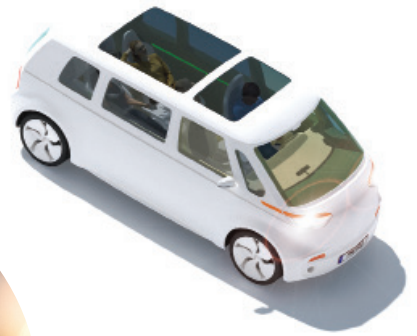


Think:Act

navigating complexity



May 2018

A new breed of cars

Purpose-built electric vehicles
for mobility on demand

THE BIG

3



Up to 1 million

vehicles is the potential annual sales volume for purpose-built ride-sharing vehicles and taxis in Europe, the US and China in 2020 – rising to 2.5 million by 2025.

Page 6

3-5 years

is the expected lifetime for electrified purpose-built ride-sharing vehicles, which makes them an asset to achieve emission regulations.

Page 13

50%

savings on vehicle-to-market costs are possible for this new breed of vehicles.

Page 15

Mobility on demand is the latest buzzword.

But what does it mean for the industry?

By now it has become a common view that the automotive market will gradually shift from vehicle ownership to new shared mobility concepts within the coming decade – Mobility on Demand and Mobility as a Service (MaaS) are the latest buzzwords. While this undoubtedly creates headaches for executives in the automotive industry given that fewer vehicles will be sold to end customers, it also opens up a new opportunity – a new breed of purpose-built vehicles for shared mobility concepts!

Ultimately those vehicles will be fully autonomous vehicles or "robocabs". While several players like Waymo or GM have announced plans to launch those vehicles as early as 2019, a more widespread adoption will most likely not occur before 2025. But vehicle manufacturers have the chance to start producing a new breed of car now: purpose-built electric vehicles for on-demand mobility solutions. Manufacturers could gain a foothold in this new segment and in so doing gain valuable experience that they can later profit from in the production of fully autonomous vehicles.

CHALLENGES AND OPPORTUNITIES

Optimizing vehicle concepts for shared mobility requires a radical shift of focus, from driver experience to passenger ride experience. It means designing flexible interior concepts to support different use cases, concentrating on durability and serviceability and includ-

ing a significant amount of additional vehicle content. Passengers value "quality time" during rides and will soon expect to be able to request a vehicle with an interior design and facilities tailored to their needs and moods – whether that is getting work done, catching up on sleep or simply having fun with friends.

At the same time, purpose-built ride-sharing vehicles give automakers an opportunity to significantly lower vehicle-to-market costs thanks to their shorter development times, lower vehicle complexity and limited number of customers. This new breed of vehicles also has implications for lifecycle management as they have shorter lifetimes and their modular nature makes it easy to replace parts.

In this paper we take a closer look at what the coming revolution means for vehicle manufacturers and rental service providers in particular: How will the market change and what is the size of the opportunity for these players? We investigate what passengers expect from tomorrow's ride-sharing vehicles and suggest three different interior design options tailored to differing needs. For the first time we calculate the vehicle-to-market costs for three different product development approaches, as well as the total cost of ownership (TCO) for the vehicles produced. Finally, we look at how purpose-built ride-sharing vehicles are set to change traditional business models and the associated differences in price-per-km for transportation.

A new market segment is about to emerge. Say hello to a new breed of vehicles.

The changes taking place in the automotive industry are hard to ignore. First, we are seeing a shift in the mobility market from vehicle ownership to on-demand services – a movement from ownership to usership that is apparent across many industries. Second, technology is developing that will soon allow fully autonomous vehicles.

A CHANCE TO BUILD UP EXPERIENCE NOW

OEMs are busy working on designs for fully autonomous "robocabs". But these vehicles are unlikely to enter mass production before 2025. In the meantime automakers have a unique opportunity to capture the valuable new market for purpose-built vehicles for on-demand mobility services – an emerging segment that they cannot afford to ignore. If they can succeed in positioning themselves in the game now, winning customers and building up valuable early experience, they will be well prepared for the next step into the robocab universe. When driverless technology finally arrives it will then be relatively simple for them to take their tried-and-tested purpose-built vehicle designs and basically replace the driver with the automated driving system, with user experience of driving the vehicle already tested and optimized to a large extent. This will put some OEMs ahead of the game compared to other OEMs that have taken a more cautious, wait-and-see approach.

RIDE-SHARING ON THE RISE

Dominating the new types of on-demand mobility services is ride-sharing (also known as "ride hailing" or "ride for hire"). Players such as Uber, Lyft in the United States and Didi Chuxing in China do pretty much what taxis did in the past, moving passengers from A to B in return for payment of a fare. However, the competitive pricing of these new entrants and their focus on convenient service offerings has added a new dimension to the traditional market.

Globally the market size for ride-sharing services is now an estimated 50 million rides a day. China, where the leading ride-sharing company Didi Chuxing provides an average of 25 million rides a day, is showing remarkable growth. Current forecasts are that ride-sharing will represent 20 percent of total consumer transportation in the country in 2018, compared to less than one percent in 2015. The market in 2018 will be worth around EUR 180 billion. This exponential growth is due to a widespread lack of mobility, the result of China's limited public transit capacity, insufficient taxi services and restrictions on the number of license plates issued for privately owned vehicles. Indeed, Roland Berger estimates that approximately 40 percent of demand for licensed taxi services in China is currently unfulfilled, met instead by unlicensed taxis and public transit where available.

PURPOSE-BUILT ELECTRIC VEHICLES

THREE EXAMPLES

StreetScooter

Founded by Achim Kampker and Günther Schuh in 2010 as a private research initiative at RWTH Aachen University, StreetScooter's mission was originally to develop electric-powered commercial vehicles for last-mile deliveries targeting municipal bodies, logistics companies and small and medium-sized enterprise fleets.

The company's revolutionary approach to vehicle design enabled them to halve development times and reduce costs by 90 percent, integrating a modular architecture into their vehicles. In 2016 they were acquired by Deutsche Post, which planned to scale up production and serve external customers as well as their company's own needs.

StreetScooter's objective is now to become the largest electric light utility vehicle manufacturer in Europe. The opening of a new plant in Düren near Aachen in Q2 2018 will enable the firm to produce around 10,000 vehicles a year. In the meantime StreetScooter has worked together with DHL Express on pilots for its City Hub concept, providing environmentally-friendly inner-city deliveries.

The company's innovative approach and rapid growth has not gone unnoticed by the major automakers. Thus, in June 2017 Ford collaborated with StreetScooter to develop the Work XL, an electric delivery van built on the Ford Transit chassis. The vehicle supplements the WORK and WORK L vans were developed internally.

e.GO

e.GO was founded by Günther Schuh, co-founder of StreetScooter. The company manufactures purpose-designed compact electric cars that it describes as fun, practical and affordable. It currently has only one vehicle, the e.GO Life, which should be available from summer 2018. The company's objective is to scale up to production of 20,000 vehicles a year, and potentially 100,000 vehicles a year by 2022. The purchase price for the low-cost vehicle is in the region of EUR 12,500.

e.GO uses typical practices associated with Industry 4.0 throughout its supply chain, such as Scrum, 3D printing for up to 30 percent of the vehicle components, and a new KPI-oriented IT infrastructure provided by PSI Automotive & Industry. The firm collaborates with ZF and NVIDIA on autonomous functions and with Bosch on connectivity. It has a dedicated location for testing new processes and systems in the Smart Logistics Cluster at RWTH Aachen University.

MOIA

MOIA was set up as a standalone company in December 2016 to spearhead VW Group's mobility services for customers (ride-pooling, ride-sharing). The company also has its own exploratory lab, MOIA Next, working in the field of mobility.

In December 2017 the company introduced the world's first purpose-built ride-sharing vehicle. The MOIA is a six-seater van offering features such as plenty of leg room, dimmable reading lights, USB ports and wireless internet access for on-the-go workers, not to mention storage space for luggage. The fully electric vehicle, produced in Volkswagen's Osnabrück plant, has a range of more than 300 kilometers and can charge up to 80 percent in around 30 minutes.

The company plans to roll out the complete MOIA ecosystem in Hamburg at the end of 2018. Ultimately it will offer various operator models tailored to the needs of partners and the different cities where it operates. MOIA's team estimates that the new vehicle can reduce urban congestion and pollution by up to 90 percent. The company pledges to take one million cars off the road in its target cities, assuming it goes mainstream. It is working directly with public transit companies and cities to ensure a streamlined mobility service that works with, not against, whatever public transportation options already exist.

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A new breed of cars

The question is, what sort of vehicles should these mobility-on-demand services use? The black cab in London developed over decades with particular needs in mind: a narrow turning circle, access for wheelchair users, capacity for six, seven or even eight passengers and space for luggage instead of a front passenger seat, depending on the model. Other purpose-built electric vehicles – albeit not designed for mobility on demand – have a very different history. Deutsche Post, having failed to find an OEM that would produce a vehicle that met its specific requirements, acquired an existing startup: StreetScooter (see box feature on page 5). Just recently the company revealed that it is working with Tier 1 supplier ZF and chip producer NVIDIA to deploy a fleet of autonomous delivery trucks starting this year.

There is a lesson here for OEMs. To avoid missing out on such opportunities in the future, they should remember that tomorrow's on-demand mobility service vehicles will likewise be purpose-built with the needs of tomorrow's passengers and drivers in mind.

SIZING THE MARKET OPPORTUNITY

The shift from vehicle ownership to new mobility concepts is unstoppable. However, it will be a gradual process rather than a sudden change. We expect the size of the global car parc to remain ownership-driven; owned vehicles will account for a forecast 98 percent of all vehicles in 2020 and 96 percent in 2025. At the same time new sales will shift strongly toward new mobility concepts, representing an expected 13 percent of new sales in 2020, rising to 20 percent in 2025.

We estimate that the number of ride-sharing drivers will grow rapidly between 2020 to 2025, reaching around 57 million. This represents a compound annual growth rate (CAGR) of 13 percent. Including taxis, the total annual addressable market for new vehicle concepts in Europe, the United States and China will grow steadily from some 700,000 vehicles in 2016 **up to 1 million** in 2020 – a CAGR of eight percent. With the introduction of purpose-built vehicles, the five years that follow (2020-2025) could see a CAGR as high as 21 percent, taking the total number of vehicles to almost 2.5 million.

These estimates refer to the volume market only as there will likely be strong cost pressure on the budget market and only marginal volume in the premium market. Another five years (2025-2030) and the advent of

The scale of this exciting new market makes this an opportunity that OEMs and suppliers cannot afford to miss out on.

self-driving robocabs could see the number of purpose-built vehicles double to five million. → **A**

The main geographical growth engine for purpose-built electric vehicles for mobility on demand in the period to 2020 will undoubtedly be where the need for PMVs has already been communicated. China will account for in excess of 60 percent of business – more than North America, the EU, the Middle East and North Africa put together. → **B** Consequently, OEMs may want to consider entering into cooperation with a Chinese partner.

The scale of this exciting new market makes this an opportunity that OEMs and suppliers cannot afford to miss out on. This is a chance for them to position themselves for the future, gaining a share in a new market that is growing exponentially, prior to the emergence of fully autonomous robocabs. Moreover, what they learn about developing purpose-built vehicles will stand them in good stead for developing their own autonomous vehicles. To a large extent they will already know exactly what passengers want, what traffic conditions demand (e.g. to access/leave the vehicle quickly and easily) and have the expertise to meet these requirements.

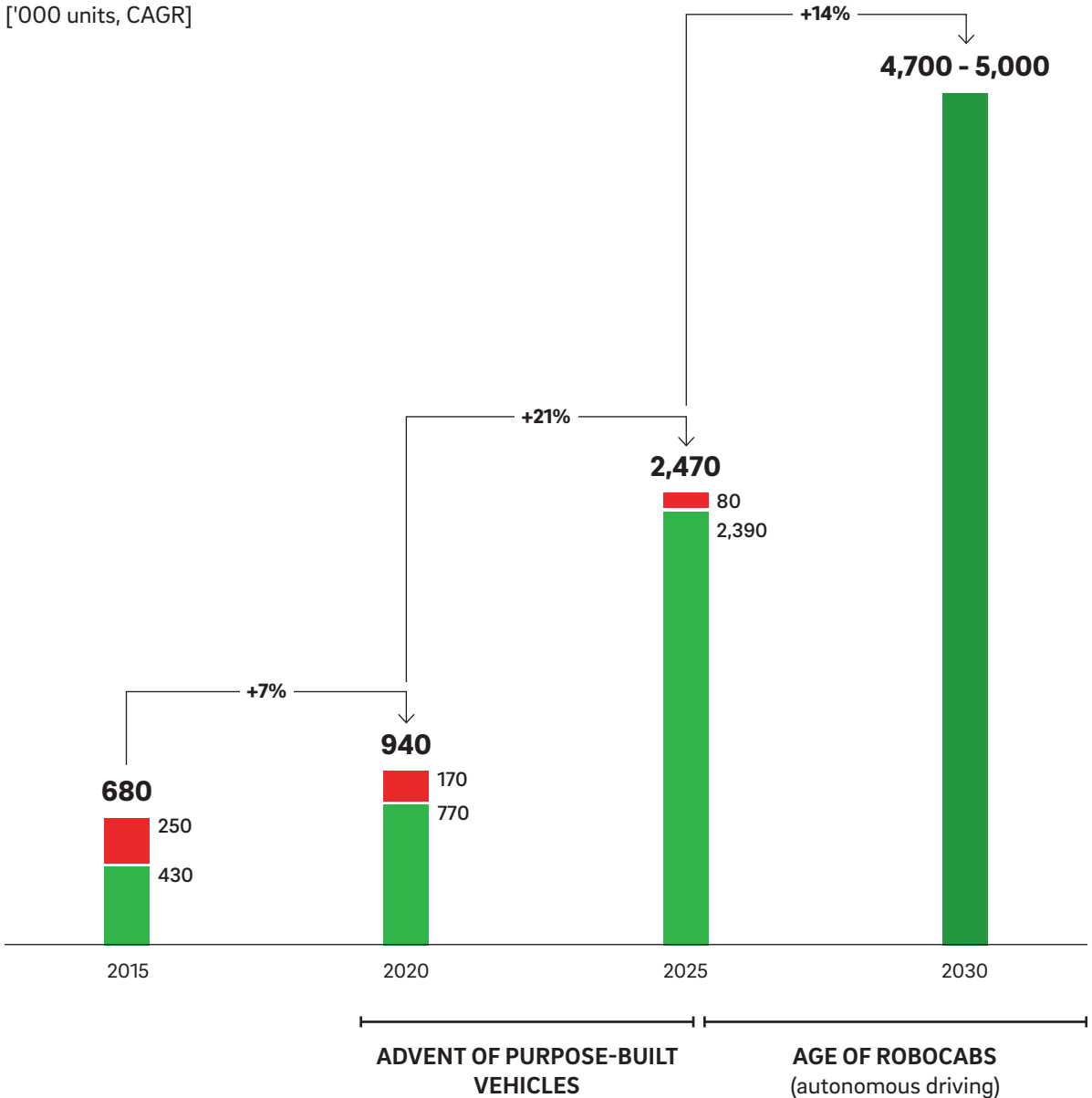
A

FROM 2020 TO 2025, THE ADDRESSABLE MARKET FOR PURPOSE-BUILT VEHICLES FOR MOBILITY ON DEMAND IS EXPECTED TO GROW BY 21% A YEAR

China, North America, EU & MENA

Vehicle sales for taxis and mobility on demand

['000 units, CAGR]



■ Taxis ■ Vehicles for mobility on demand

8 Think:Act

A new breed of cars

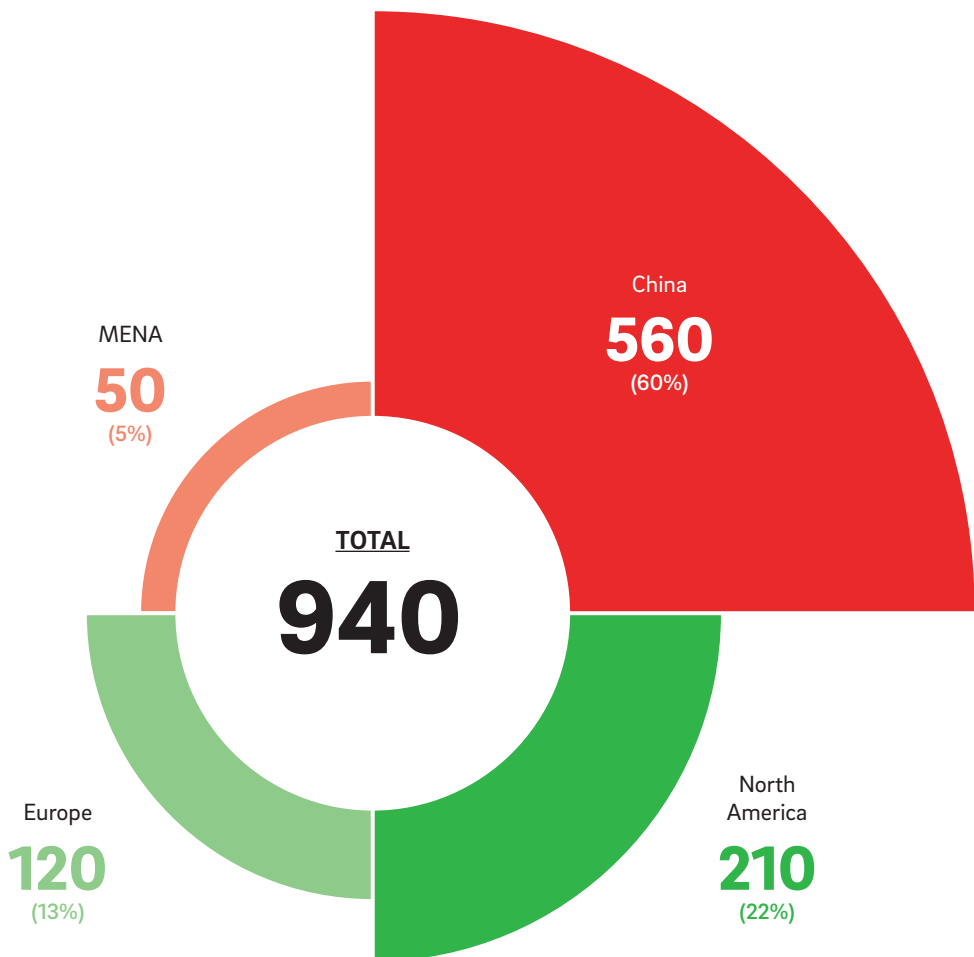
B

CHINA WILL ACCOUNT FOR ALMOST 60% OF THE MARKET IN 2020 – COOPERATING WITH A CHINESE PARTNER MAY BE AN ATTRACTIVE OPTION

China, North America, EU & MENA

Vehicle sales for taxis and mobility on demand by region, 2020

[‘000 units]



OEMs must shift their focus from drivers to passengers. Increasingly, passengers expect a unique experience.

Designing vehicles for specific uses is already common for commercial vehicles, such as postal delivery vans and buses. Passenger vehicles on the other hand are designed for private use, with their primary focus on the driver.

Ride-sharing is essentially an extension of passenger vehicle use. Rather than using their own cars, passengers consume a mobility service. But because they are paying customers, they expect the design of the vehicle to be geared toward their needs rather than those of the driver. This requires a shift of perspective for automotive manufacturers who decide to manufacture purpose-built vehicles, whether for mobility service providers or traditional taxi firms.

Today's traditional taxis – with the exception of London's black cabs and JPN taxi (Toyota) – are little more than conventional vehicles with a taxi sign on top. Purpose-built vehicles are a whole new ball game. They offer almost unlimited potential for automakers to shape a unique selling proposition (USP), generate customer enthusiasm and at the same time build a powerful brand identity.

ELIMINATE PAIN POINTS, ADD VALUE

In order to identify current "pain points" – real or perceived problems – we conducted a survey of users of taxis and ride-hailing services. We also asked what features vehicle manufacturers could include that would add value. The things that passengers complained about came as no surprise. The ride was uncomfortable when the vehicle was full. They couldn't control the air conditioning in the rear seats of the vehicle. They had problems fitting baby strollers into conventional vehicles, let alone wheelchairs. They were tired of annoying conversations with opinionated drivers.

Purpose-built vehicles can eliminate these problems. More importantly still, they can create "wow" effects for customers – features that surprise and delight them. We believe that these features should be based around the core elements of the future mobility experience: connectivity, infotainment and customization.

Based on our research we have defined three interior design options, each of which meets different passenger needs. → **C**

C

THREE INTERIOR DESIGNS FOR HAPPY PASSENGERS

Vehicles need to be constructed in such a way that they can quickly adapt to the different design options using swiveling seats, adjustable lighting and foldable tables and monitors. When placing their order through an app, passengers would choose what sort of interior setup and facilities they require: a "productive" design that allows them to work during the journey, a "relaxing" design so they can rest or even catch up on sleep, or a "fun" design if they are on their way to a party or sightseeing in a new city. The options available would depend on the location. The vehicle would automatically adapt its interior to the desired setup while on the way to pick up the customer.

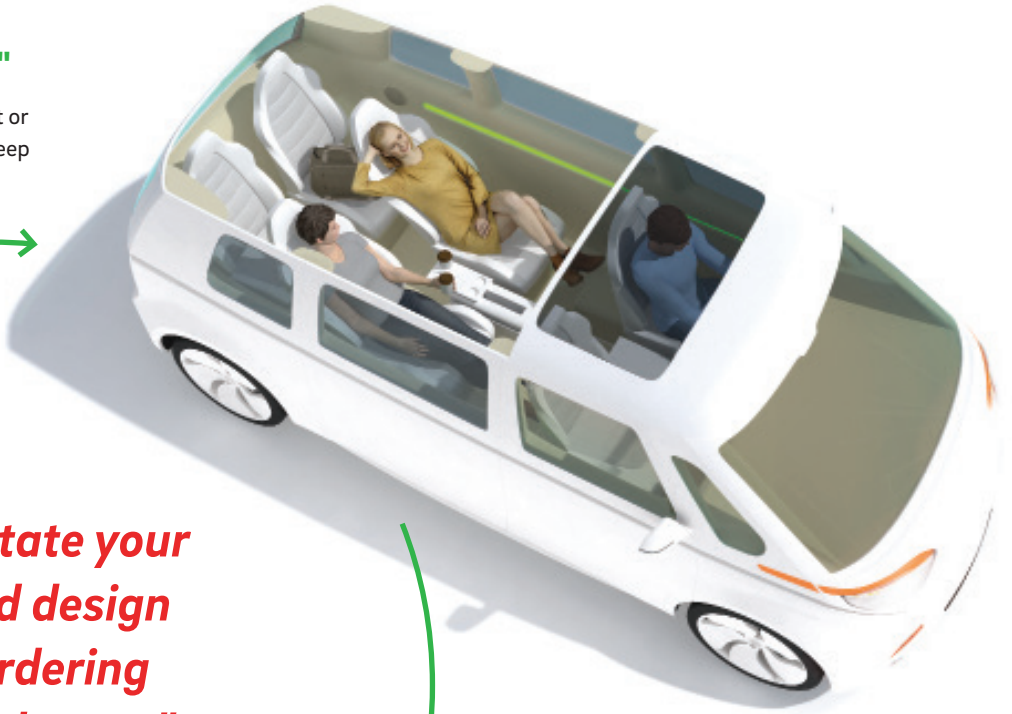
"PRODUCTIVE"

Allows passengers to work during the journey



"RELAXING"

Passengers can rest or even catch up on sleep



"Please state your preferred design when ordering through the app"

"FUN"

If passengers are on their way to a party, sightseeing in a new city, or simply with family



Purpose-built vehicles can significantly reduce vehicle-to-market costs. Savings could be as high as 50 percent.

OEMs have three options when it comes to designing this new breed of cars. → **D**

The first is the simplest option of basing the vehicle on an existing model. This entails high production costs; we estimate around EUR 32,500 for a 6-seater MPV-sized car in 2020 based on an annual production volume of 100,000 vehicles. To make this economically attractive, production volumes will need to be as high as possible.

The second option is to follow the traditional product development concept and build the new, purpose-built vehicle on the basis of an existing model or platform, reducing the number of features or downgrading the performance specifications in order to optimize costs. Moderate production volume will be needed for this approach but production costs may be up to one-third lower, at around EUR 21,000. This approach is suitable for manufacturers who are able to produce vehicles more cheaply than traditional OEMs.

The third option is to design a completely new, out-of-the-box vehicle concept. This approach entails higher costs on the design side but highly competitive costs on the production side, at an estimated EUR 16,000 –

almost half the production costs of the first option. Manufacturers can use 3D printing for the majority of parts or construct them from a single block of aluminum, as with the StreetScooter. Even with very low volumes of vehicles, this approach is economically viable. Producing the vehicles in China would reduce the costs even further: The additional saving could be up to EUR 600 per vehicle.

Whichever solution automakers choose, they should aim for the least complexity possible. The simpler the vehicle's design, the easier it will be to build it on the production line – and the simpler and cheaper to manufacture the end product.

OTHER BENEFITS OF PURPOSE-BUILT VEHICLES

Another area where manufacturers can substantially reduce the vehicle-to-market cost is in selling, general and administrative (SG&A) expenses. Around 90 percent of this cost block consists of marketing and selling efforts, including price discounts. In the case of purpose-built cars, manufacturers can employ direct sales structures, selling the same vehicle in bulk direct-

As a side benefit, sales of electric purpose-built vehicles will make it much easier for OEMs to meet CO₂ emission targets for their fleets.

ly to their fleet customers without having to invest in advertising. Margins for a dealer-based retail network or other intermediaries can be saved by cutting out this part of the value chain.

As a side benefit, sales of electric purpose-built vehicles with short lifecycles will make it much easier for OEMs to meet CO₂ emission targets for their fleets. Manufacturers need to comply with these regulations in most regions and the easiest way for them to do so is with electric vehicles. Electric purpose-built vehicles, cheaply produced and sold in high volumes, make it simpler to meet the regulations quickly.

Since purpose-built vehicles will form part of a digital mobility service, they will have to evolve at a speed closer to that of consumer electronics than that of traditional vehicles. Customers are likely to consider them old after just a few years, even though their technical components are still in good condition. Rather than seven to eight years between models, we expect to see a gap of **3-5 years**. As the new vehicles will be modular in design it will be relatively easy to switch individ-

ual modules, such as the seats or the battery, for updated modules with minor improvements. That means a longer run for vehicle components and spare parts.

The new, updated versions of models should feature improvements primarily in areas that customers can see and experience – the exterior of the vehicle, the interior design, the infotainment system and so on. Replacing these modules will give passengers the sensation that they are in a new vehicle although in fact the underlying powertrain components (electric motor, power electronics and so on) will be reused from the previous model. This will significantly reduce the costs per model of second-generation cars.

TOTAL COST OF OWNERSHIP

From the perspective of customers, purpose-built electric vehicles will also represent significant savings in terms of total cost of ownership (TCO). Savings will stem from a multitude of areas: the lower purchase price and slower depreciation of the vehicle; its significantly lower maintenance cost (with 50 to 70 percent fewer components, significantly fewer mechanical parts, no liquids to replace such as oil, less wear on brakes, cheaper components and so on); less expensive insurance due to the lower purchase price, lower component costs and lower top speed; and cheaper fuel.

How these vehicles will be serviced depends on the operating model of the fleet. Large ride-sharing providers such as Didi and Uber will most probably establish their own affiliated network of independent repair shops in order to further improve the TCO of the entire fleet. However, OEMs could generate additional upside by offering usage-based, full-service "pay-per-km" models, including insurance, servicing and so on – as we discuss in the following section.

D

THREE APPROACHES TO DEVELOPING PURPOSE-BUILT VEHICLES FOR MOBILITY ON DEMAND

MANUFACTURING

COMPONENTS

DEVELOPMENT

OPTION 1

OEM designs new vehicle based on existing concept



High production volume required



Vehicle specifications excessive for urban use



Interior adapted by large organization

OPTION 2

Ride-sharing firm contracts an OEM to adjust an existing vehicle design



Moderate production volume required



Reduced vehicle specifications



Entire interior and selected exterior parts developed

OPTION 3

OEM, ride-sharing firm or other player designs an entirely new vehicle



Small and medium volumes realizable with tailored production methods



Cost-optimized vehicle specifications



New vehicle with simpler specifications developed by small team

● High complexity ○ Low complexity

.....

New players will need to develop entirely new vehicles, but can save on costs through lower complexity and tailored production methods.

Production costs for each approach, based on production of 100,000 vehicles in 2020
[EUR '000]

OPTION 1



OPTION 2



OPTION 3



-50%

- SG&A (incl. R&D) Depreciation License fee Labor Energy
Non-electronic components Other electronic components Battery pack

The new breed of vehicles requires a review of business models. Players have a number of options to choose from to conquer markets with fresh concepts.

The development of purpose-built vehicles for mobility on demand will go hand in hand with the emergence of new business models for established automotive OEMs, suppliers, mobility platform providers and new entrants. All of these players will be looking for opportunities to conquer the markets with fresh concepts. We foresee three main potential business models, which we outline below.

SELECT YOUR BUSINESS MODEL

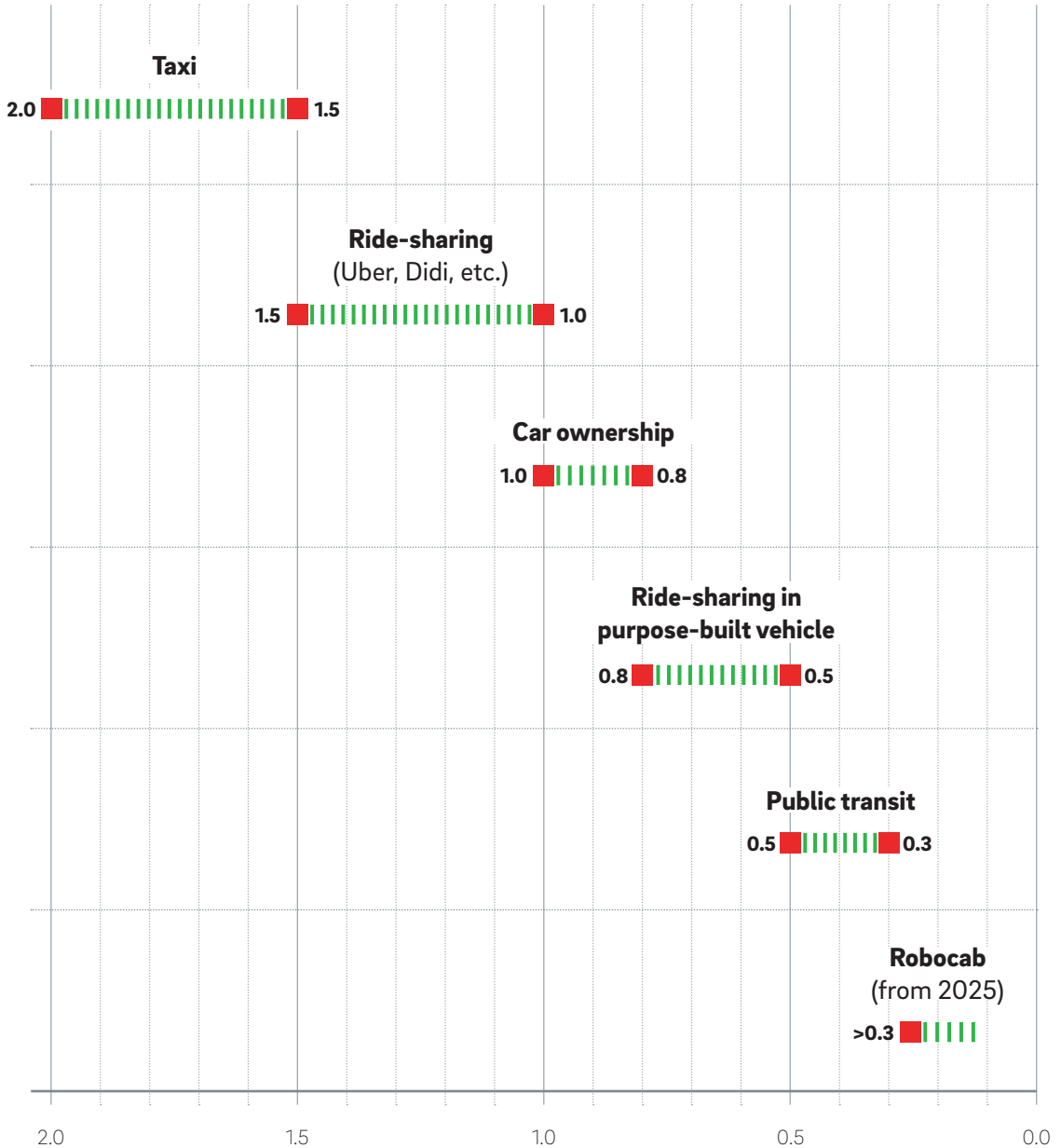
First, OEMs could develop and produce purpose-built vehicles and also operate their own ride-sharing services. We already see this happening in the car-shar-

ing industry, with automakers such as BMW (through DriveNow) and Daimler (car2go) using their car-sharing fleet for revenue as well as an extra channel for acquiring new customers. Given the high costs of vehicle production and maintenance by the OEM through its own in-house service network, the profit margins from operating the fleet will be rather low, making lean ride-sharing operations essential. This business model is both a threat and an opportunity for the automotive industry. While new mobility offers will reduce sales of passenger cars and light commercial vehicles, autonomous fleets will create an attractive new market for the service network.

E

NEW PURPOSE-BUILT VEHICLES FOR RIDE-SHARING COULD BE THE LEAST EXPENSIVE FORM OF CAR TRAVEL (UNTIL ROBOCABS COME ALONG)

Price per kilometer of selected means of transportation – Example in Europe (EUR/km).



A new market segment is evolving that requires a new breed of vehicles, and leaving incumbent players with some important decisions to make.

The second option would be for OEMs to build purpose-built vehicles and provide ride-sharing companies such as Uber and Didi with Vehicle as a Service solutions. These solutions would bundle the financing, insurance, service, repair and operation of the vehicle fleet. Essentially this translates into a fixed monthly fee or "pay-per-km" model. It would mean a new role for OEMs, one that offers new revenue streams but also demands new skills, such as maintenance-free vehicles, residual value management and the remarketing of fleets.

A third option would be for ride-sharing providers, be they current players or new entrants, to specify their requirements for a vehicle and then contract manufacturers to build that vehicle for them on a white-label

basis. Once again, OEMs would miss out on a valuable opportunity to develop their own vehicles. For ride-sharing companies, this is probably the most cost-effective option.

We have calculated the approximate price per kilometer for transportation for each of these business models. Today, taxi services are the most expensive mode of transportation at EUR 1.5-2 per kilometer. Moving down the price scale, we have ride-sharing services and traditional vehicle ownership. However, using the new purpose-built vehicles for ride-sharing gives an even lower price at around EUR 0.5-0.8 per kilometer – a direct result of the vehicle-to-market cost reduction potential of purpose-built electric vehicles. The only options that beat these vehicles on price per kilometer are public transit and, looking forward, fully automated robocabs. → **E**

Where does that leave the incumbent players in the automotive industry? With some important decisions to make. A new market segment is evolving that requires a new breed of vehicles. This represents an attractive opportunity in terms of market size, customer demand and cost assumptions. But OEMs are not the only ones to have spotted the emerging potential: Ride-sharing service providers may want to muscle in on the action, too. All players must therefore make careful decisions about their investment strategy and how they plan to integrate their value chain, if at all. And they must make those decisions sooner rather than later.

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Roland Berger, founded in 1967, is the only leading global consultancy of German heritage and European origin. With 2,400 employees working from 34 countries, we have successful operations in all major international markets. Our 50 offices are located in the key global business hubs. The consultancy is an independent partnership owned exclusively by 220 Partners.

Navigating Complexity

Roland Berger has been helping its clients to manage change for half a century. Looking forward to the next 50 years, we are committed to supporting our clients as they face the next frontier. To us, this means navigating the complexities that define our times. We help our clients devise and implement responsive strategies essential to lasting success.



Automotive Disruption MADE by RB

We believe that the combination of 4 dimensions (Mobility, Autonomous driving, Digitalization and Electrification) is likely to trigger a major disruption in the automotive industry over the next 15 years. In 2018, we are bringing 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.

LINKS & LIKES

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