged

1. Most recent data available per country 2. Total = amount of income spent on transport and communication
Source: Bureau of Labor Statistics, Statistisches Bundesamt, China Statistical Yearbook, LMCA Q2/2017, OECD, Oliver Wyman analysis

4 Supplier performance (Jan 2017)

With the OEM's common platform/part strategy, and despite a challenging environment, suppliers were able to show a healthy financial performance

PROFIT AND LOSS STATEMENT

REVENUE GROWTH
4.9%

EBITDA MARGIN
11.9%

EBIT MARGIN
7.2%

ROCE
20.7%

BALANCE SHEET

EQUITY RATIO
38.9x

NET DEBT/ EBITDA
1.1x

CASH FLOW

INVENTORY TURNOVER
12.6x

CASH CREATION[1]
0.05x

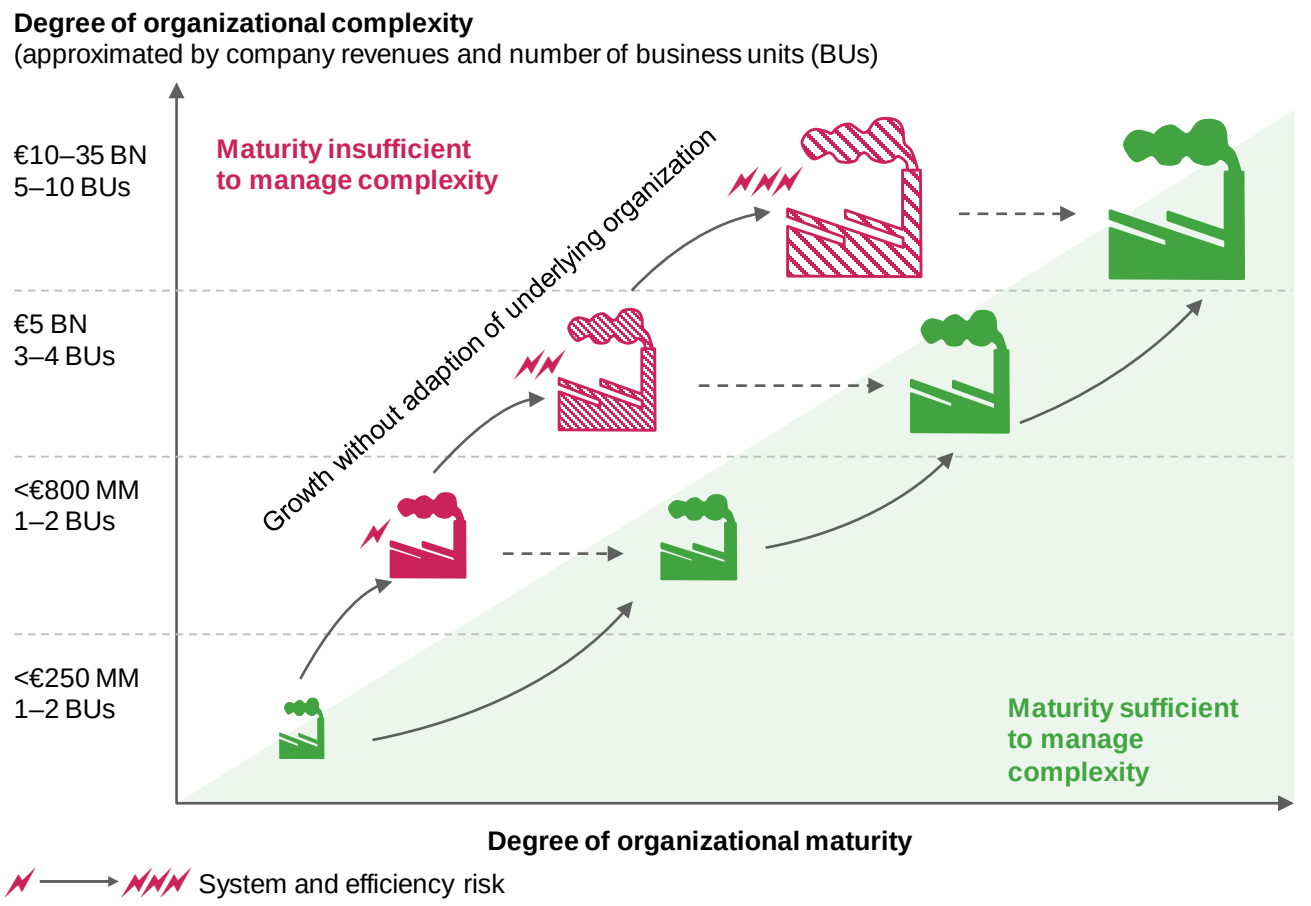
1. Change in Net Cash (average liquid minus financial debt) in relation to working capital at period end
Note: Suppliers with KPI variance greater than three standard deviations from mean have been omitted
Source: Oliver Wyman Supplier Benchmarking Database, company reports, Oliver Wyman analysis

Development from 2010 to 2016

5 First struggles of the automotive industry

Given strong business growth, many suppliers were slow at adapting their organizational model simultaneously risking system and efficiency problems

Organizational complexity



Source: Oliver Wyman Supplier Best Practice Benchmarking

Insight

- Most suppliers were "born" by creating a single product or having a single business line
- Along with organic growth or via M&A, suppliers developed in several different domains by expanding their portfolios and OEM applications, growing their client lists, moving from low-end to high-tech products, and going global
- Consequently, complexity has risen dramatically in many organizations

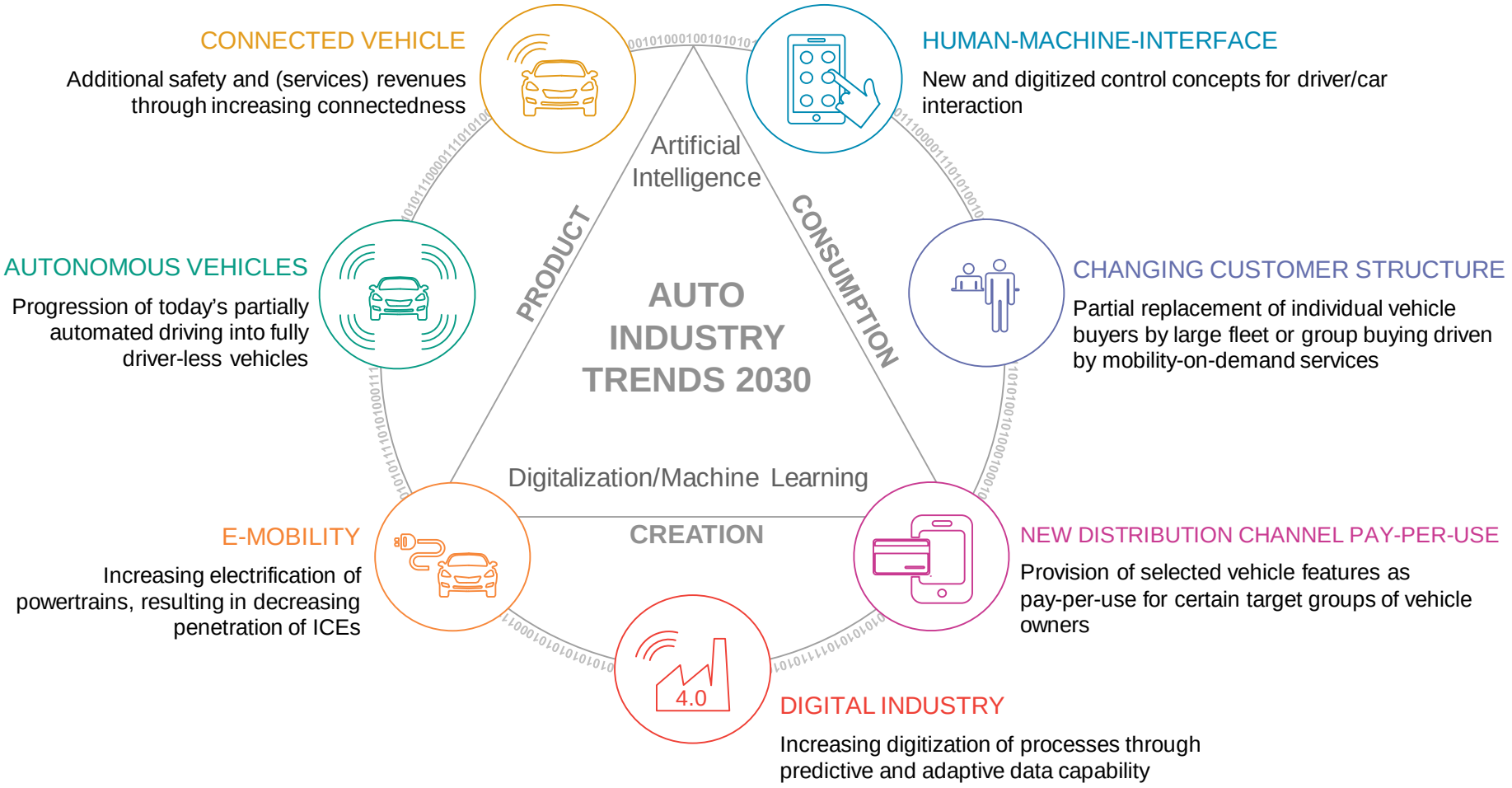
Many of the suppliers were hesitant to perform fast and bold enough modifications in their organizational structure needed to efficiently manage new types of challenges

2

TRENDS:
Current and emerging trends changing the automotive industry

The Mighty Seven – Automotive industry trends until 2030

Seven fundamental trends drive the automotive industry until 2030, enabled and accelerated by Digitalization, AI and Machine Learning



Source: Oliver Wyman analysis

Changing customer structure

TREND

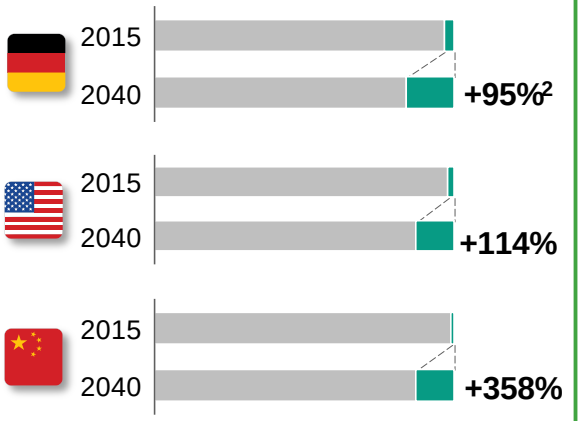
- Increasing shift from vehicle ownership to usership ("mobility on demand")
- New mobility fleet operators enter the market and increasingly replace individual vehicle buyers

DRIVERS

URBANIZATION · CUSTOMER PREFERENCES · DEMOGRAPHIC CHANGE

TREND REALIZATION

Mobility spend for passenger transport 2015 vs. 2040 by mode; total vs. 2015



Other modes of transport

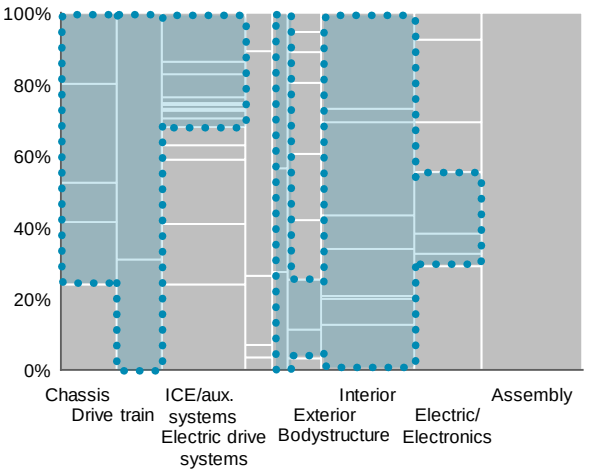
Bus · Air · Smart mobility services · Train · Private car

Individual mobility services

Car sharing · Car rental · Ride hailing

IMPACT ON VALUE CREATION

Value creation per vehicle module (2017)



Key potential impact on:

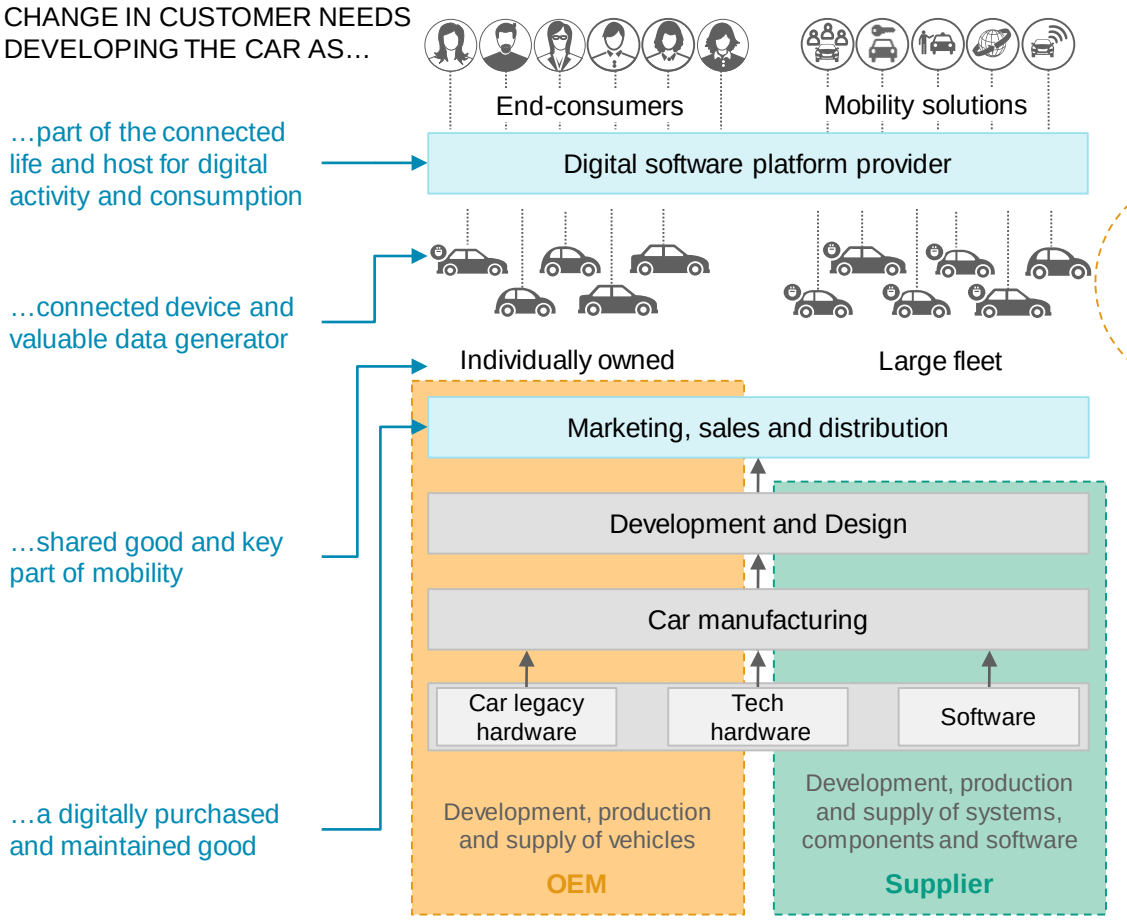
- Overall **vehicle design** to be more robust/low-maintenance, and less safe (for AD vehicles only)
- **Vehicle interior** to be more **functional** to meet customer usage patterns (e.g. robust materials, self-cleaning systems)

Source: Oliver Wyman study "Mobility 2040", Oliver Wyman analysis

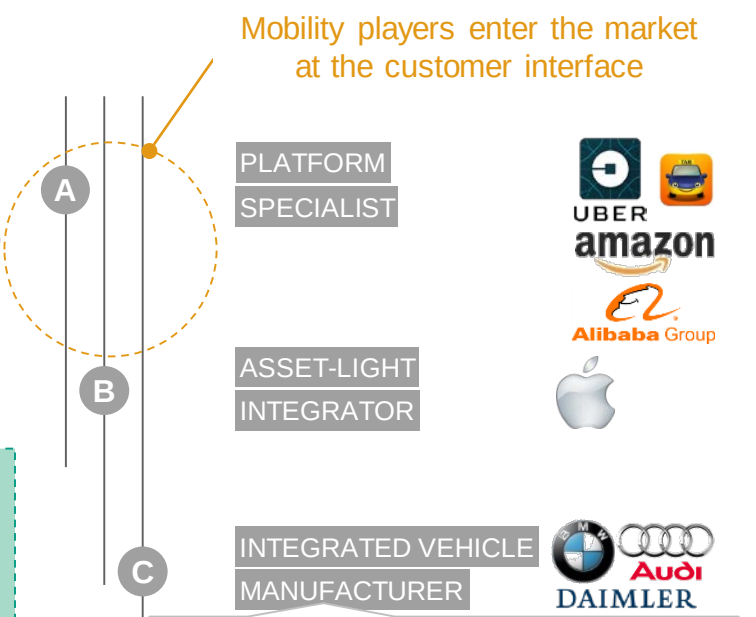
Changing customer structure – Automotive value chain under attack

Meanwhile, new mobility players are pushing into the automotive value chain and continuously replacing more individual vehicle buyers

Changing customer needs lead to disruptions in the mobility ecosystem…



…and the emergence of new mobility providers



OEMs increasingly investing in mobility services to find new usage models for cars:

- **Daimler (2017)**: Invest in **Via** (ride-hailing) and **Turo** (peer-to-peer car sharing)
- **Volkswagen (2016)**: Foundation of **MOIA** to offer own mobility services (ride-hailing)
- **GM (2016)**: Invest in **Lyft** (ride-hailing)
- **BMW (2016)**: Invest in **Scoop** (carpool platform)

Source: Oliver Wyman analysis

New distribution channel pay-per-use

TREND

- Customers ask for **individualized, selective, on-demand mobility** and service solutions, captured by pay-per-use business models
- These business opportunities occur in a variety of vehicle modules, opening up **new revenue generation models**

DRIVERS

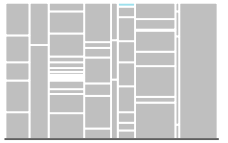
CUSTOMER PREFERENCES

TECHNOLOGY

TREND REALIZATION

Potential development pay-per-use

2017



Pay-per-use functions/services are technically feasible and envisioned

2030

Pay-per-use will be implemented in specific, best suitable (sub-)modules

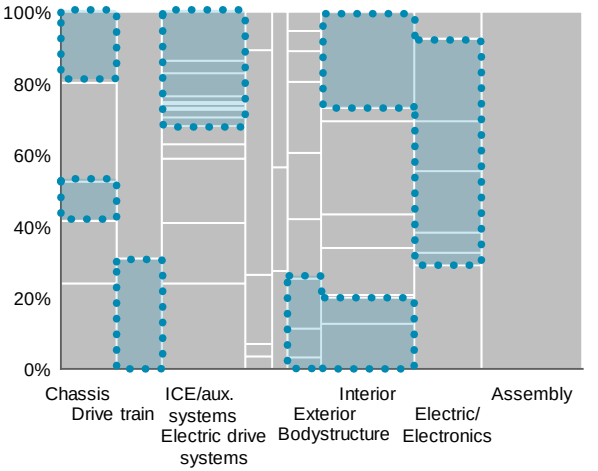
2060

\+ Near-vehicle pay-per-use services (e.g. streets, infrastructure, etc.)

Pay-per-use functions/services become more the rule than exception

IMPACT ON VALUE CREATION

Value creation per vehicle module (2017)



Key potential impact on:

- **Interior functions**, e.g. massage, park assistant and 3D sound
- **Performance features**, e.g. add. HP/kW and battery range extension
- **Exterior functions**, e.g. infrared/laser light, rain sensor

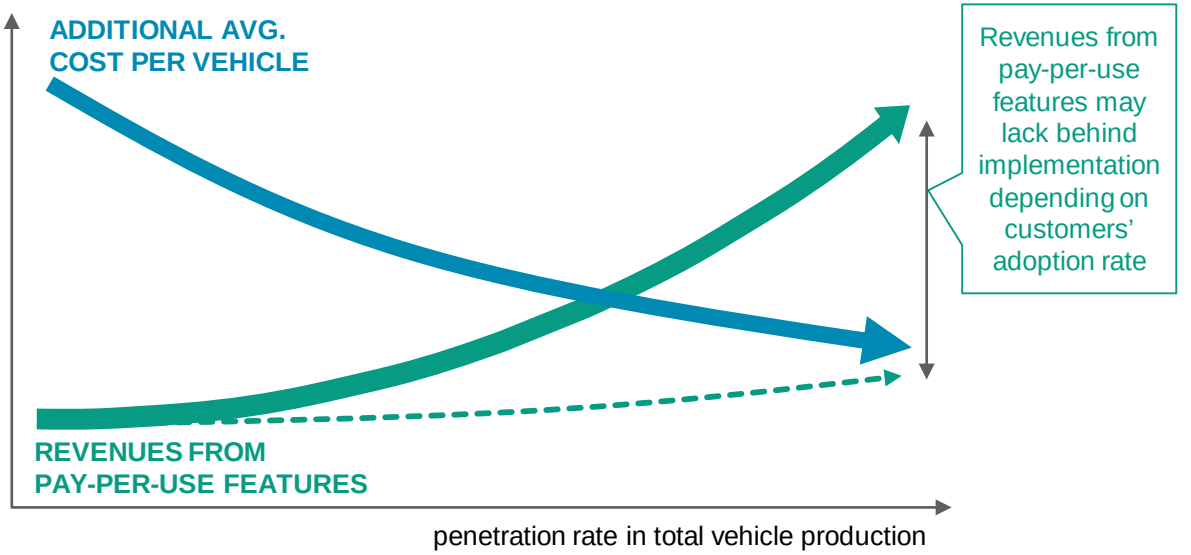
Source: Oliver Wyman analysis

New distribution channel pay-per-use

The interplay of increasing pay-per-use penetration and thus, component requirements, will significantly affect suppliers' cash flows

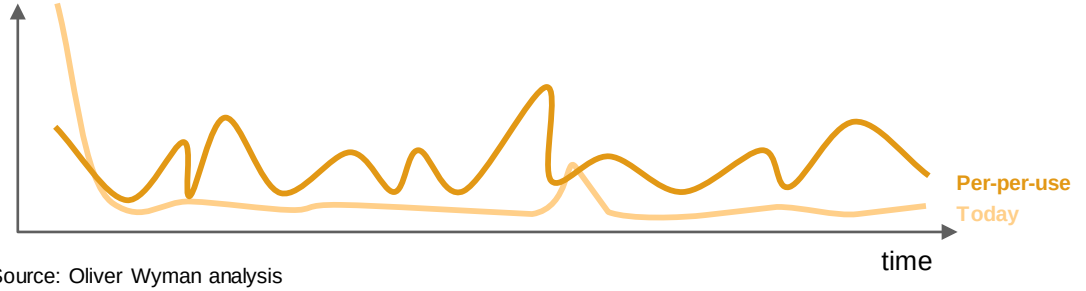
Potential development of pay-per-use and value creation impact

Exemplary cost and revenues for one pay -per-use feature



Cash flows for pay-per-use features vs. traditionally built-in components

Cash flow per vehicle over vehicle lifecycle



Source: Oliver Wyman analysis

Comments

- By **incorporating** components that allow **pay-per-use features, total cost per vehicle would increase**, while no revenues are generated at vehicle sale unless negotiated as higher fixed prices to the OEM upfront
- With increasing penetration in new vehicles sales, **cost per component could decrease** through economies of scale/standardization/lower variability
- However, **revenues and finally profits from pay-per-use are highly dependent** on customer acceptance, the consequent adoption rate and OEMs willingness to pass-through pay-per-use revenues
- Additionally, **cash flows would differ significantly** compared to today as revenues are generated only when customers are using features

Digital industry

TREND

- Digitization of processes through predictive and adaptive data capability:
- **Digitization and optimization** of core processes to support target customer experience
- Build up of superior data analytics, machine learning and "big data" competencies to deliver one holistic **customer-centric experience**

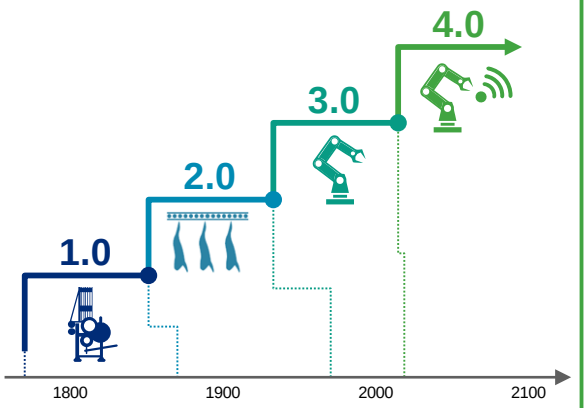
DRIVERS

CUSTOMER PREFERENCES

TECHNOLOGY

TREND REALIZATION

Development of the industrial era



1.0 Usage of water- and steam-power for mechanical manufacturing

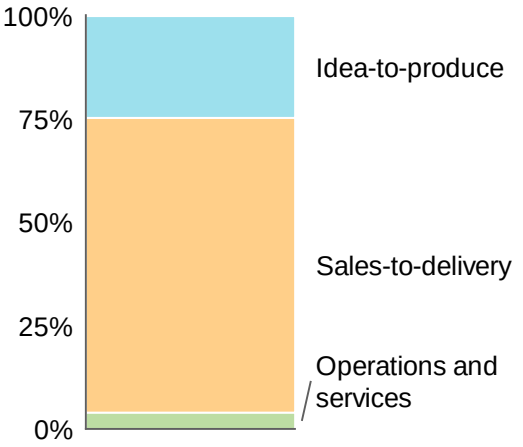
2.0 Electrically-powered mass production based on the division of labor

3.0 Leverage of electronics and IT to achieve further automation of manufacturing

4.0 **Cyber-Physical Systems to integrate production systems as well as product and production process**

IMPACT ON VALUE CREATION

"Digital industry" potential in 2030
Margin impact[1]



5% **Average impact** relative to industry revenue in 2030

1. Gross effect not including downside, basic production efficiency and pricing effects as well as specific business case considerations (i.e. investments); Value spaces were estimated based on industry-specific cost structures and were applied on approximated global value creation in 2030 (GDP growth assumed); Source: Oliver Wyman "Digital Industry" study

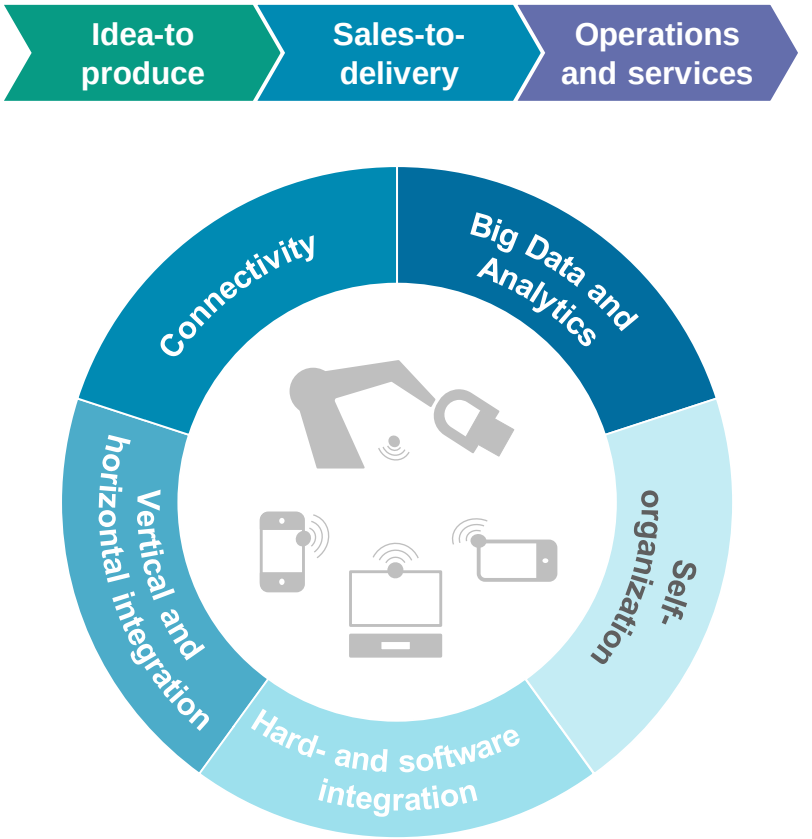
Digital industry

Driven by changing customer preferences and new technical solutions, the "Digital Industry" is gaining ground

Changing customer preferences

- Product individualization
- Permanent connectivity
- Personalization through Big Data
- Product as a service
- Hassle-free solutions
- Willingness to share data

Digital automotive industry



Technical enablers

- Data availability
- Declining technology costs
- Mechanical development progress
- Accelerating innovation cycles
- New production techniques
- Changing R&D patterns

Source: Oliver Wyman analysis

E-Mobility – Overview

TREND

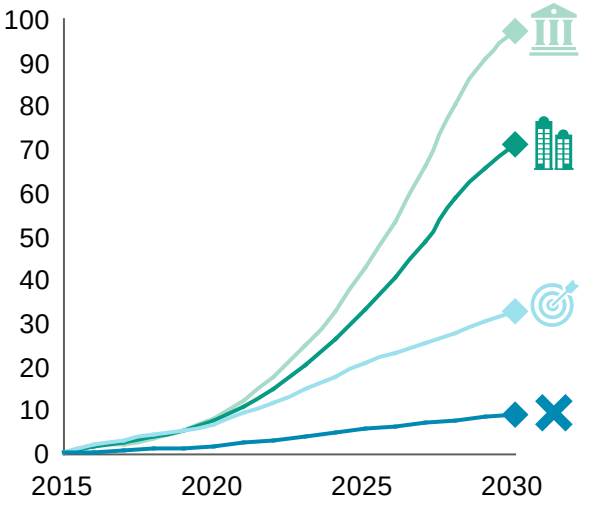
- **Electrified vehicles** are emerging as alternative powertrains to the internal combustion engine

DRIVERS

REGULATION · INFRASTRUCTURE · TECHNOLOGY

TREND REALIZATION SCENARIOS

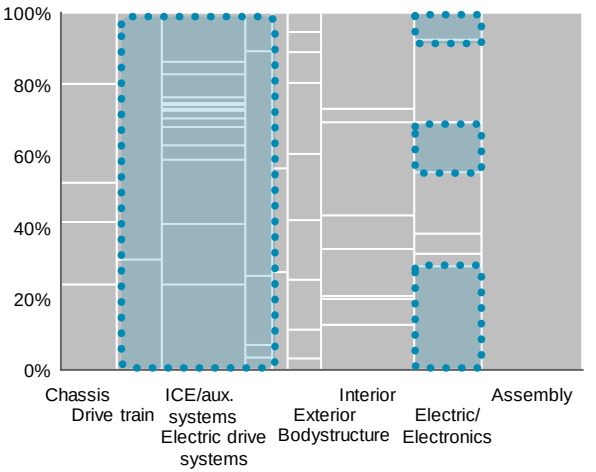
Ramp-up new EV sales 2015–2030 (%)



- Strong legislation (full ICE ban)
- Urban legislation (bans) and incentives
- Focus on incentives for urban areas
- No further legislation or incentives

IMPACT ON VALUE CREATION

Value creation per vehicle module (2017)



Main impact on:

- **Complete powertrain**, replacing combustion engine with fuel tank and exhaust system by battery with electric infrastructure
- **Electrics/electronics systems** related to E-Mobility (e.g. BMS and battery wiring)

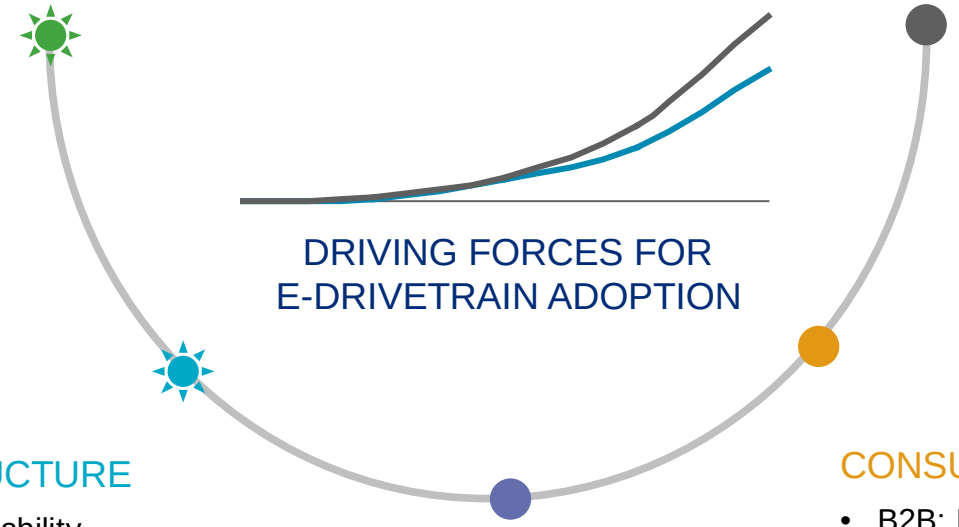
Source: Oliver Wyman analysis

E-Mobility – Drivers

How fast suppliers have to transform their portfolio and capabilities depends on the speed of market penetration which is driven by five major factors

LEGISLATIONS/ REGULATIONS

- Legislation and incentives
- Environmental concerns
- Fuel independence
- Sustainable mobility



COMPETITORS

- Brand and innovation strategy
- Product and service offerings
- Costs and investments needed

INFRASTRUCTURE

- Energy availability
- Charging infrastructure
- Technological compatibility
- User friendliness

TECHNOLOGY/COST

- Energy storage capabilities and fuel economy
- Performance and cost of new technologies
- Connection to Smart Home

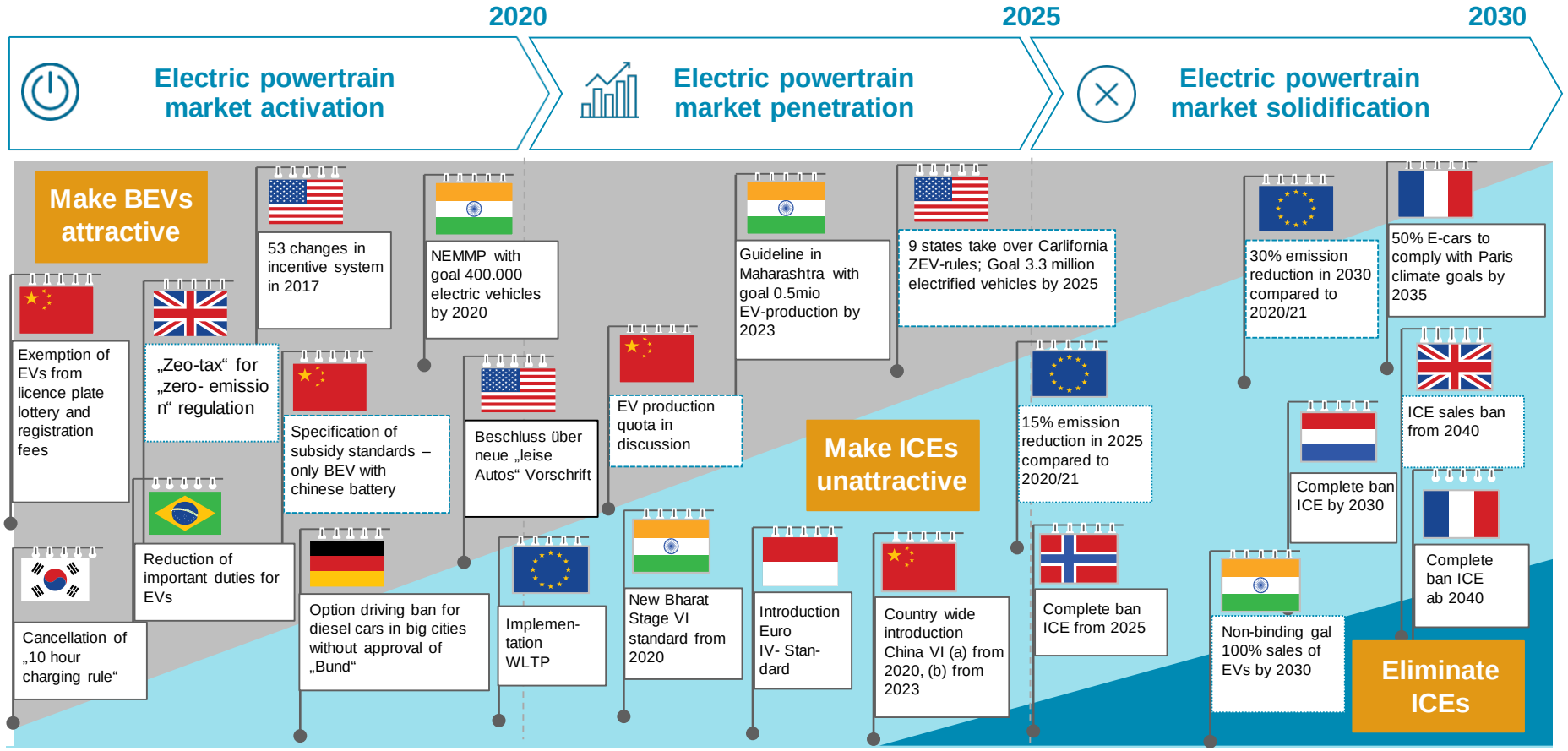
CONSUMERS

- B2B: Business strategy and long-term cost reduction
- B2C: Environmental awareness and preference for “green” modes of transportation
- Sharing economy
- Fleet management

Source: Oliver Wyman analysis

E-Mobility – Legislation and regulation

Regulatory interventions intensify and clearly reveal a three-stage agenda towards a comprehensive powertrain electrification within the next decades

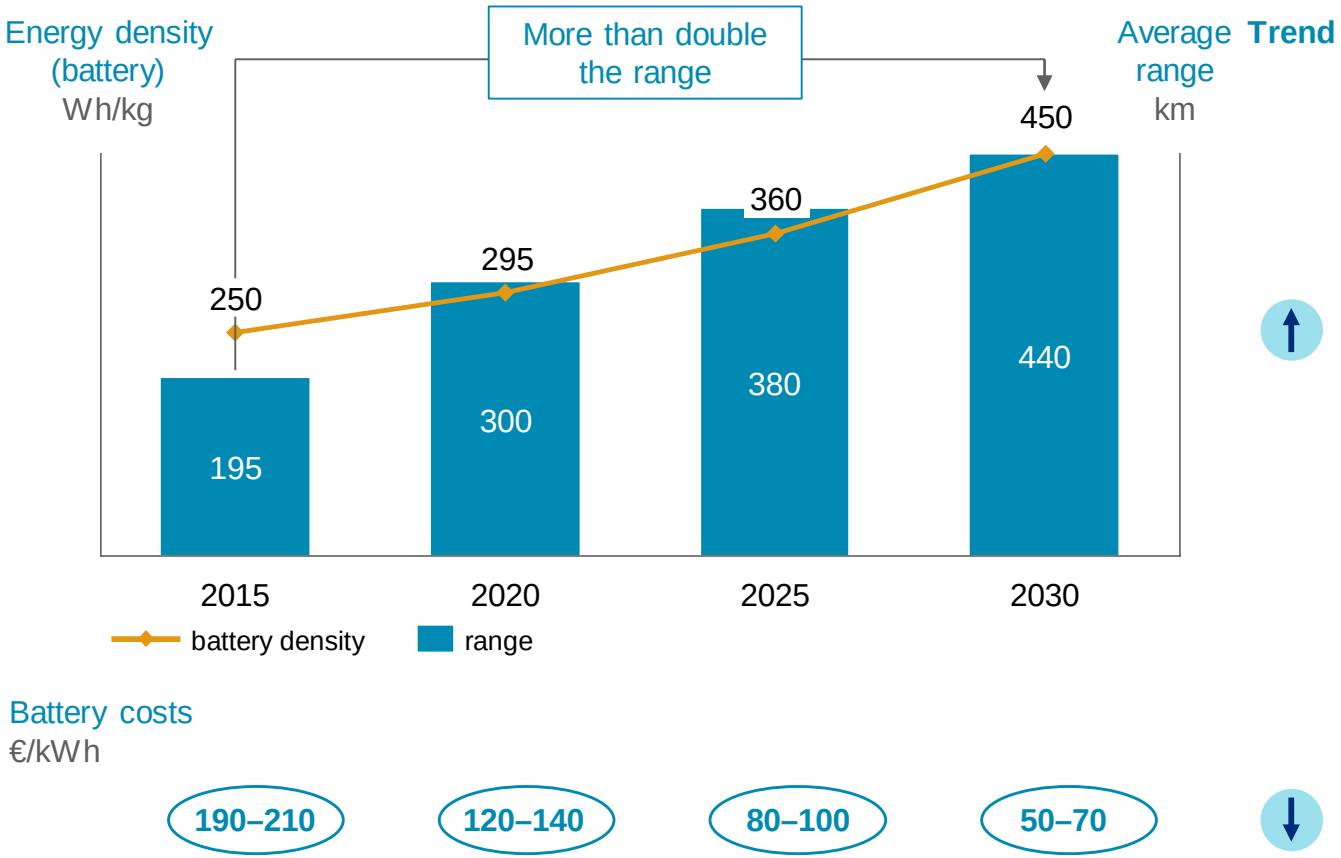


1. Statement„Climate Action Tracker Report“ with impact on all member states of Paris climate agreement
Source: ICCT; diesel.net; Press; Oliver Wyman analysis

E-Mobility – Technology and cost

Technological progress and decreasing costs will accelerate breakthrough of E-mobility within next decade

Forecast development of key technological parameters for E-mobility



Source: Merrill Lynch; Oliver Wyman analysis

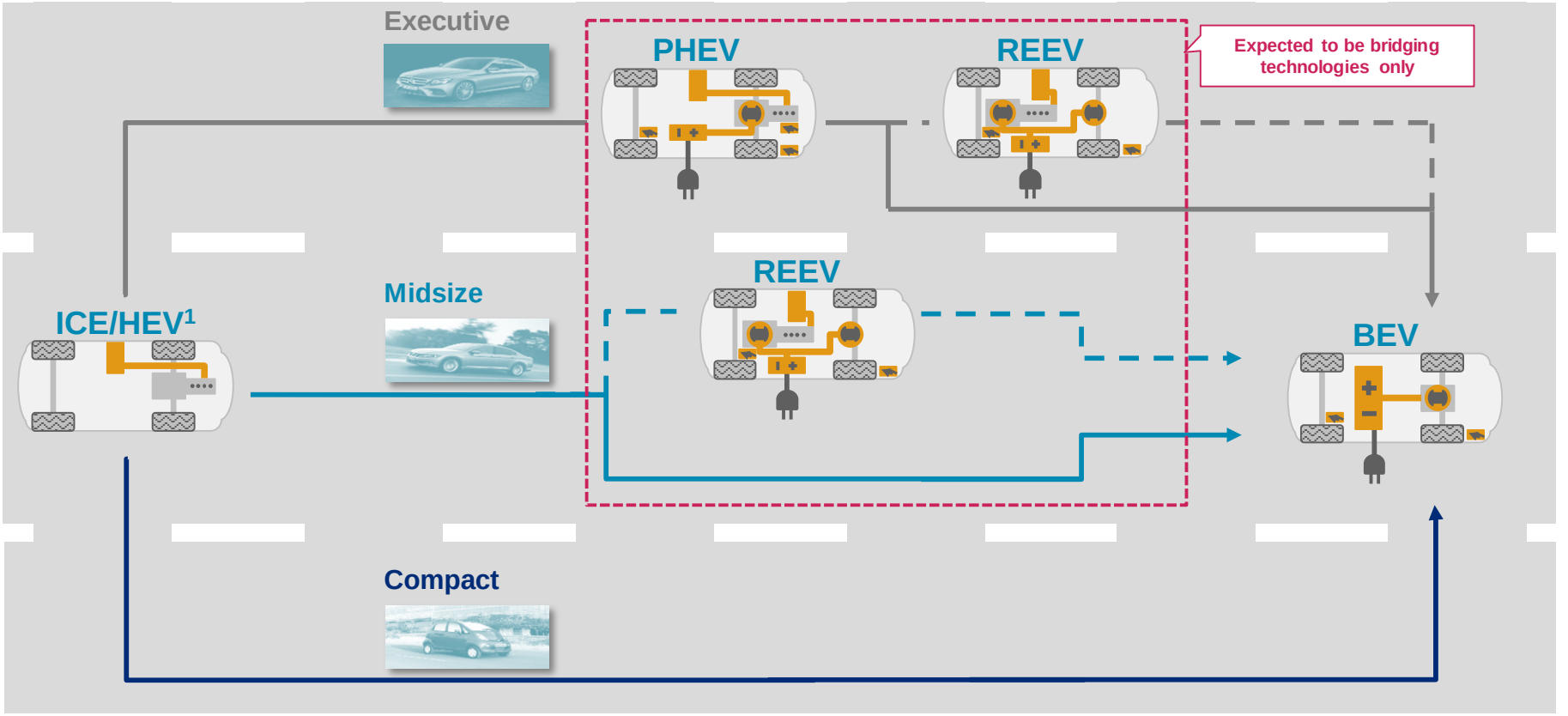
Comments

- **Range increase** – as one key purchasing criteria for consumers **– is technological focal area** for OEM and battery manufacturers
- Current developments promise **50–100% increase of energy density**
- **Additional long-term potential** through new technologies post 2025 likely (e.g. solid-state, LiAir)
- In parallel, **battery cost will decrease** continuously through **new materials**, **processes** and process **automations** along with new/lighter **cell designs** and **higher production volumes** (“economies of scale”)

E-Mobility – Competition

Car manufacturers have different electrification strategies depending on their vehicle class specific product portfolio

Different adoption paths for different vehicle classes over time



ICE = Internal Combustion Engine; HEV = Hybrid Electric Vehicle; PHEV = Plug-in Hybrid Electric Vehicle; REEV = Range-Extended Electric Vehicle; BEV = Battery Electric Vehicle; FCEV = Fuel-Cell Electric Vehicle

1. Including micro and mild-hybrid

Source: Oliver Wyman analysis

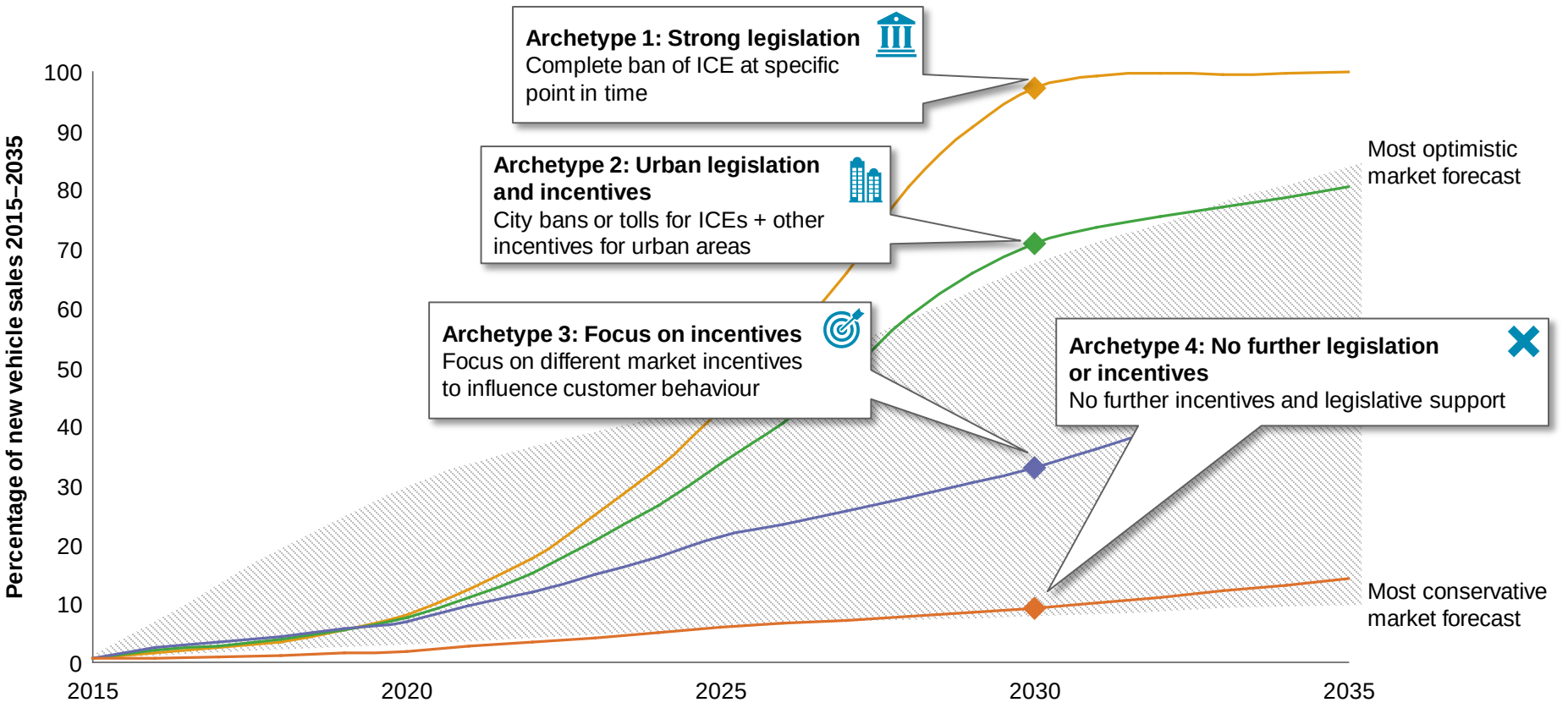
E-Mobility – Electrification scenarios

As such exist very different ramp up scenarios depending on specific level of governmental legislation and incentives

Forecast of new EV -sales 2015–2035

%

Illustrative



Source: Oliver Wyman “E-Mobility 2035” study

Autonomous vehicles – Overview

TREND

- **Advanced driver assistance systems** are already reality and allow the owner to hand over "driving" to the vehicle in certain situations
- Partially automated (L2) driving will progress into fully automated (L5) in the long run

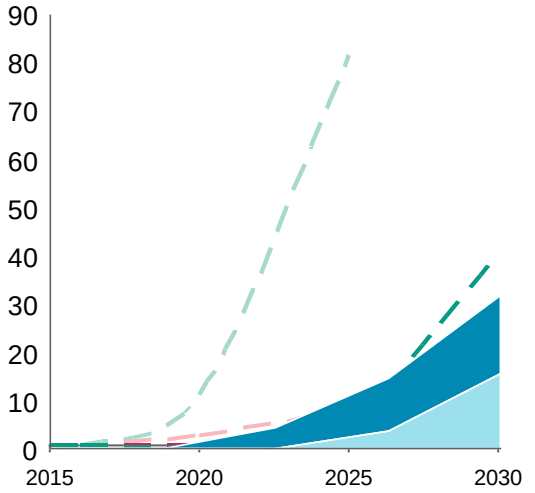
DRIVERS

SAFETY

COMFORT

TREND REALIZATION

New autonomous vehicle sales (# LV)[1]



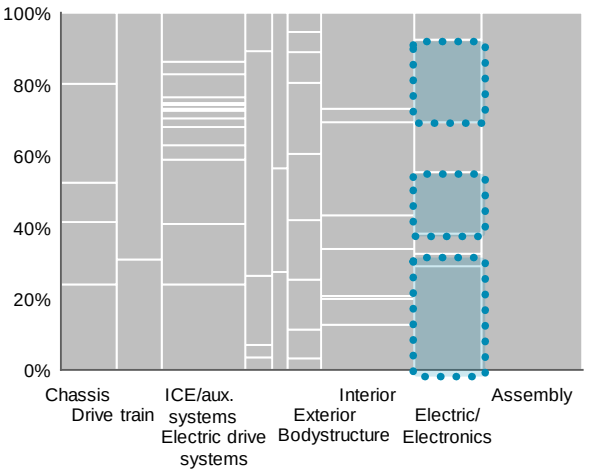
Base case: Automation Level 2/**Level 4**

Best case: Automation Level 2/**Level 4**

Worst case: Automation Level 2/**Level 4**

IMPACT ON VALUE CREATION

Value creation per vehicle module (2017)



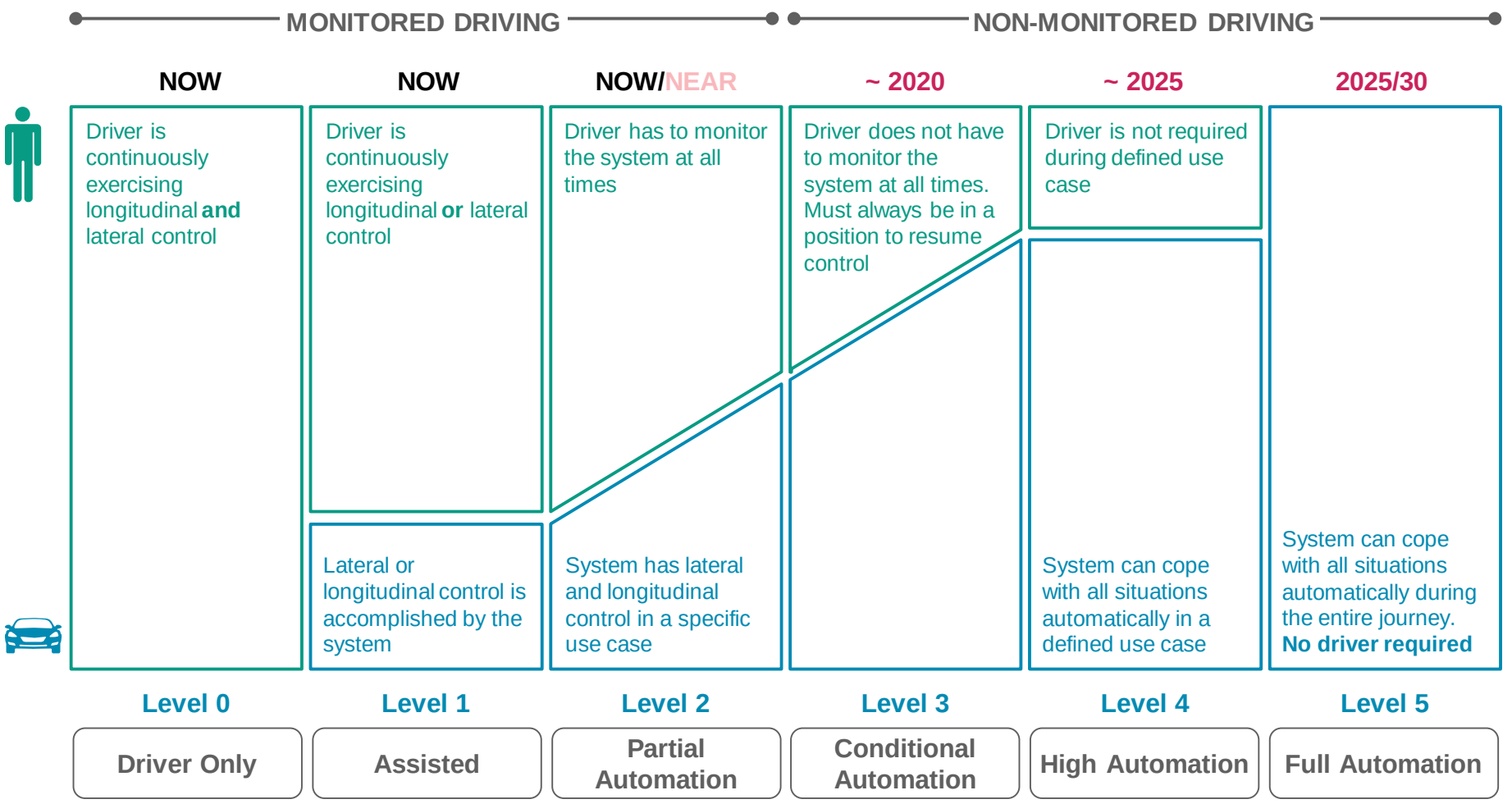
Main impact on electric/electronics systems:

- **Sensors** (incl. camera, radar etc.)
- **Information** and **communication** (maps/V2X communication)
- **Actuation**
- **Control unit** ("Intelligence")

1. Level 2 = Partial automation, where drivers still have to monitor the system at all times but systems takes over control in specific use cases; Level 4 = High automation, i.e. driver is not required during defined use case; Source: a16z. NHTSA, SAE, Oliver Wyman analysis

Autonomous vehicles – The evolution has already begun

Autonomous driving is still in early stages but is expected to reach full automation levels between 2025 and 2030



Source: NHTSA, SAE, Oliver Wyman analysis

Autonomous vehicles – 'Big players' moves

Big digital giants have already announced the introduction of self-driving vehicles in the near future

Tech-companies with deep pockets are pushing for fully automated vehicles…

	Company value in € BN[1]	Market introduction		Main partners	Origin
		Level 3	Level 4/5		
Google	417	–	~2020	Fiat, Chrysler	
Tesla	29	~2018	~2020	Nvidia	
Tencent 腾讯[2]	201	–	~2020[3]	Foxconn, Harmony	
Apple	536	–	~2021[4]	–	
Baidu 百度	49	~2018	~2021	Unconfirmed	
Uber	–	–	~2021	Volvo	

…while traditional automakers focus on a evolutionary step-by-step approach with partly less ambitious targets

	Company value in € BN[1]	Market introduction		Main partners	Origin
		Level 3	Level 4/5		
Nissan	92	~2018	–	NASA	
BMW[5]	129	~2021	~2021	Intel, Conti Mobileye, Nvidia	
VW[6]	178	~2019	~2025	Nvidia	
Daimler	152	~2020	~2025	LG, Quanergy, Bosch	
Toyota	287	~2020	–	Several Universities, Microsoft	

1. Thomson Reuters on 30th of August , 2016 – exchange rates of same day; 2. New start-up under the name Future Mobility; 3. Only for restricted cities and highways; 4. Unconfirmed activity
5. BMW iNext promises level 3 and level 5 autonomy option. The former will be more likely; 6 Including Audi with introduction of A8 with level 3 autonomy beginning of 2019
Source: Thomson Reuters, Faktiva, Forbes, Company websites, Oliver Wyman analysis

Human-Machine-Interface (HMI)

TREND

- Technological advancements and consumer pull for convenience and comfort will further drive the **shift from analog to more intuitive and augmented** HMI technology

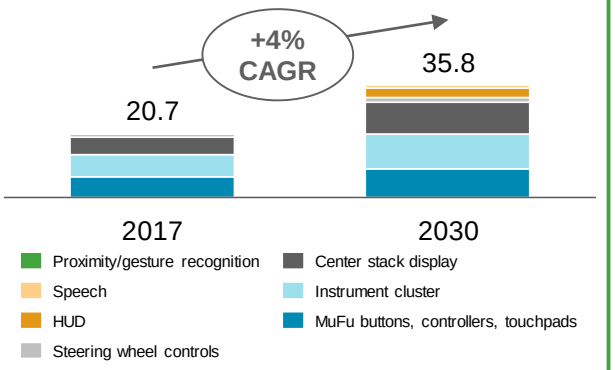
DRIVERS

CUSTOMER EXPECTATION

DIGITALIZATION

TREND REALIZATION

Automotive HMI market, 2017 vs. 2030 (in € BN)



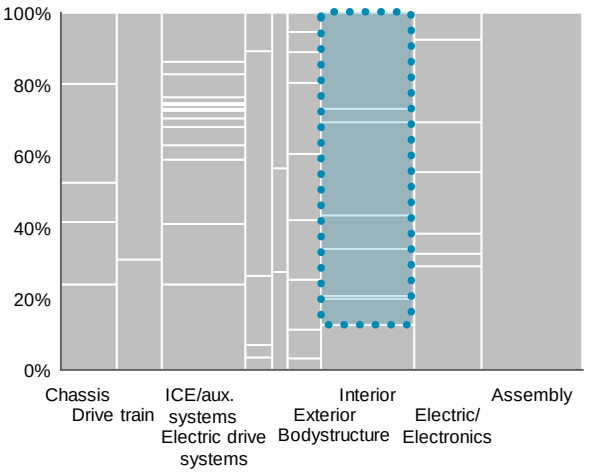
+19% CAGR **Proximity/gesture/voice recognition** Fast growing, but smallest HMI market

+15% CAGR **Head-up displays (HUD)** Fast growing segment, becoming the fourth largest HMI market by 2030

+5% CAGR **Center stack display** Moderately growing, becoming the largest HMI market by 2030 (joint pole position with instrument cluster category)

IMPACT ON VALUE CREATION

Value creation per vehicle module (2017)



Main impact on cockpit through ongoing digitalization:

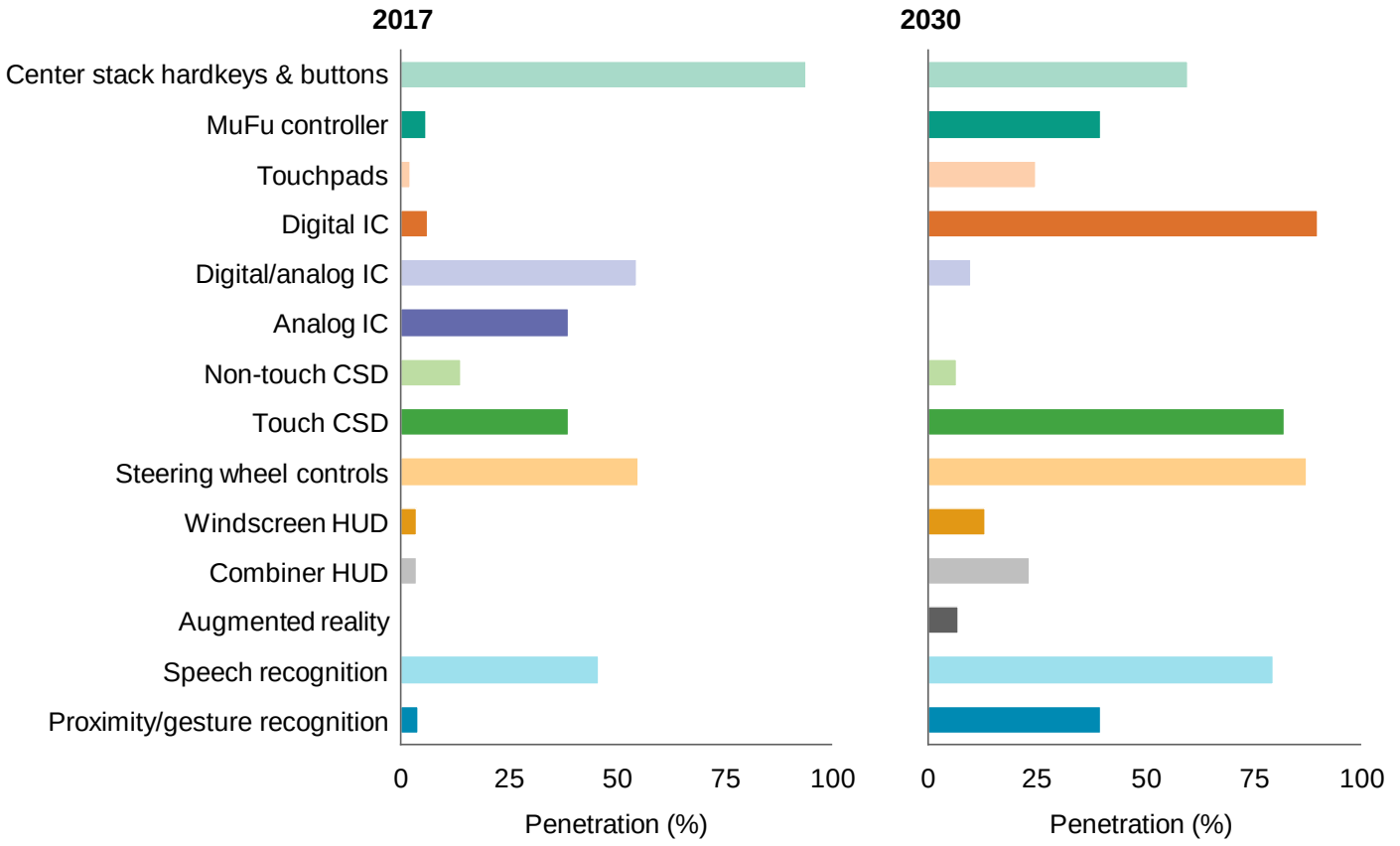
- (Central stack) displays
- Multifunctional controls
- Digital instrument cluster
- HUDs
- …

Source: Oliver Wyman analysis

HMI – Increasing demand for comfort and connectedness

Currently emerging technologies are expected to reach > 50% penetration already before 2030; ongoing digitalization of controls and instruments

Penetration rate of HMI technologies
In % of total vehicles, 2017–2030



Note: MuFu = Multi-Function, CSD = Center stack display, IC = Instrument cluster, HUD = Head-up display
Source: Oliver Wyman HMI Point of view

Comments

- The future cockpit will deliver an increasingly **intuitive, innovative and personalized user experiences**
- This next-generation HMI is expected to prevail until 2030, smartly combining **voice control**, **touchscreens** and **conventional controls** depending on **application** and **passengers**
- Development will be fueled by ongoing **vehicle automation**, and – predominantly – the achievement of **critical mass** together with **increasing functions/components integration**

HMI – Non-auto players enter the market

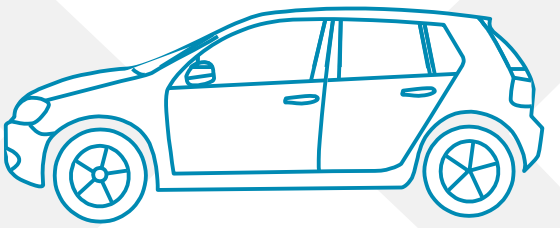
Increasing importance of electronics and automated systems attracts non-auto technology experts – competition for traditional suppliers increases

Large established player

Digital giants

Consumer electronics players

Technology specialists



Startups

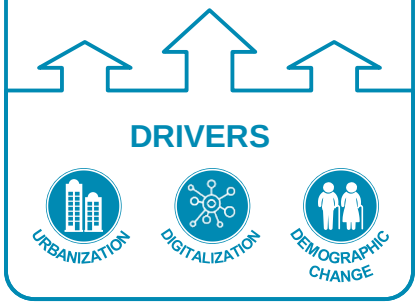
1. Samsung, already involved in automotive through Renault Samsung Motors, is creating a new automotive components team specialized on infotainment and autonomous driving

Source: Oliver Wyman HMI Point of view

Connected vehicle

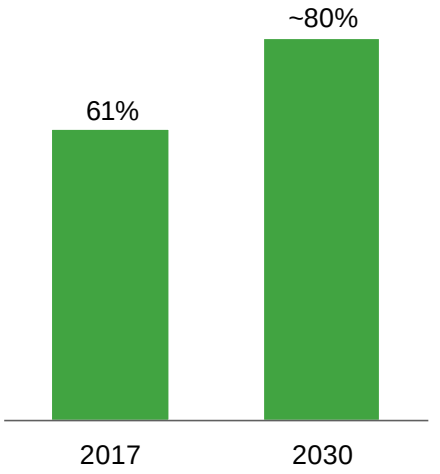
TREND

- **Urbanization** and the **demographic change** put “digital natives” in the driver seat
- Consumer expectations shift, making **individualization** and convenient device/service **integration** key
- Further, continuous **smart device and mobility** availability is fueled by the rate of change of converging industries



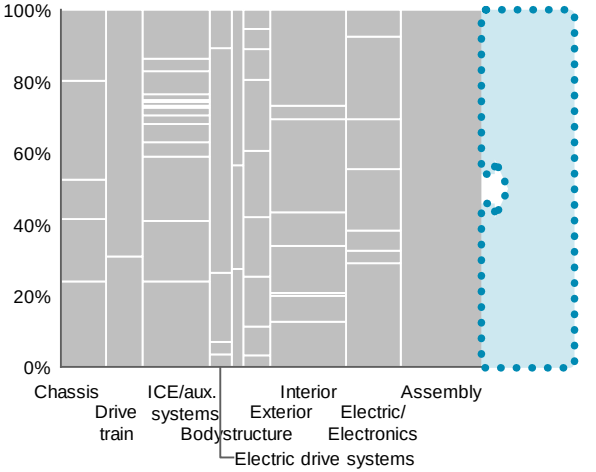
TREND REALIZATION

Penetration rates of embedded connectivity units in LV production



IMPACT ON VALUE CREATION

Value creation per vehicle module (2017)



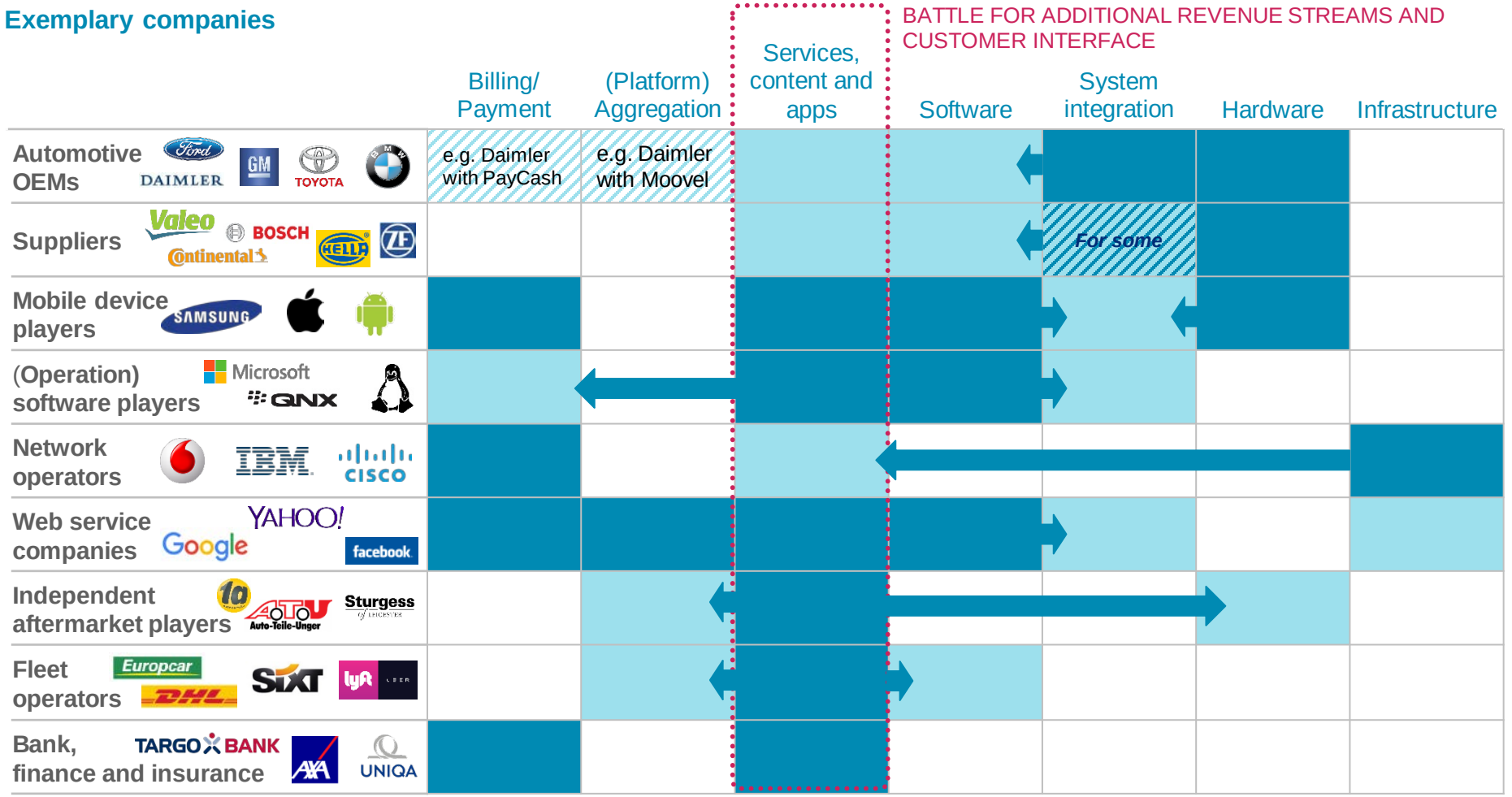
Main impact by creating add-on connected services, such as:

- Telematics-enabled **insurance services**
- **Fleet management** services
- **Safety and remote** services

Source: Oliver Wyman analysis

Connected vehicle – Battlefield for revenues and customer access

Consequently, many players of the connected car ecosystem are getting into position with a focus on entering and monetizing (data based) services



Source: Oliver Wyman analysis

2a

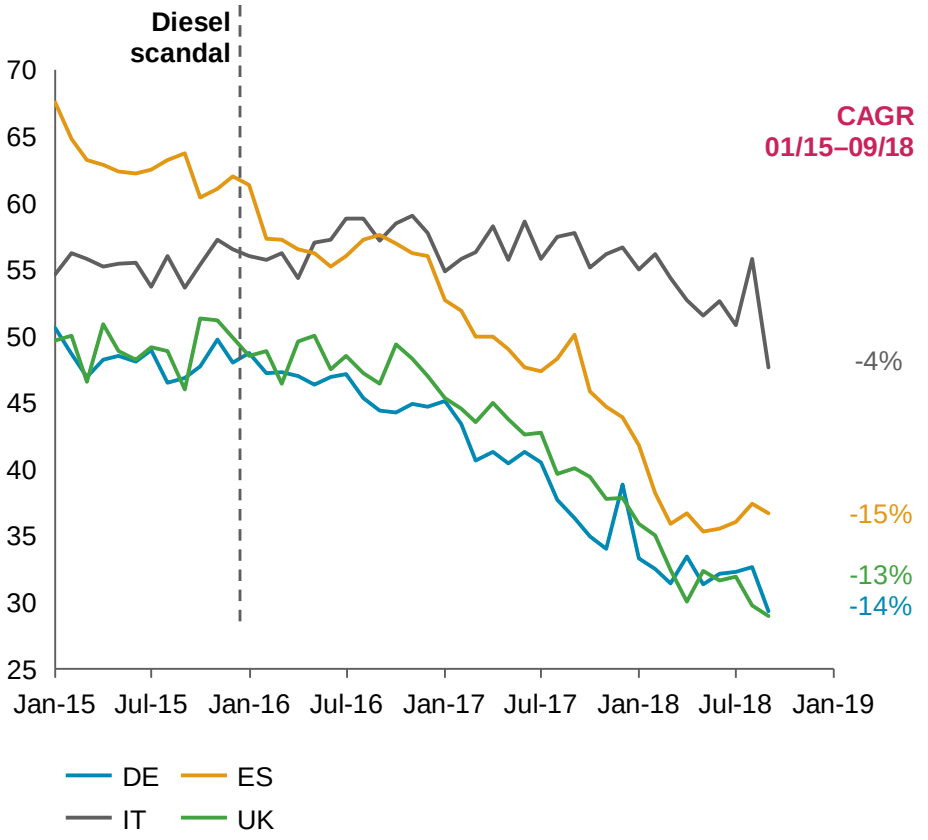
Trends:
Recent developments

2 Diesel demand development (1/2)

Diesel sales have significantly declined in face of the recent diesel scandal and do not yet show a sign of recovery

Diesel share of passenger vehicles

In % of ICE vehicles, Jan 2015 – Sep 2018 by month



Commentary

- Sales of diesel driven vehicles have significantly declined across Europe and the US since the 'Diesel-gate'
- Continued negative press and bad public perception on diesel emissions while in reality diesel total emission balance (for mid-sized & larger) is better than for gasoline
- Public uncertainty about future usefulness of diesel engines in face of public discussion on diesel bans in cities currently limits sales

> *We definitely see massive decreases in the diesel share which puts a lot of pressure on the OEMs for hybrids and BEVs to meet CO_2 targets*
>
> – Senior Manager, Tier-1 Supplier

> *For small PV we do not see any diesel engines anymore in the future. In the long-term we see approx. 20% market share of diesel in Europe*
>
> – Senior Manager, Tier-1 Supplier

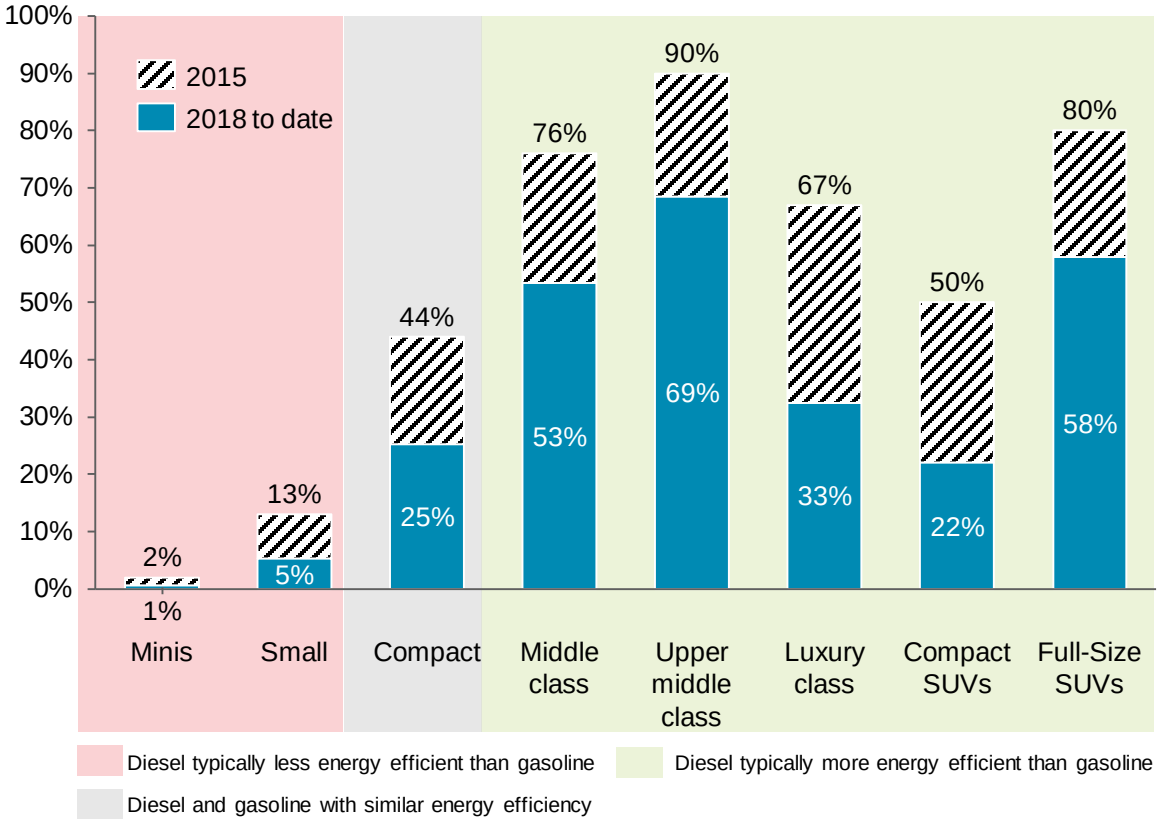
Source: KBA, SMMT, ANFIA, ANFAC, Wikipedia, Financial Times, Bloomberg, Tagesspiegel, n-tv, expert interviews, Oliver Wyman analysis

2 Diesel demand development (2/2)

Diesel sales have decreased across all segments in Germany since the diesel scandal, also in the more energy efficient segments

Diesel share of passenger vehicles by segment [1]

In % of ICE vehicles, 2015 vs 2018



1. Segmentation according to KBA statistics

Source: Expert interviews, KBA, Tagesspiegel

Commentary

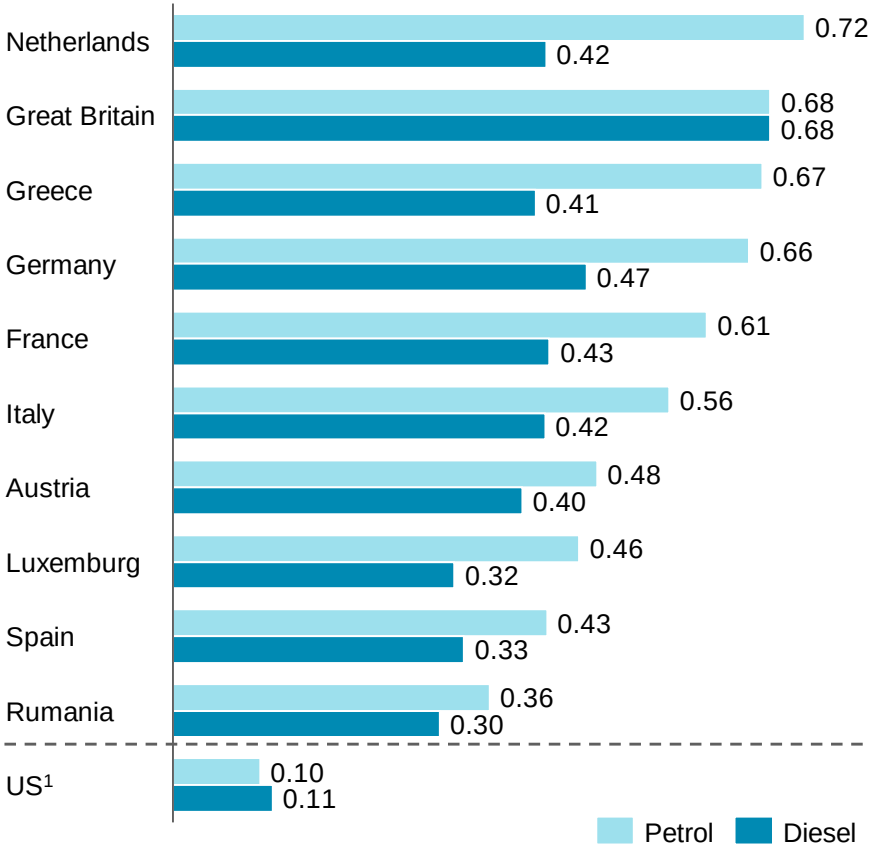
- Already in 2015, Diesel has been the primary energy source in the larger vehicle segments
- Diesel shares have fallen significantly across all segments since 2015 in face of the diesel scandal
- Decline of diesel share in mini and small car segments beneficial to overall emissions while decline in mid-sized to large segments will increase total emissions and thus pressure on OEMs to find alternative to meet fleet emission targets by 2021

3 Diesel market background

Diesel engine demand in Europe is supported by low tax, diesel attractiveness would significantly decline if lawmakers remove the benefit

Fuel taxes for gasoline and diesel by country

In EUR/liter



1. Conversion rate: 1 USD = 0.81 EUR, 1 gallon = 3.79 l

Source: EIA, Statista, expert interviews, Oliver Wyman analysis

Commentary

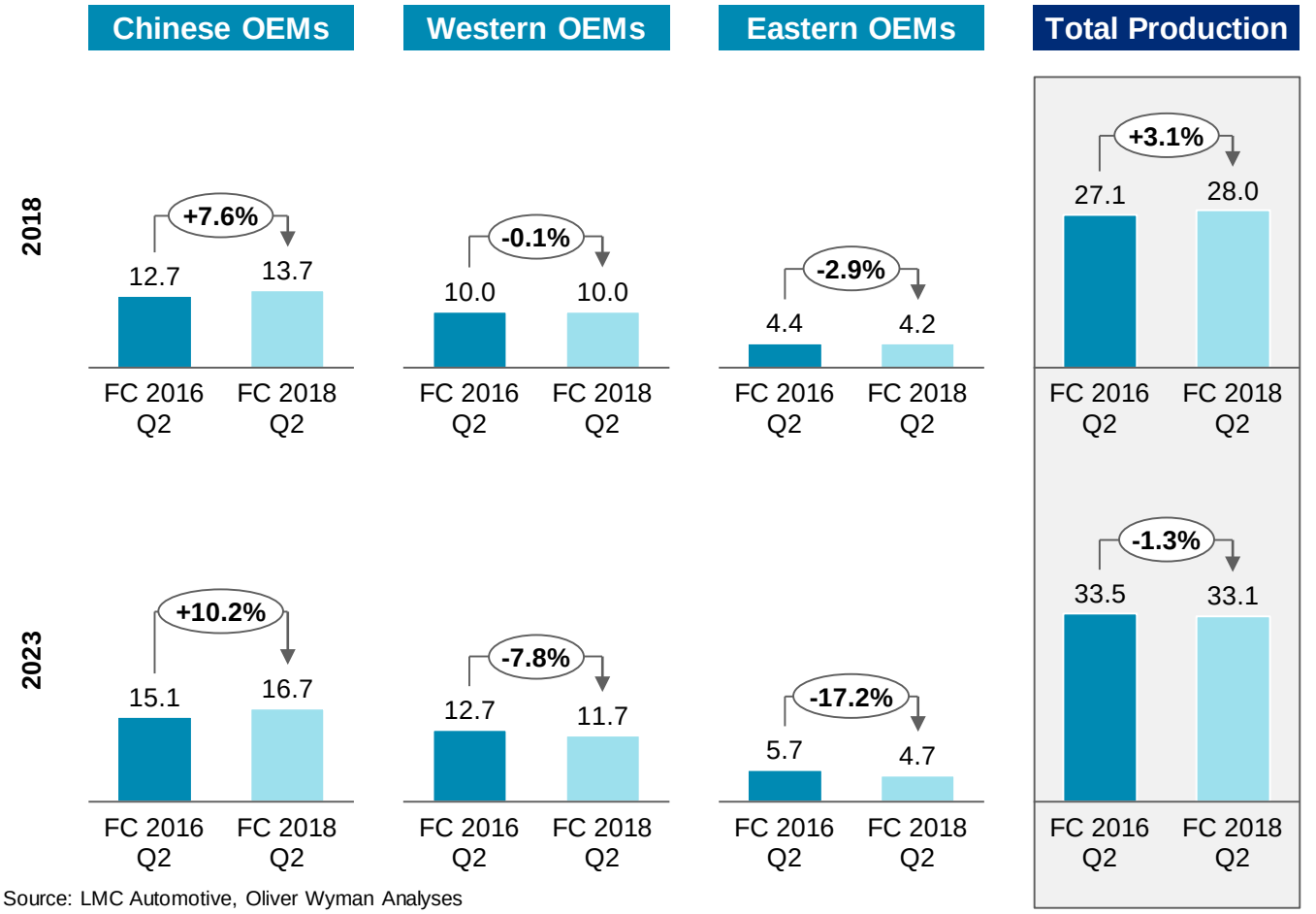
- Europe: Gasoline fuel taxes generally higher than for diesel
  - Diesel favored by customers from TCO perspectives
  - Aim of governments to reduce CO_2 emissions and fuel consumption
  - Strong standing of European automotive industry developing diesel technology
- US: No tax incentive for diesel, diesel purchases in the US driven by utility considerations
  - No tax incentive and higher purchase prices
  - Use-case mainly for higher torque requirements/ towing capabilities

China light vehicle production | OEM shift

Western OEMs are losing ground in China in favor of local OEMs inducing a business risk for international players

Chinese light vehicle production 2018 and 2023 by forecast year

In mn. light vehicles



Source: LMC Automotive, Oliver Wyman Analyses

First insights

- Compared to the forecast 2016 Q2, overall car production 2018 in China is estimated to be higher
- Western and Eastern OEMs did not participate at higher volumes, while Chinese OEMs strongly increased production
- The trend of a shift to local OEMs is expected to accelerate until 2023
- A shift to local OEMs induces a major risk for Western automotive suppliers, which spent substantial amounts of CAPEX in China, as expected production volumes with key clients may not realize
- Participating at increased volume of local OEMs might be challenging due to a general preference of local suppliers

3

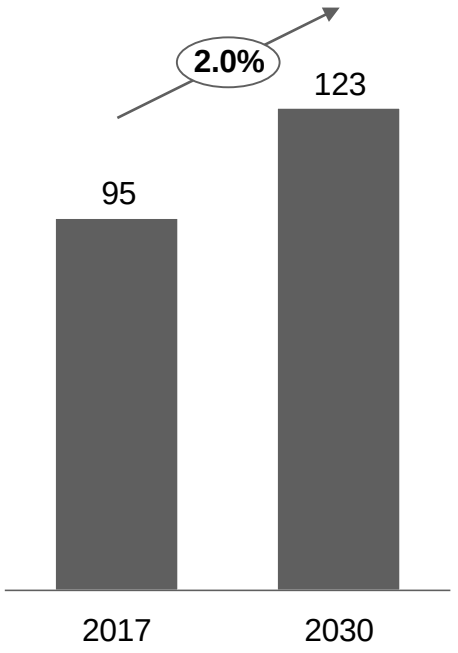
VALUE:
Automotive value creation development until 2030

Total automotive value creation development until 2030

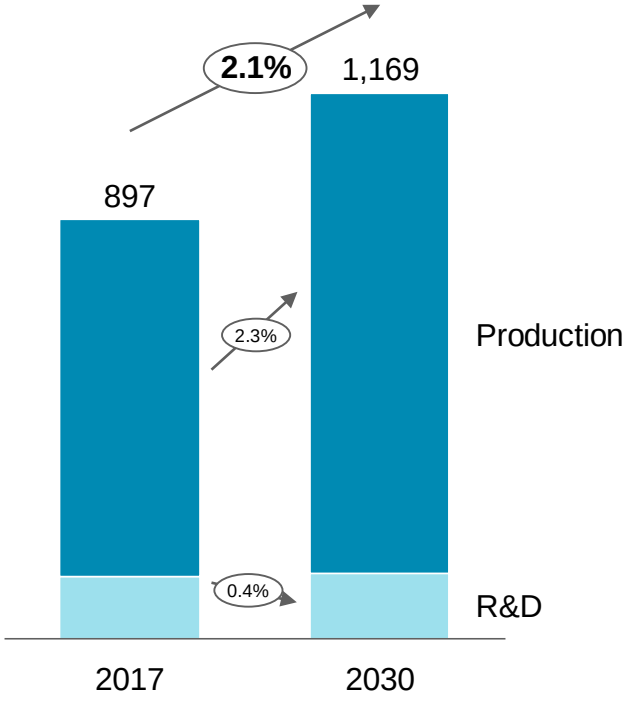
Despite multi-dimensional changes, automotive value creation is expected to only track car production growth at around 2% p.a.

Growth forecast of automotive market

Vehicle production volume
(in MM units)



Value
(in € BN, inflation corrected)



Source: Oliver Wyman value creation model

Comment

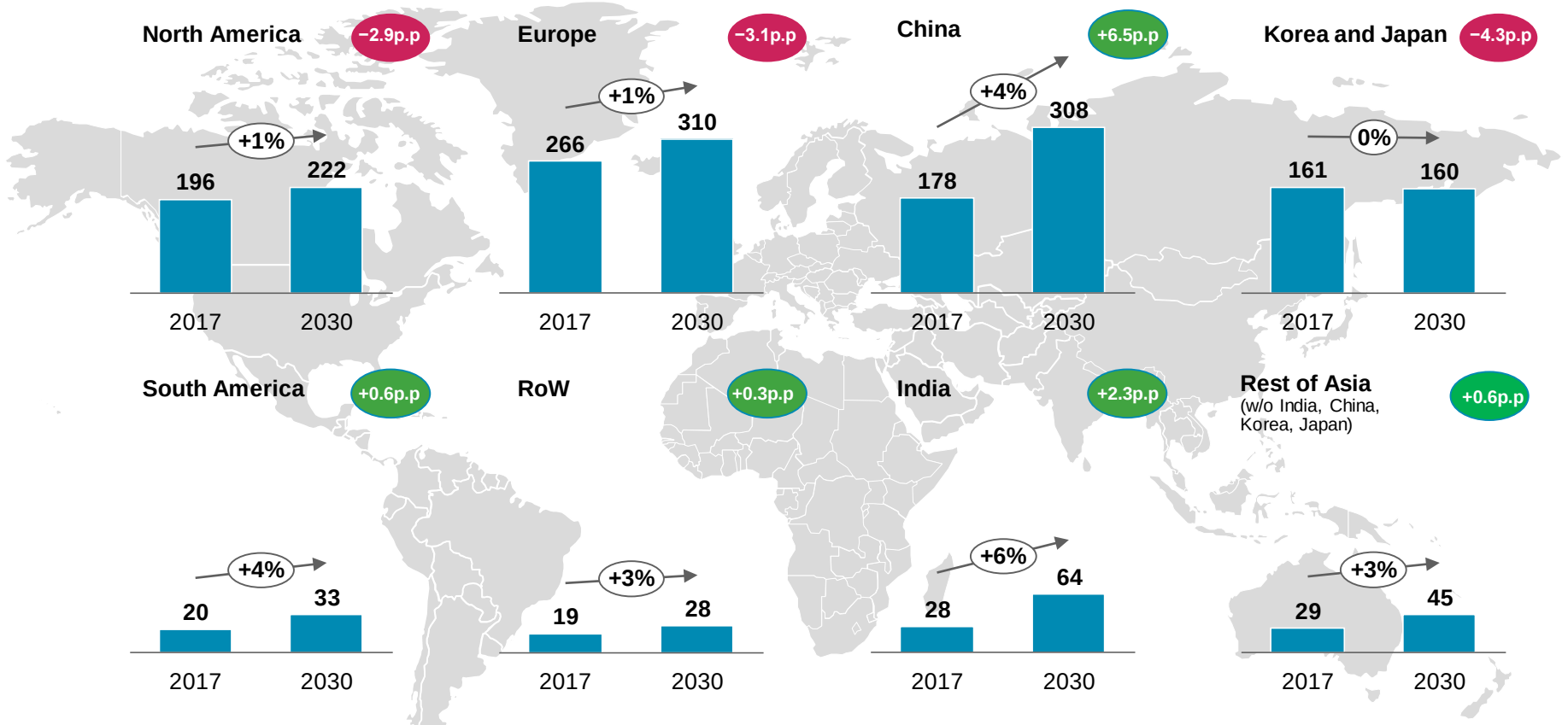
- The increase in **value creation** will mainly be driven by **vehicle production,** i.e. increasing **number of cars sold** and **higher value technologies** build into cars (~2.3% p.a.)
- **R&D gains only slightly** (0.4% p.a.) as already today industry players are investing heavily in the development of new technologies (e.g. vehicle electrification and autonomous driving), which is expected to remain stable or even decrease in future
- Besides setting the right technological development focal areas, **OEMs and suppliers need to continuously increase efficiency** and subsequently **decrease costs** within their R&D efforts

Regional shifts in automotive value creation until 2030

Emerging markets continue to catch-up and gain around 10 p.p. value creation share by 2030

Development of value creation by region/segment

In € BN



X.X% CAGR (Compound annual growth rate)

Change in share of total value creation 2017 vs. 2030

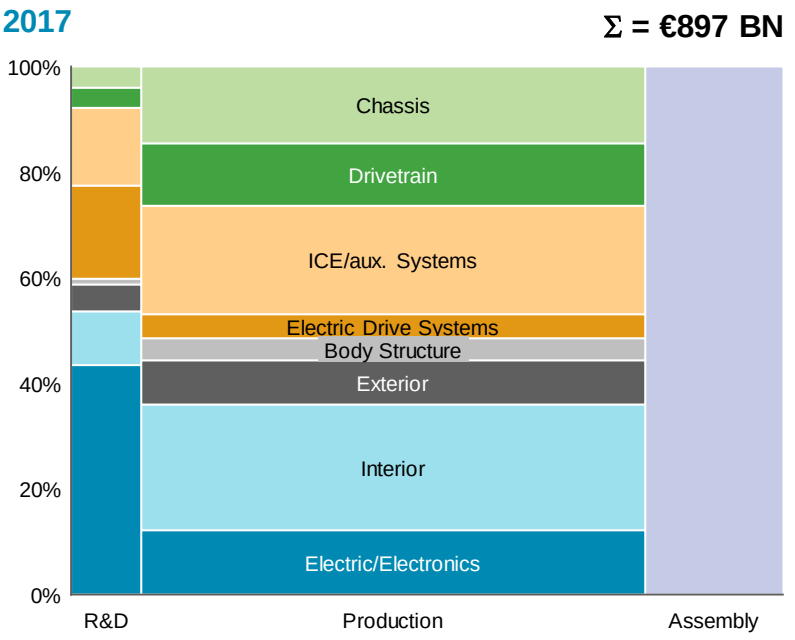
Source: Oliver Wyman value creation model

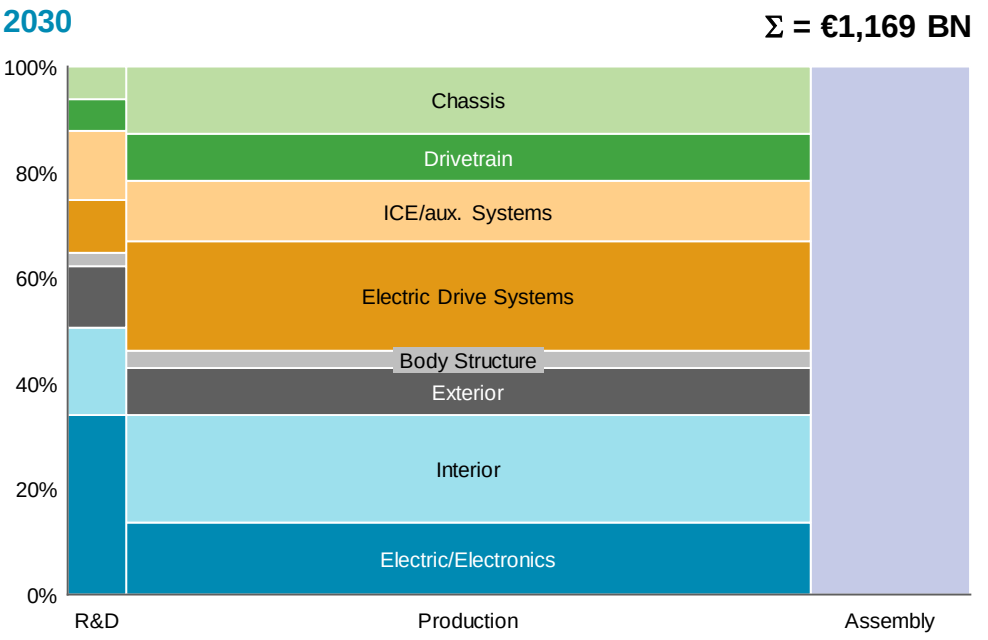
Horizontal shifts in automotive value creation until 2030

Value creation continues to grow along most steps of the value chain and modules with strong shift from value creation in ICE to electric drive systems

Development of value creation

In % of total





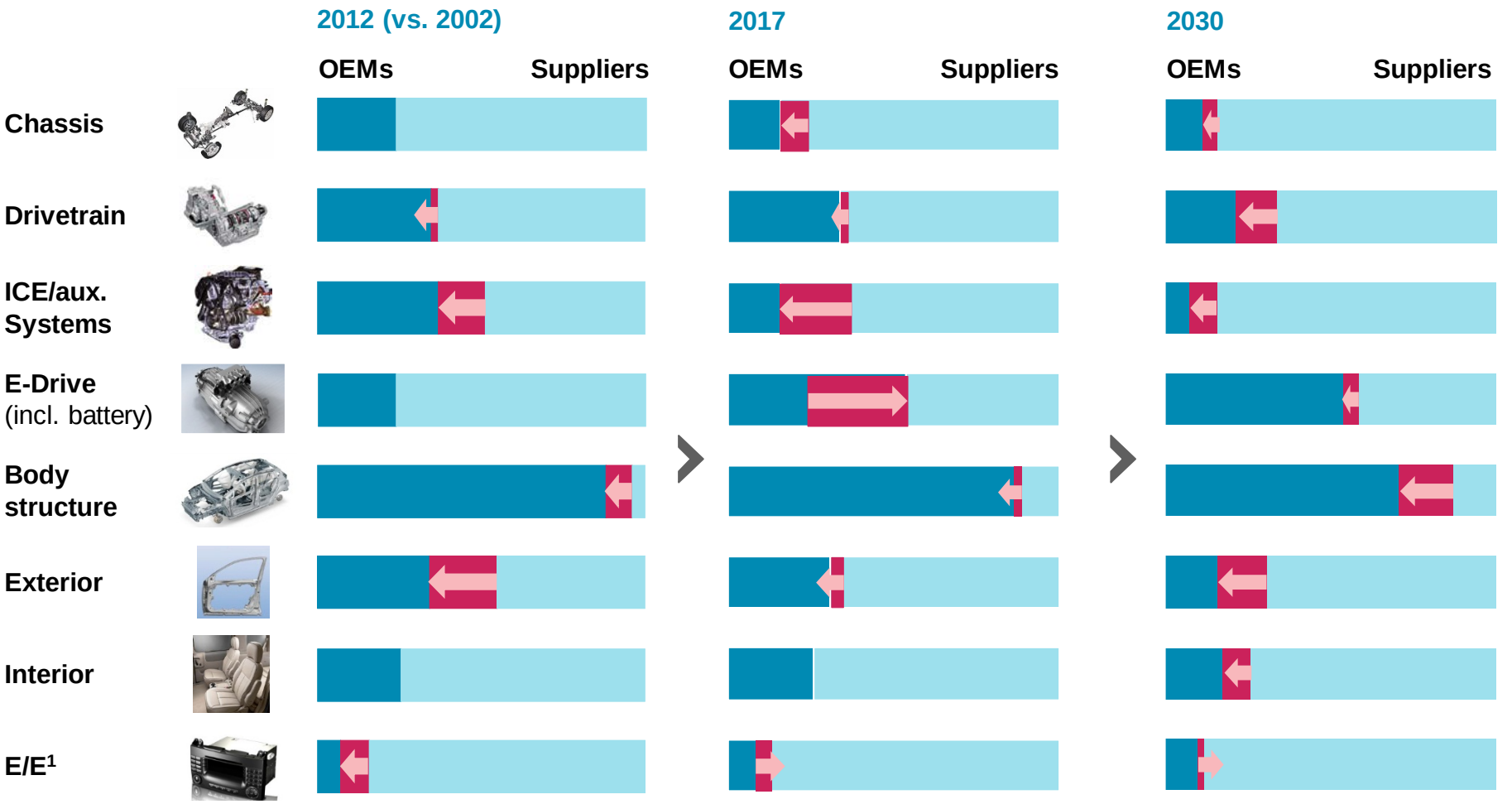
Comment

- **E-drive gains** significantly share (+14%)
- In contrast traditional **ICE powertrain and auxiliary systems loose** share continuously
- Comparably **high growth of E/E** eased by today's high level of R&D efforts to rapidly foster trend technologies
- **Body-in-white, chassis and interior** expected to **grow below market**; But also in these categories **growth pockets exist**

Source: Oliver Wyman value creation model

Vertical shifts in automotive value creation until 2030

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

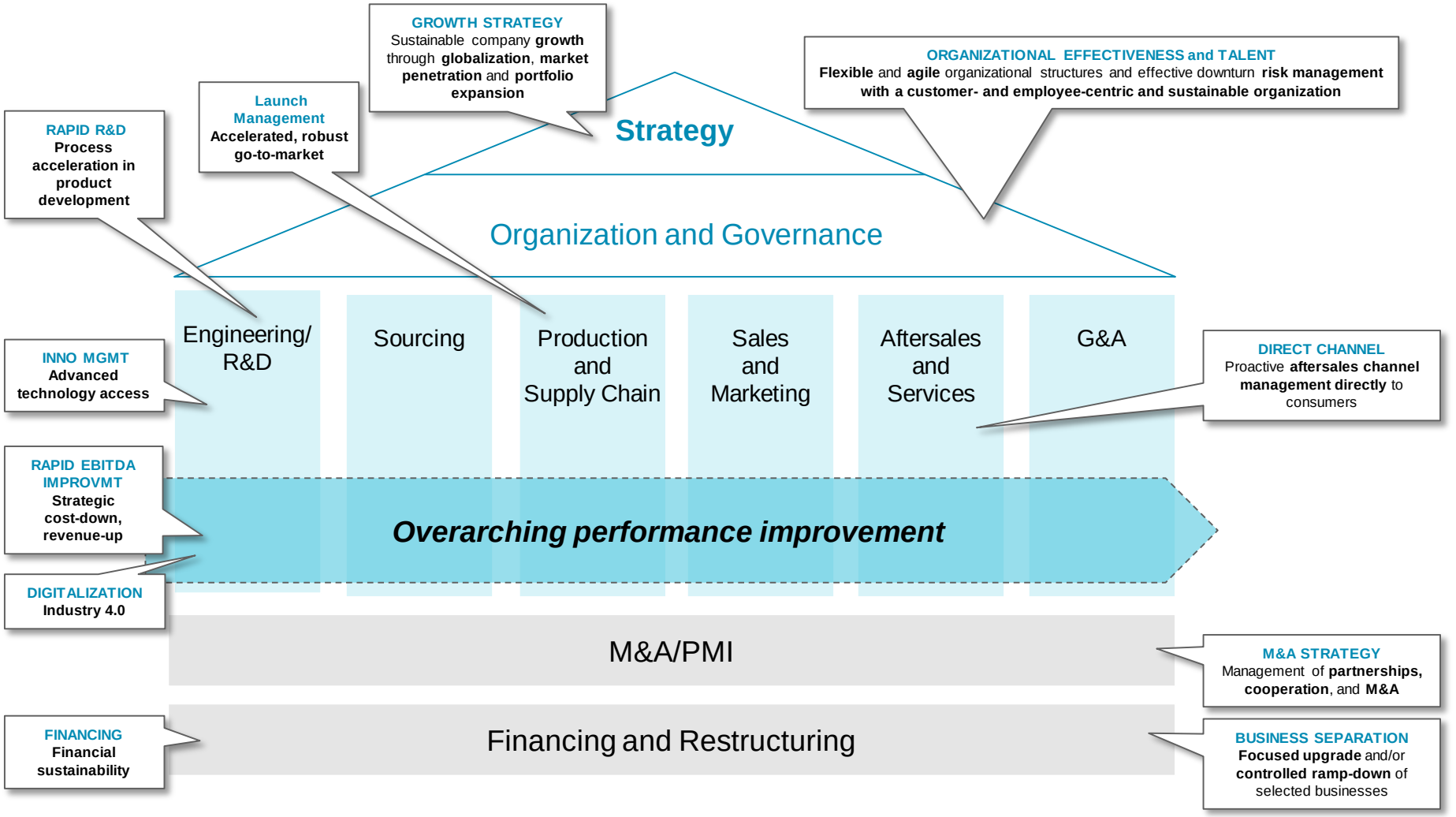


1. Driven by advancement of ADAS and autonomous driving (AD)
Source: Oliver Wyman value creation model

4 IMPACT:
Areas of impact and strategic business model options for automotive suppliers

Impact on suppliers: Many fronts

Development of new business/operating models and holistic performance improvement will be required for suppliers to remain competitive



Source: VDA, Oliver Wyman analysis


OLIVER WYMAN
VDA
Verband der
Automobilindustrie