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Sales and market potential through autonomous and automated driving:

Case study of Baden-Wuerttemberg

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Executive Summary

Electrification and digitization are key drivers of structural change in the automotive industry against the background of the increasing importance of climate and environmental protection. They show both new ways and, at the same time, new demands on the design of the mobility of the future. The effects of digitization and autonomous driving on new concepts and technologies in the mobility sector are likely to be great - but the timing is not clear. Nevertheless, it can be foreseen that autonomous driving could also have far more positive effects than negative ones, provided that it is actively supported and politically managed early on. For example, the McKinsey study "Automotive revolution - perspective towards 2030" estimates that by the year 2030, alone in the emerging digital market, global sales of $ 1,500 billion can be achieved. In comparison, the authors of this study assume that the classic sale of vehicles can still be converted to $ 5,200 billion and by the aftermarket another $ 3,500 billion. Overall, the authors of the McKinsey study report that the automotive market will grow to a total of $ 6,700 billion worldwide by 2030, which would translate to average growth of approximately 4.4% per year. Baden-Württemberg's share of this amounted to EUR 108 billion, making the automotive industry in Baden-Württemberg the industry with the highest turnover. If these figures and the calculations of the "high-disruption" scenario of the McKinsey study are taken as a basis, this means for the Baden-Württemberg automotive industry that a potential turnover of around EUR 42 billion could be realized in 2030 as a result of digitization.

1 Introduction

> *"The future belongs to automated and networked driving. Automated driving is an important driver for innovation and added value and therefore of great importance for the automotive location of Germany as a whole. It is important for the German automotive industry to maintain its leading position. "*
>
> Federal Minister of Economics Sigmar Gabriel, 2015

Electrification and digitization are key drivers of structural change in the automotive industry against the background of the increasing importance of climate and environmental protection. They show both new ways and, at the same time, new demands on the design of the mobility of the future. In all likelihood, the effects of this change will have a major impact on a wide variety of industries and the value creation and employment structures that exist there. In Baden-Württemberg they will also be included and discussed in the "Strategy Dialogue for the Automotive Industry". Autonomous driving is in this case a special position and effect in the overall process attributed.

Definition of "autonomous driving"

Decisive for the further explanations is the differentiation between highly automated and autonomous driving, the following description being based on the definition of Daimler AG. In the current admission discussion of the VDA working group "Automated Driving" with the Federal Highway Research Institute (BASt), the German OEMs have agreed on the following basic stages of autonomous driving (Daimler AG, 2017):

Highly automated:

The automatic system recognizes its limits and in this case requests the driver to take over in good time. Non-driver activities of the driver are limited possible.

Fully automated or autonomous:

The system can handle all situations autonomously, monitoring by the driver is not required. Non-driving activities are allowed to the driver. Likewise, driverless driving is possible in this stage.

This distinction can also be found in the definition according to SAE (SAE International, former designation Society of Automotive Engineers). They define the highest level of automation (Level 5) as "... the consistent execution of all aspects of dynamic driving by an automated driving system in all driving and environmental conditions that can be managed by a human driver ...". In this definition, there is no human "fallback system" that - in an emergency - can take over the task of driving. This is the crucial difference between highly automated and autonomous driving.

In current projects, however, it has repeatedly been found that the currently used definitions of levels 1 0 to 5 are often not accurate. Thus, e.g. a vehicle in a restricted area equipped with appropriate sensors already operates at SAE level 5, but not outside this area. Here, a more precise definition would be desirable to better describe the actual capabilities of autonomous vehicles (Buchholz, 2018). In addition, the levels for BASt, VDA and SAE are defined or described differently:

Table 1: Difference in Definition of Levels of autonomous driving between BASt, VDA & SAE

Level	BASt	VDA	SAE
0	Driver Only	Driver Only	no automation
1	Assisted	Assisted	Driver assistant
2	partially Automated	partially Automated	partially Automated
3	highly automated	highly automated	Conditional automation
4	fully automated	fully automated	High automation
5		driverless	Full automation

For the other paper, therefore, a definition of autonomous driving as any form of mobility, which can do without driver or can get along. "Autonomous" is understood as being independent, independent and provided with individual freedom of choice. This definition is not yet an official result of a comprehensive discussion process, but serves as a self-understanding of the scope of the paper.

2 Development of Autonomous Driving in the next few years

Basically, it can be assumed that over a period of several years hybrid forms of the variants - ie the degree of automated / autonomous driving - will exist. This also means that legal and legislative norms must be created, which on the one hand cover the "grown" applications in traffic, on the other hand at the same time enable openings or new regulations for new forms of traffic.

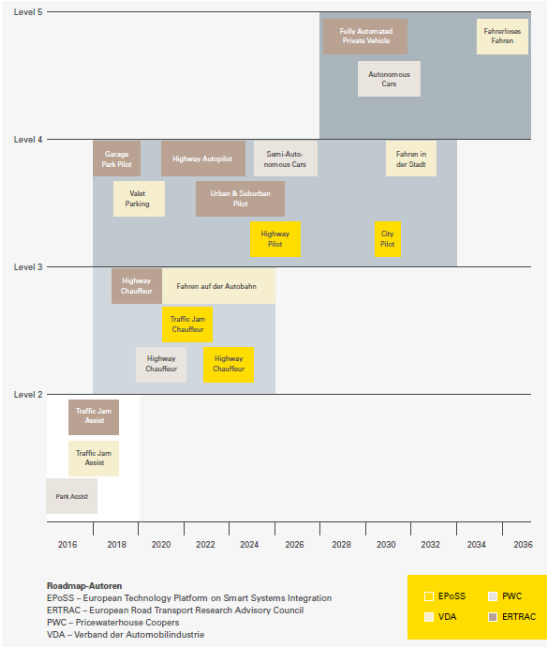
Whether and which degree of disruption is triggered by autonomous driving can only be answered with great difficulty today. However, a large number of expert assessments assume that autonomous systems will penetrate the market in the future and that this can mean far-reaching changes in the entire economy.

An essential aspect of autonomous driving is turning away from the goal of making people "better drivers" or enabling them to drive the vehicle more safely. This opens up new possibilities for developers, manufacturers and the associated industry: For example, mechanical technology can be dispensed with here (eg human-geared operating systems such as pedals and steering wheel), so that effort, costs and weight can be saved, even if in return new electronic systems are added (Carl, 2015). Autonomous systems are therefore no longer aimed (only) at the individual driver in the development and design, but at their general transport task in the future mobility system. In combination with the current trend of the "sharing economy" and a decreasing personal and individual appreciation of the vehicle ownership or its perception as a status symbol, this leads to new requirements and usage patterns. Irrespective of this, however, there will always be requirements for individual ownership and differentiation. However, new business models and sales potential are more likely to come from the first trend.

The transition scenarios to purely autonomous driving over time are manifold. Based on an evolutionary development over the different degrees of automation there are first representations of when which use cases might occur. In this context, a quote from Amnon Shashua, head and founder of the sensor and chip manufacturer Mobileye is interesting, which puts the pure technical development in the context of other framework conditions and influencing factors:

> *"The real challenge is not technological, but legal and social. Regulators play a crucial role in this. We note that in most countries, the authorities do not want to be in the way of technical development. "*
>
> Amnon Shashua, Mobileye, 2017

Based on previous studies on this topic, the following scenarios for purely autonomous driving are possible. Here, the essential periods are mentioned, in which different automated driving functions are differentiated according to the application expected.



Finally, in order to obtain a general replacement of today's individual traffic on a significantly large scale, too many parameters are still unclear today. A subjective assessment of several experts shows the following expected course of the penetration of autonomous driving:

- Phase I to 2025: preparation by research and real tests with various industrial scale applications (e.g., airport, agriculture, etc.)
- Phase II to 2030: Specification of business models and restructuring of the legal framework as well as adjustments to the infrastructure and production networks (especially internationally driven).
- Phase III until 2035: Rapidly increasing number of autonomous vehicles.

Figure 1: Scenarios and applications of automation in road traffic (Source: e-mobil BW, 2017)

• Phase IV until 2040: The vast majority of mobile operations (people and goods) are carried out by autonomous vehicles.

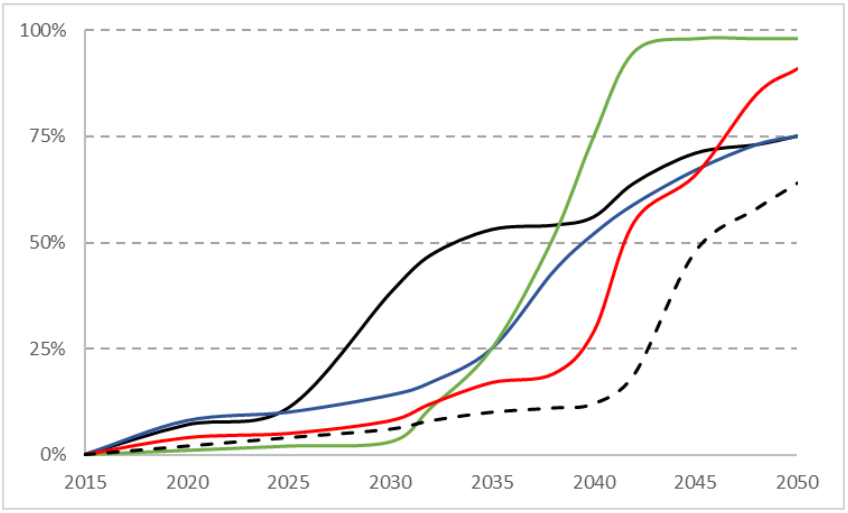


Figure 2: Subjective assessments of the penetration of autonomous driving

Factors influencing the market penetration of autonomous driving

In order to provide an overview of the factors influencing the market penetration of autonomous driving, so-called scenario descriptors were developed and discussed in expert workshops and a clustering of the descriptors into spheres of influence was carried out. Subsequently, relevance factors are assigned to these descriptors, which allow an approximation to a qualitative description of a consistent and coherent scenario. The analysis was not conclusively scientifically evaluated, but does show the range - and thus complexity - of the influencing factors.

Table 2: List of influencing factors

#	influence	name
1.1	Legal framework & policy	EU-wide regulations
1.2	Legal framework & policy	Legal Framework - Legislation (Federal, State)
1.3	Legal framework & policy	Promotion and prohibitions
1.4	Legal framework & policy	Insurance
2.1	Acceptance	Trust (Technology & Legal Aspects)
2.2	Acceptance	Security
2.3	Acceptance	Acceptance in society
2.4	Acceptance	Linking old and new world of mobility
2.5	Acceptance	Jobs
3.1	Technology	Reliability of the technology

3.2	Technology	Development of artificial intelligence
3.3	Technology	Data usage
3.4	Technology	Technology in general
4.1	Price / Cost	Cost Autonomous Features / Mobility
4.2	Price / Cost	Cost models
5.1	Infrastructure	Infrastructure
5.2	Infrastructure	Energy supply of autonomous vehicles
5.3	Infrastructure	Financing Infrastructure
6.1	Purpose	Spatial allocation (city, country, separate purpose)
6.2	Purpose	Elimination of stationary traffic
6.3	Purpose	Commutes
7.1	Need	For simplicity of use
7.2	Need	For flexibility in use
7.3	Need	Climate & Environment
7.4	Need	Motivation for change (hype?)
8.1	Business mode	New customers
8.2	Business mode	Mobility Added value
8.3	Business mode	New offers
8.4	Business mode	Internationality

3 User behavior and megatrends

In analyzing the factors influencing the market penetration of autonomous driving, the user and his / her future mobility and behavior patterns are included in the "demand" influence area. However, due to the unclear effect of the megatrends, this descriptor is difficult to define and can not be clearly differentiated. Currently, analyzes, especially in the automotive sector, rely heavily on the premise that vehicles have a dedicated buyer and thus owner. Business models such as insurance, value preservation (services), care, accessories etc. have developed along this property, and tax models are also based on this basic assumption.

Opposite this is a so-called megatrend - the "sharing economy". This refers to the systematic "use instead of possession" and refers to both material objects and z. B. sharing space and space, especially by individuals and stakeholders. The focus is on "Collaborative Consumption", ie a common consumer behavior. According to some experts, autonomous driving could further support and reinforce this trend, so that a large number of classic business models would no longer be relevant or lead to new approaches.

An example of a decreasing emotional attachment to classic possessions is provided by the company car: over the years, these have become more of a commodity, especially when - as practiced in some companies - these only last for relatively short periods (about 6 months). being held. The "all-inclusive package" when using a company car is still associated with great benefits in the opinion of those affected, but at the same time it leads to the fact that hardly any personal connection to the "own" vehicle is established.

This mega trend is reinforced by another aspect: demographic change. This leads to a fundamental change in the age structure of the population, so that - transferred to the application of autonomous driving - a large number of potential users are either not yet entitled to drive a vehicle or due to age no longer (certainly) able to drive independently , These user scenarios are not assigned any explicit influencing factors. Since statements about the relevance of this descriptor or a specification are unequivocal, a precise classification is difficult. However, the impact of change in age structure may be disruptive.

Another aspect directly derived from user behavior is the question of what the user does with the "gained" time that is not required for the driving task. According to some analyzes from 2016, there is generally a very high willingness to pay for new services and offers. Without taking into account the impact of business models in the context of employment effects, the following figures show what sales potential and volumes can be expected here (Horvath, 2016).

4 Impact on sales potential, value added and employment

The effects of digitization and autonomous driving on new concepts and technologies in the mobility sector are likely to be great - but the timing is not clear. Nevertheless, it can be foreseen that autonomous driving could also have far more positive effects than negative ones, provided that it is actively supported and politically managed early on.

In the following, the possible effects of vehicle automation, vehicle networking and new mobility concepts on different sectors are described approximately qualitatively. These assessments thus complement the quantitative calculations on the effects of electrification in the main study on a qualitative - but less reliable - level. In the following part, different studies are used for this qualitative assessment based on the methodology of Grounded Theory in order to summarize existing analyzes and to present their core statements. These core statements are supplemented by qualitative expert interviews so that an assessment of the analyzes generated by research, industry and consulting firms can be made.

For example, the McKinsey study "Automotive revolution - perspective towards 2030" estimates that by the year 2030, alone in the emerging digital market, global sales of $ 1,500 billion can be achieved. In comparison, the authors of this study assume that the classic sale of vehicles can still be converted to $ 5,200 billion and by the aftermarket another $ 3,500 billion. Overall, the authors of the McKinsey study report that the automotive market will grow to a total of $ 6,700 billion worldwide by 2030, which would translate to average growth of approximately 4.4% per year. The market for autonomous and connected driving is expected to grow by a total of 30% over the same period (McKinsey, 2016).

In 2017, the automotive sector generated worldwide sales of approximately EUR 3,200 billion. Baden-Württemberg's share of this amounted to EUR 108 billion, making the automotive industry in Baden-

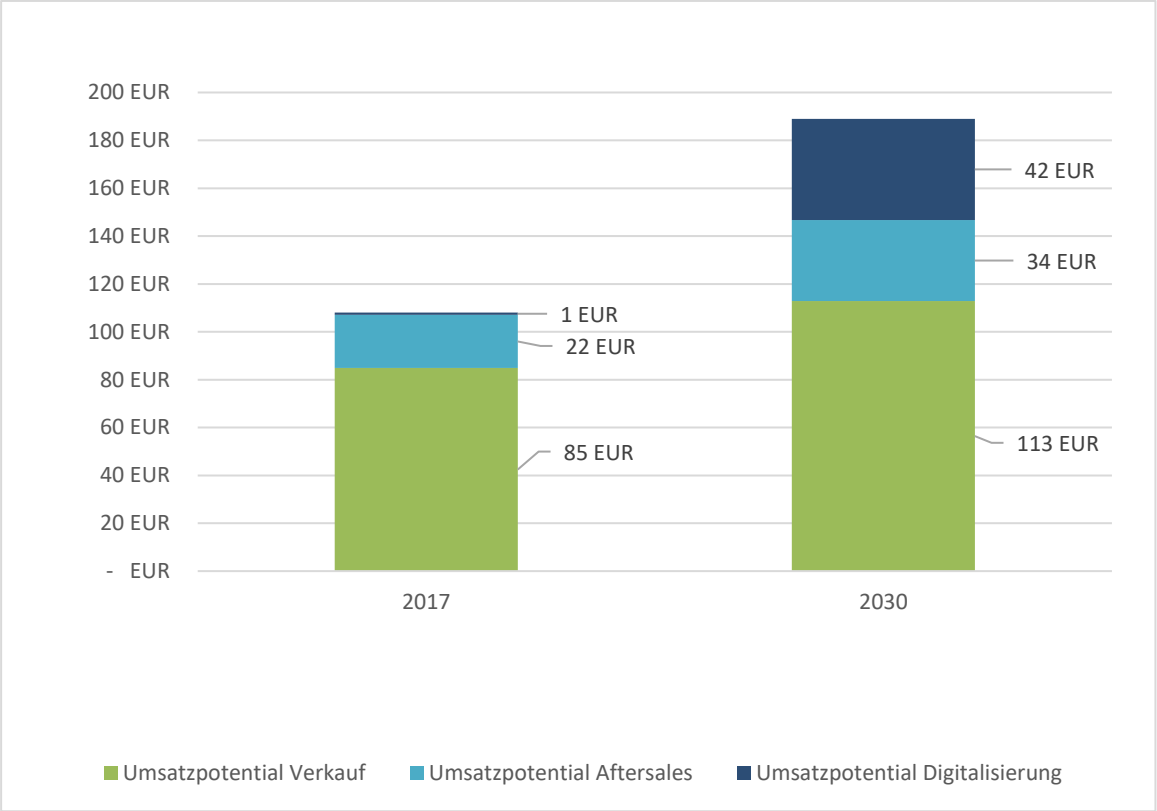


Figure 3: Sales Potential Automotive Industry Baden-Württemberg

Württemberg the industry with the highest turnover. If these figures and the calculations of the "high-disruption" scenario of the McKinsey study are taken as a basis, this means for the Baden-Württemberg automotive industry that a potential turnover of around EUR 42 billion could be realized in 2030 as a result of digitization.

If the sales potentials for digitization are distributed equally in a global analysis, the above figures (McKinsey, 2016) as well as the shares of states in the worldwide production of the automotive industry (VDA / Statista.de, 2017) in 2030 indicate sales potential by digitization for China of € 429 billion, for Japan of € 143 billion and for the US of € 216 billion.

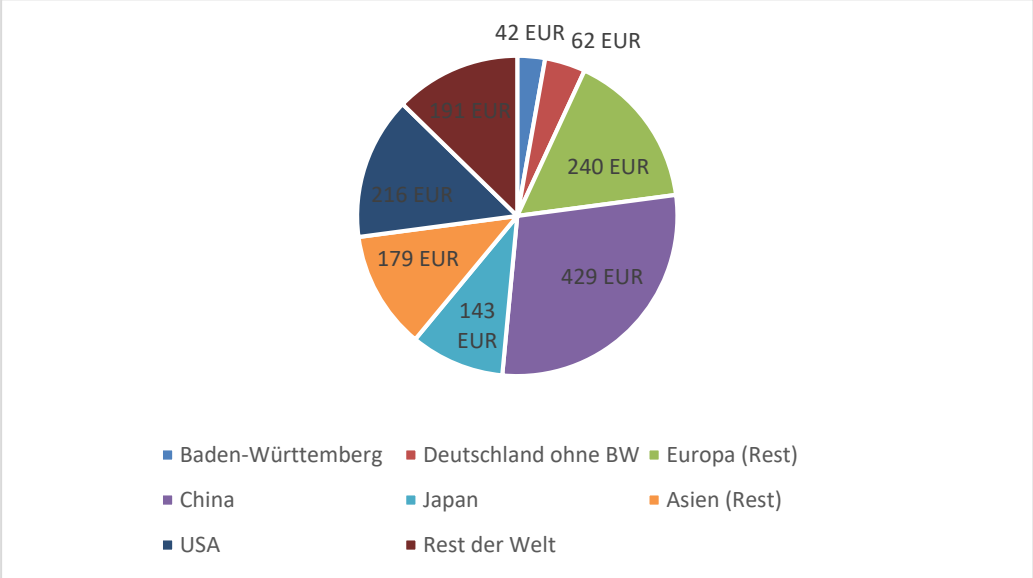


Figure 4: Distribution of sales potential through digitization of the automotive industry in 2030 billion EUR

Conclusion

The penetration of first autonomous systems has already begun and is normal in protected areas, e.g. In industrial applications. Test vehicles are currently on public roads around the world. Derived from a variety of expert opinions and assessments, there is a possible scenario that will show a significant increase in autonomous vehicles over the next 5-10 years. However, the potentially disruptive change in employment structures and value creation processes is unlikely to occur until 2030. The speed of implementation of the climate policy goals is of crucial importance, since the pressure to act on internal combustion engines increases and electric drives can also accelerate autonomous driving.

If possible, the right time must be sought in all relevant system facets for the active and effective design of change processes. This time will be approximately determinable by intensive monitoring of change processes in the future. However, particular interests of individuals (albeit large ones) may not hamper or hinder the entry into change - and thus the active shaping of the change process. It is important to understand that trends are not only caused by technological developments, but also based on the wishes and imaginations of stakeholders and consumers. Thus, trend analyzes are always dependent on objective facts on the one hand, but also on public discussion, the presentation in the media and ultimately on the other (Schnieder, 2011).

The adaptation of the legal framework conditions, which have a significantly greater influence than any technical challenges, is essential for the design of the transformation process caused by digitization and autonomous driving. In addition to the legal issues that go hand in hand with the digitization of the automotive industry and autonomous driving, societal questions must also be considered. Thus, these two points can certainly lead to a shift in market penetration by up to 20 years (Horx, 2018).

The ordering and structuring role of the state, including its social obligation to socially acceptable compensation of disadvantages in the population, continues to play an important role. Confidence in the ability of industry, politics and society to change will also contribute to the acceptance of autonomous driving and new, flexible mobility solutions, so that in the end the opportunities for positive change can be consciously perceived and shaped.

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Sven Lierzer was born on June 2nd 1982. Following his studies of political science and sociology at the University of Tubingen, he started to work at BridgingIT GmbH.

In the last five years he has been engaged in issues of several industries mainly utilities. He worked on innovations such as Smart Grids, new mobility concepts e.g. electric mobility and smart cities, both on national and international level. At this, Sven Lierzer advises large companies and corporations as well as governmental organizations on aligning their strategy

Within the scope of innovation and business development Sven Lierzer is engaged with the current trend topic of Digitization – from Change Management, IoT and Future Work.