

# Structural Study BW 2023

Transformation of the Automotive and Commercial Vehicle Industry in Baden-Württemberg through Electrification, Digitalisation and Automation

**Key Findings and Recommended Action**

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# Foreword

Dear Readers,

The future of mobility is at a turning point. It is dominated by the issues of electrification, digitalisation and automation. The transformation under way does not only involve wide-ranging technological change, it also entails far-reaching structural changes and a new business model. Electrification and digitalisation are changing the entire development, production and distribution processes. New competitors and ever shorter innovation and market cycles are posing challenges for the established actors. Baden-Württemberg is playing a central role in these developments. Today we are one of the world's leading centres of automotive technology. As such, Baden-Württemberg is ideally equipped to play a leading role in the ongoing transformation process. The region's cooperation structure and innovative strength, which benefits from a tight-knit network of car manufacturers, suppliers and research institutions, offers a sound foundation for management of the change process.

The Federal Government and the European Union have set clear goals. Among other things, these establish the framework for the transformation process in relation to electric mobility and renewable energy. Alongside this there are Baden-Württemberg's specific objectives, for instance full climate neutrality by 2040. Challenges such as the Covid-19 pandemic and geopolitical changes have exacerbated the complexity of this transformation.

The 2023 Structural Study is thus appearing at a decisive moment in relation to our response to these changing conditions. It offers a scientifically sound analysis of the consequences these changes will have for value creation and employment in Baden-Württemberg. As well as the transformation of the automotive industry through the electrification of the drivetrain, the study also looks into the prospects and consequences arising from the increasing digitalisation, automation and networking of mobility.

The study aims not only to highlight the challenges but also to pinpoint the opportunities thrown up by this transformation. It serves as an important source of information for a wide spectrum of players, from industry to politics and civil society, as well as providing targeted recommended action for the successful long-term transformation of Baden-Württemberg as a major centre of the automotive industry. The study findings are of central importance for the structuring of a path leading to a sustainable and intelligent mobility landscape.

Despite the complexity and the multidimensional challenges which the transformation process entails, there are grounds for optimism. Baden-Württemberg has the unique opportunity to exploit its strengths, which include a highly qualified skilled workforce, excellent universities and research institutions, and a strong industrial base, thereby retaining and indeed reinforcing its leading role in the mobility landscape of the future.

Successfully confronting these challenges will require a systemic and intersectoral approach. It will need close collaboration between different players from the fields of business, science, administration, politics and society as a whole. In Baden-Württemberg over 200 partners are now active in the Electric Mobility South-West and Fuel Cell BW clusters respectively. Back in 2017 the Baden-Württemberg state government inaugurated Strategiedialog Automobilwirtschaft BW (Strategic Dialogue for the Automotive Sector in Baden-Württemberg), an institutionalised, cross-sectoral collaboration of all relevant actors aimed at successfully shaping the future of the automotive industry.

To conclude, we would like to thank everyone who has contributed to the execution of this important study. The findings should serve as a wake-up call for all stakeholders. We must intensify our collaborative efforts in order to ensure that Baden-Württemberg remains a sustainable and competitive location for the automotive industry.



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# 01

## Starting Point and Objectives

All round the world the automotive industry is undergoing a process of transformation of ever greater dynamism and intensity. Driven by factors such as technological change in the fields of electrification, digitalisation and automation, existing innovation, production and value chains are being transformed, and entirely new ones created, all of which has major consequences for Germany and Baden-Württemberg as major automotive centres. Additional economic opportunities, arising for instance, from automated driving, may be set against, risks of loss of competitiveness, for example in the field of battery technology. Uncertainty prevails concerning the impact these changes could have on value creation and employment in the Baden-Württemberg automotive cluster.

This short version summarises the key findings and recommended action arrived at by the Structural Study BW 2023: Transformation of the Automotive and Commercial Vehicle Industry in Baden-Württemberg through Electrification, Digitalisation and Automation.



The full version of the study can be accessed free of charge at [e-mobilbw.de/service/publikationen/Studien](https://e-mobilbw.de/service/publikationen/Studien). Simply scan the QR code.

The purpose of this study is to describe the changes which Baden-Württemberg has undergone as an automotive industry centre. The study will focus on the challenges and opportunities created by the electrification, digitalisation and automation of driving in both the passenger car and commercial vehicle sectors. Setting these out in a scientifically sound, comprehensible and transparent way is a prerequisite for the active and positive structuring of change in politics, society and industry. Other important criteria for a successful transformation are meeting climate targets and limiting further

global warming. To this end, the electrification of vehicle drive systems is a necessary but not a sufficient measure. However, the need to change the entire mobility system and mobility behaviour is not the subject of this study, which involves the scenario-based examination of electrified and automated passenger cars and commercial vehicles, including their technology and components, and also of the effects of electrification, digitalisation and automation on value creation and employment. Possible effects from the fields of energy, software and Industry 4.0, on the other hand, are not calculated here on the basis of our own simulation models, rather being discussed qualitatively. The present study offers answers to the following questions:

- What is technological change?
- What is the status of electrification, digitalisation and automation, and what trends can be seen?
- How is the automotive industry structured in Baden-Württemberg (passenger cars and commercial vehicles)?
- How quickly and under what conditions will alternative drive systems become established? How quickly will vehicles be automated?
- How are value creation and employment progressing?
- What structural options are available for the transformation?

# 02

## Summary of the Study Findings

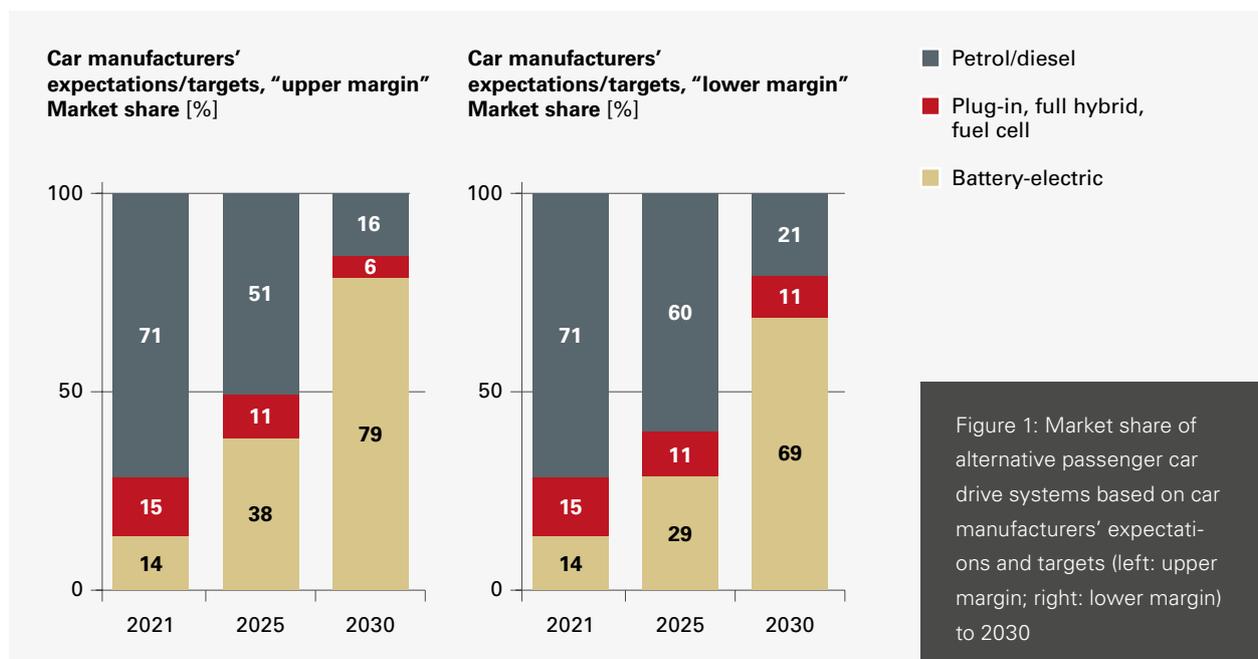
### 2.1 Technological Change and Main Trends

The electrification of vehicles is growing steadily. The proportion of vehicles with hybrid and, most importantly, battery-electric drives newly registered worldwide is increasing rapidly, and on top of this ever more electrical and electronic components are being incorporated into vehicles with classical combustion engine power trains. As a result a wide variety of designs and degrees of electrification have come into being, from hybrid to purely battery-powered vehicles, with differing electrical outputs, ranges and driving proportions. The number of electrified passenger cars on offer is also steadily rising, with over 1,000 electrified model variants currently available on the German market. German car manufacturers' current corporate, innovation, product and platform strategies reveal a clear orientation towards battery-electric drives.

Conversely, the development of classical components will reduce in scope and variety, in favour of new electric power trains (battery, electric motor, power electronics) and automated/connected driving components. New components are significantly changing the value-added shares in vehicles, with the focus of value creation shifting from mechanical systems to electrics and electronics, or from hardware to software.

An essential aspect of digitalisation in mobility is connectivity, that is communication of vehicles with each other, with external infrastructure and with special platforms, so that new functions and business models become possible.

In conjunction with this, driver assistance systems such as lane-keeping, lane change and distance assist are being developed, as are parking aids, all of which represent technological



steps on the road to highly automated driving. Partially automated vehicles already exist today, and fully automated or autonomous driving is expected between 2025 and 2035. These should contribute to increases in road safety and mobility services for all social groups. The application of artificial intelligence (AI) or technological breakthroughs, for instance in battery cell production, may have a major impact on value chains and the evolution of future employment patterns. These game changers must be tracked via scouting and monitoring and then taken into account in future industry descriptions and market analyses.

Combining connected, intelligent transport elements and automated/autonomous vehicles is leading to the development of new mobility services and business models.

## 2.2 Industry Description and Market Analysis

The automotive industry is one of Baden-Württemberg’s key industrial sectors, with an annual turnover of just over €135 billion and around 225,000 employees. In addition, broadening our view to include other manufacturing industry sectors and services, such as the motor vehicle retail, repair and aftermarket trades, etc., around 480,000 people work in the automotive cluster, 315,000 of them in core value creation areas and 66,000 in R&D-related fields of work. The automotive industry’s direct and indirect employment effects account for about one-tenth of all jobs liable for social insurance contributions in Baden-Württemberg. The commercial vehicle segment accounts for some 12% of the automotive industry workforce in Baden-Württemberg and adds many technically sophisticated commercial vehicles and buses to the range of vehicles produced.

The transformation of the automotive cluster towards electric mobility and automated driving calls for a high level of investment. However, the investment activities of a sample of manu-

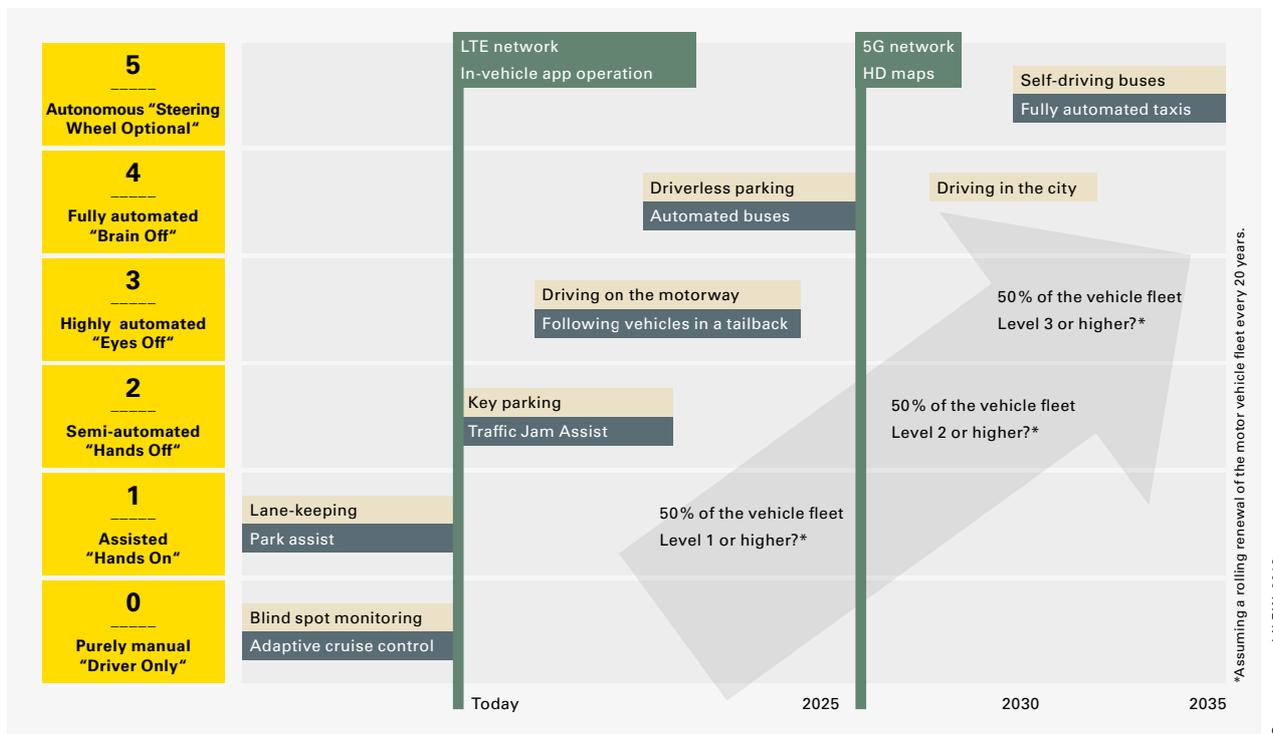


Figure 2: Examples of vehicle systems for automation and connectivity

facturers and suppliers with sites in Baden-Württemberg have in fact diminished over the past two years. In Baden-Württemberg, the need for additional industrial space for the new products also poses a particular challenge, as the space available is very limited. In recent years case studies involving companies such as Northvolt and Cellcentric have shown how difficult it is to relocate here, and the state government has responded by drawing up a relocation strategy.

The investment and financing required for the transformation are posing major challenges for the industry. A sample analysis of investment indicators at selected OEMs and suppliers shows reluctance to invest in German locations, as opposed to sustained investment abroad. After building up production capacities abroad, manufacturers in particular are now aiming to establish largely independent “local for local” production networks in the three world market regions of Europe, North America and Asia (and here above all China). In 2022, around 7.8 million BEVs and 2.8 million PHEVs were newly registered worldwide, bringing the total number of electrified passenger cars to over 27 million. China is the main driver of this development, with more than 50% of all electric vehicles worldwide. Germany and Baden-Württemberg are a long way behind in terms of both relative market share and absolute figures, especially when compared to the main drivers China, Norway and the Netherlands. International comparisons show that political targets, purchase incentives, emissions limits and availability of infrastructure vary greatly. Electric mobility in particular has led in recent times to many new providers entering the German market and competing with classical car manufacturers and suppliers. Moreover, providers of new mobility services are competing with OEMs for access to end customers.

### 2.3 The Baden-Württemberg Automotive Cluster

The automotive industry, development service providers and the motor vehicle retail, repair and aftermarket trades etc., are segments of the Baden-Württemberg automotive cluster. This includes all companies that focus on production, distribution, maintenance and repair as well as other services related to both passenger cars and commercial vehicles. As elsewhere, in the Baden-Württemberg automotive cluster employment extends far beyond “automotive industry” jobs in the delimitations applied in economic statistics: alongside manufacturers and suppliers, other manufacturing industry sectors perform upstream work for the automotive industry. Take, for example,

the car windows provided by the glass industry or tyres and, above all, innumerable parts for the interior and for car bodies supplied by the rubber and plastics industry. Various mechanical and plant engineering companies supply parts such as pistons for internal combustion engines, while other companies provide manufacturers and suppliers with machines for metalworking or for the production of electromagnetic coils for electric motors. Based on the degree of specialisation for the specific product “motor vehicle”, we may distinguish between the cluster core, the extended value-added cluster and the automotive cluster as a whole (a detailed description of the cluster and the methodology used may be found in e-mobil BW, 2019a).

- The **core of the cluster** comprises companies directly involved in the production of motor vehicles. These are vehicle manufacturers such as Mercedes-Benz Group AG, Daimler Truck AG, Porsche AG and Audi AG, as well as suppliers in the Tier 1 to Tier 2 stages of the value chain (e.g. Robert Bosch GmbH, ZF Friedrichshafen AG, the Mann + Hummel Group, ElringKlinger AG and the Eberspaecher Group). Portions of other manufacturing sectors, such as the glass industry, metal processing and the rubber and plastics industry, are assigned to the cluster core, given that their products are directly included in vehicle parts and components. The core also includes elements of mechanical engineering (e.g. piston production), automotive development service providers as well as plant service providers working directly at automotive sites, for instance security services, logistics companies at automotive sites and personnel leasing operations.
- The **extended value-added cluster** includes companies that supply the automotive industry but whose products are not specialised for motor vehicles. These include mechanical engineering operations active in the field of vehicle construction (in particular an element of the machine tool industry), as well as other Tier 3 to Tier 4 level material suppliers of items such as screws, technical textiles, etc., and also services such as legal advice, advertising and wholesale.
- The **automotive cluster as a whole** is complemented by industries necessary for the use of motor vehicles: the motor vehicle industry, as well as petrol stations and refineries ensuring a secure supply of fuel.

<b>Cluster core</b>	<b>315,500</b>
<b>Extended value-added cluster</b>	<b>381,600</b>
<b>Full automotive cluster</b>	<b>480,100</b>

Table 1: Jobs in the Baden-Württemberg automotive cluster in 2022

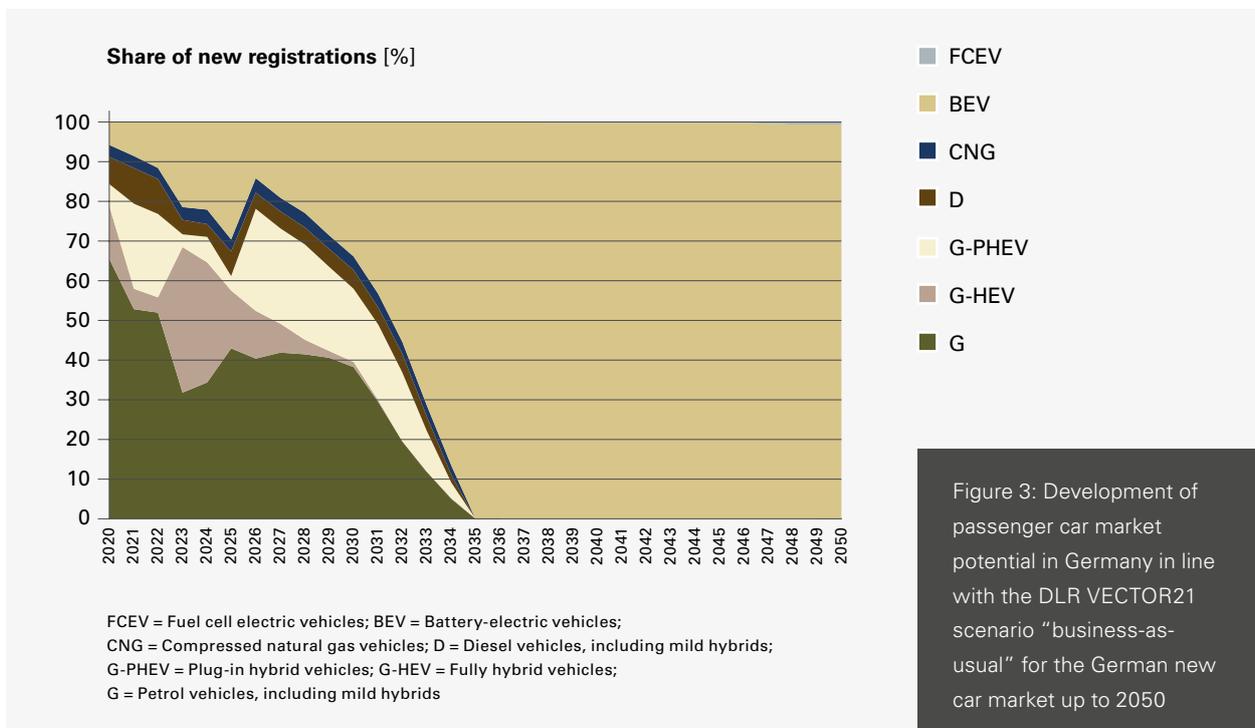
Source: DLR and IMU own research, 2023

### 2.4 Structural Change Scenarios

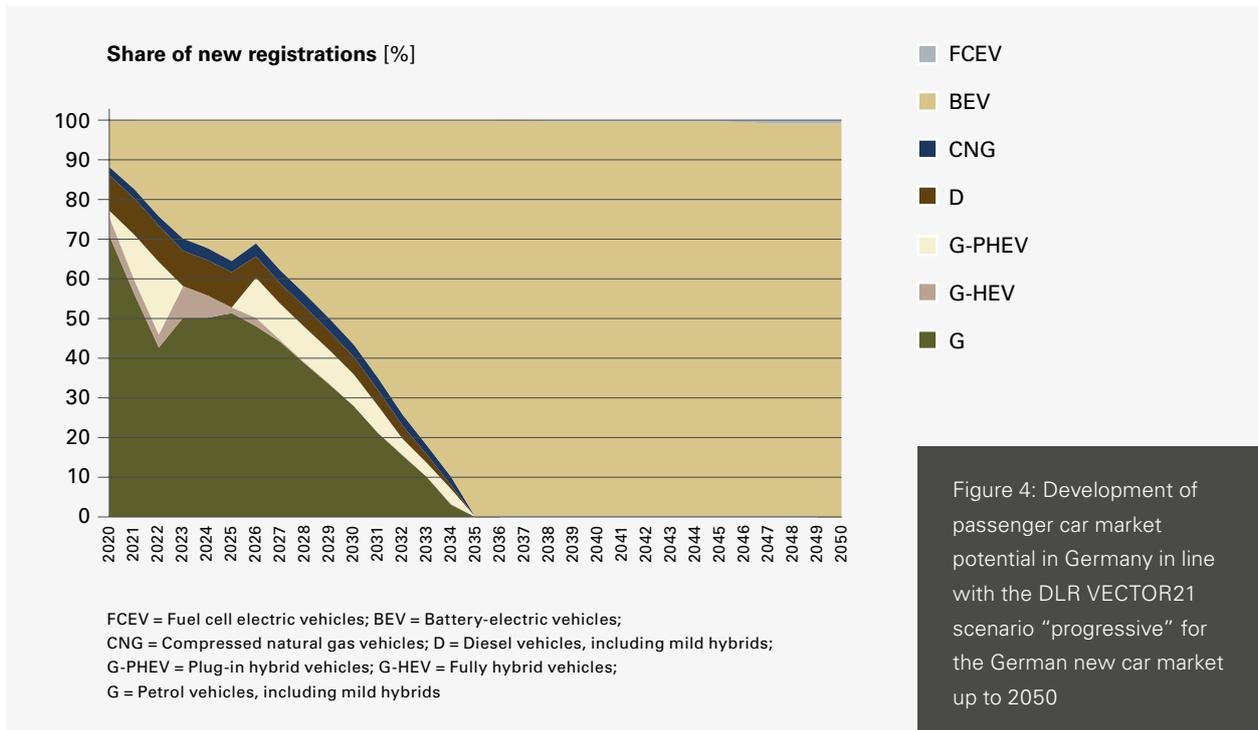
The relevant factors influencing the speed of the market ramp-up of alternatively powered vehicles include battery costs, infrastructure availability, CO<sub>2</sub> legislation and financial incentives to buy. Depending on the criteria applied (“business-as-usual” vs. “progressive”), our simulated scenarios for Germany, using DLR VECTOR21, predicted that purely battery-electric passenger cars will achieve a market share of between 34 % and 57 % of new registrations by 2030 (EU: 45%/62 %). Between 66 % and 43 % will be (partially) electrified by then, and will still have an internal combustion engine (EU: 55%/38 %). By 2040, demand will be almost exclusively for

battery-electric vehicles, with fuel-cell-powered vehicles being an option in the passenger car sector, chiefly in high-performance vehicles with luxury-class range requirements, though these will only achieve market share of less than 0.5 %.

In 2030, purely battery-electric trucks will achieve share of new registrations in Germany ranging from 23 % (“business-as-usual”) to 50 % (“progressive”), but with major differences between individual commercial vehicle segments: fuel cell commercial vehicles will be in demand where range requirements and mileage are high, whereas for lighter vehicles or lower range requirements, the shares of battery-electric vehicles will be higher. Under the progressive scenario, there

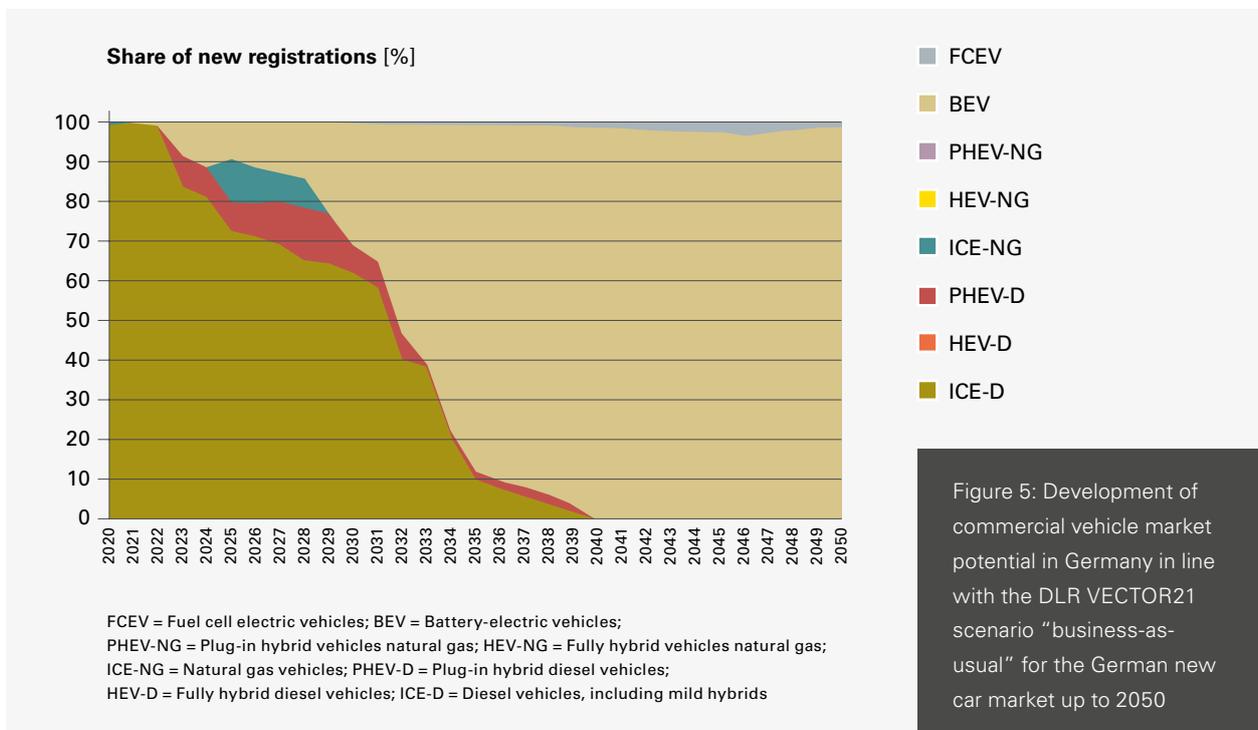


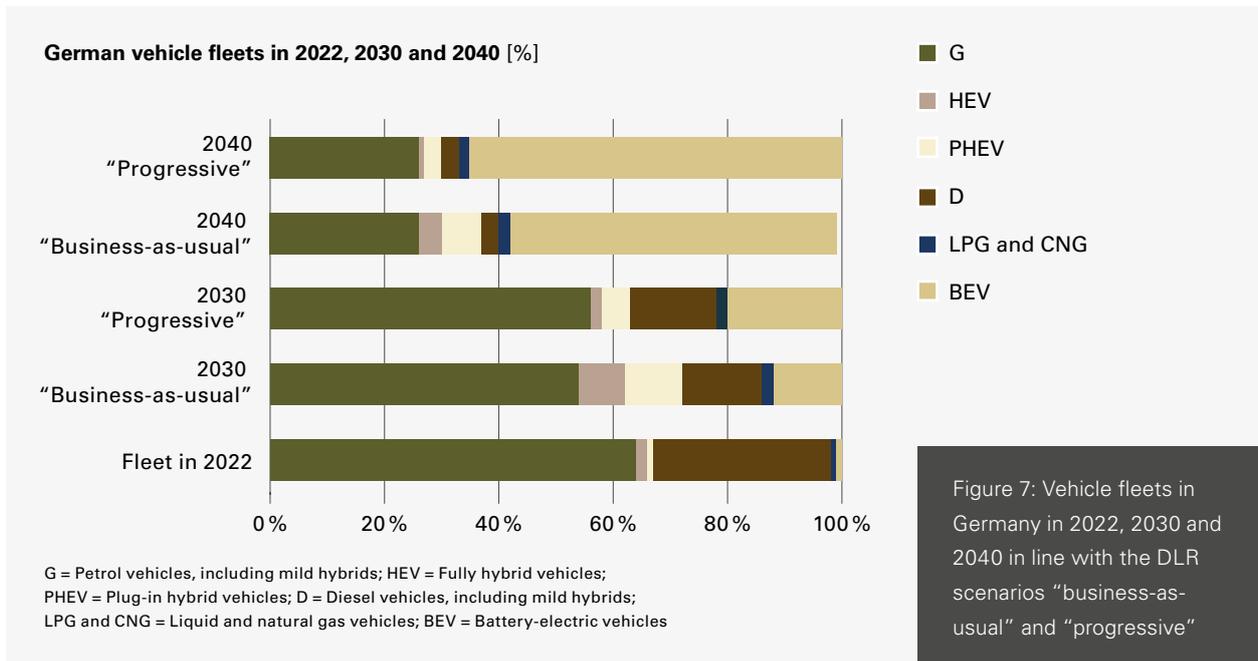
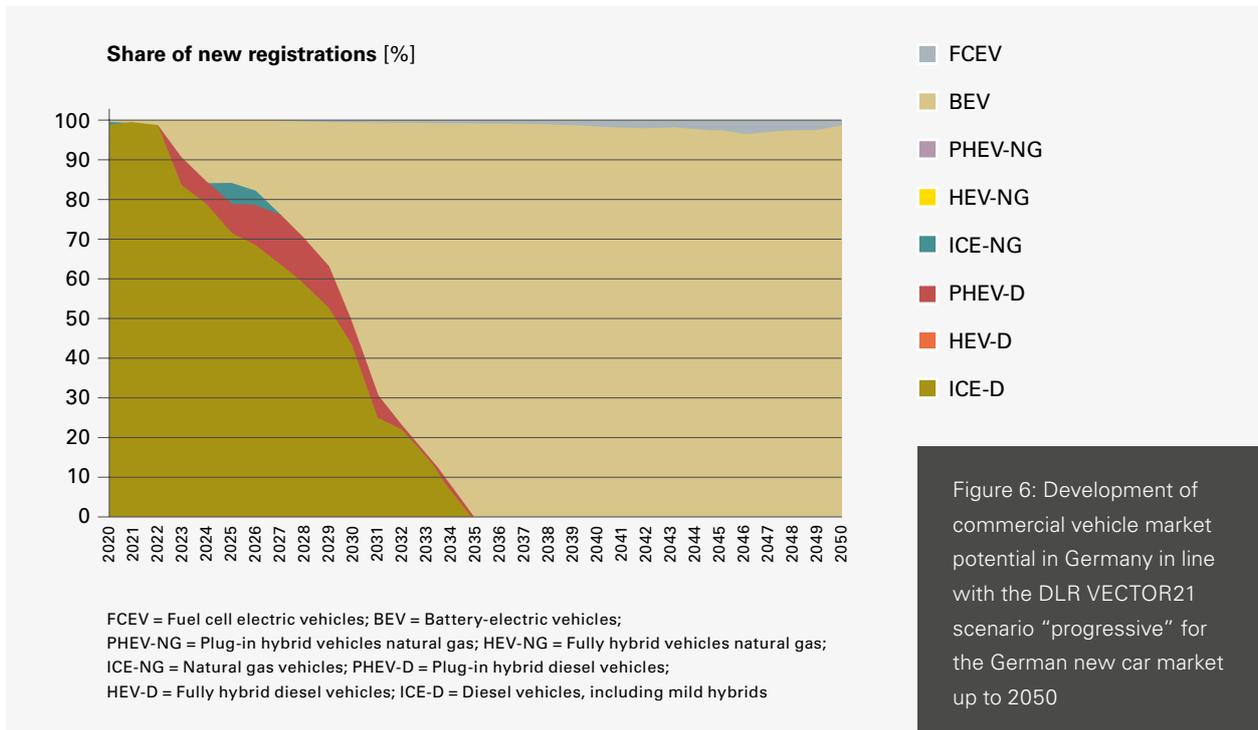
Source: DLR own research



will be approx. 10 million battery-electric cars and some 900,000 commercial vehicles in the German vehicle fleet. This means

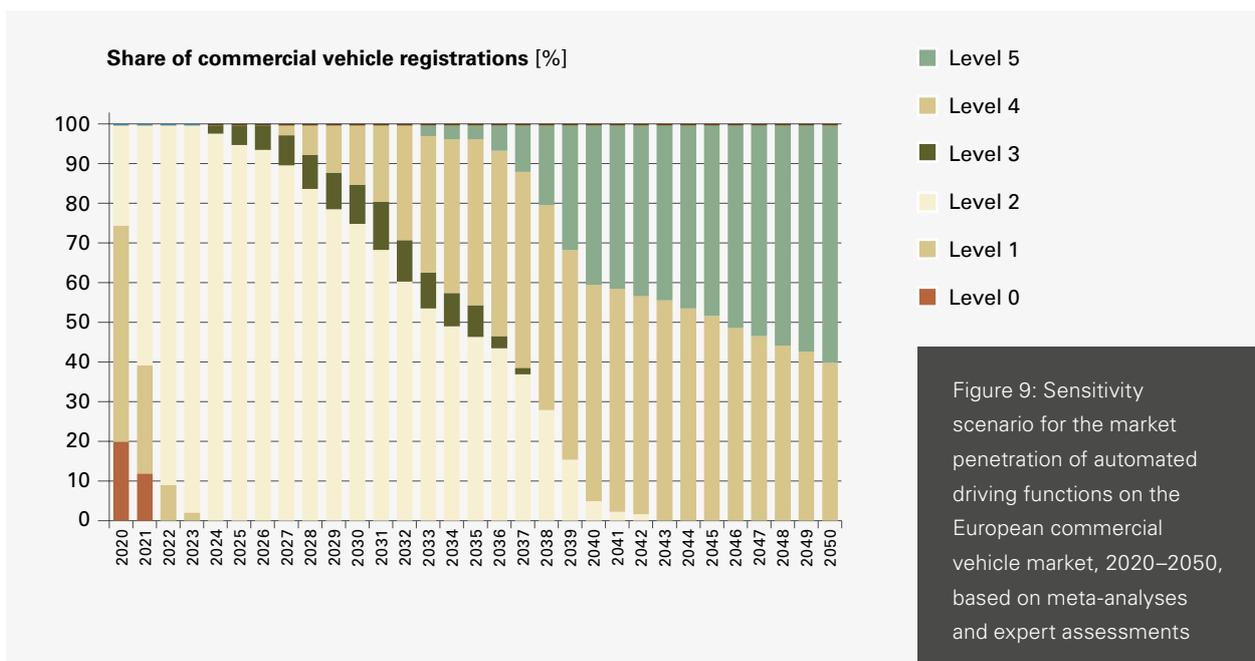
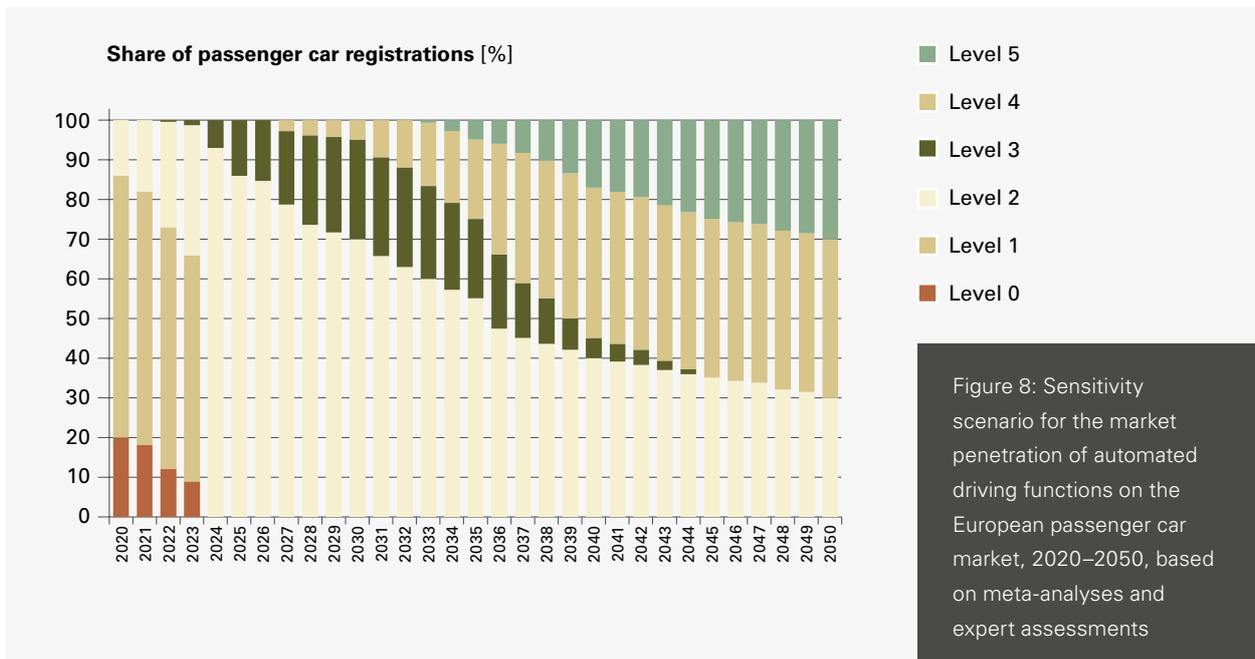
that, even assuming accelerated electrification, the Federal Government's target (15 million BEVs) will be missed.





The cumulative greenhouse gas emissions from the passenger car and commercial vehicle sectors will exceed the 2030 milestones set out in the Climate Protection Act by around 27 %, even under the progressive scenario. Accordingly, alongside the technological renewal of the vehicle fleet, further political measures will be needed in order to reduce greenhouse

gas emissions in the transport sector. Meta-analyses and expert assessments show the demand for new components such as LiDAR, radar and camera systems resulting from the market ramp-up of vehicle automation. The following figures set out the anticipated market ramp-up for the various levels of automation of cars and commercial vehicles in Europe.



## 2.5 Employment Effects of Electric Mobility and Automated Driving

The employment effects associated with the phasing out of the internal combustion engine (fade-out) and the market ramp-up of components for electric mobility and automated

driving (fade-in) will have a significant impact on the entire automotive cluster in Baden-Württemberg.

- The business-as-usual scenario yields a decline in employment of around 8% or 36,700 jobs by 2030, while the progressive scenario leads to figures of approx. 14% or

66,000 employees. By 2040, the employment effect from the complete elimination of the ICE<sup>1</sup> will be mathematically much stronger (over –30 %, or around 154,500 jobs).

This may be viewed as a development path arising from an accelerating market ramp-up of electric vehicles, exhibiting greater dynamism than the scenarios considered here. These figures take into account increases in employment attributable to electric mobility.

- A further 5,000 to 7,000 jobs (2030/2040) may be offset by automated driving components, which will mean additional value creation potential for the industry.
- Demographic change is expected to lead to a decline of around 29,500 people of working age for the Baden-Württemberg automotive cluster by 2030. The retirement of heavily populated age cohorts over the next few years is seen as an option whereby employment in the automotive industry can decline in a socially acceptable way, i.e. without redundancies.
- By 2040, the number of employable people in the cluster is expected to fall by around 39,400 from today's level, to some 413,800. Here, the fade-out effects attributable to electric mobility will be substantially greater than the effect of demographic change (the model predicts a decline to approx. 330,000 people).

Moreover, the model already incorporates the assumption that Baden-Württemberg locations will undergo thoroughgoing conversion and expansion for new technologies and that companies will achieve market share similar to today's figures for combustion engine power train components. For instance, taking the planned expansion of battery production capacities as an example, it is noteworthy that, with a volume of more than 545.5 GWh, battery production sites in Germany account for some 20 % of total capacity planned in Europe. However, Baden-Württemberg's share of this amounts to a mere 2 % or so, making it significantly lower than the state's previous share of European automotive industry turnover and jobs. The competition expected from Chinese electric vehicle manufacturers and strong price pressure mean that there are considerable risks here, especially for Baden-Württemberg-based suppliers. Only if these prerequisites are met will it be possible to actually realise the calculated fade-in effects in full, and the effect on the entire cluster may be viewed as manageable. This will call for joint efforts by companies, politics and society as a whole.

However, a detailed examination of individual cluster segments clearly shows that they are affected to differing degrees by the decline in employment. This also leads to strong regional variations in the degree of impact on individual locations. Production sites for components and parts, as well as research and development, are much more strongly affected by the decline in employment: even under the business-as-usual scenario, half of the volume of work will disappear by 2030. At the power train production sites in particular, expected rationalisation effects and relocations will lead to even greater job losses. As a result, key segments of Baden-Württemberg's innovation cluster are at risk.

## 2.6 Baden-Württemberg as an Industrial Innovation Cluster

The entire automotive industry is subject to long-term megatrends, which throw up both opportunities and risks for Baden-Württemberg locations. The sustained optimisation of production and, in recent years, also of administrative and R&D activities, has safeguarded the highly competitive performance of Baden-Württemberg companies. However, a downside of these productivity boosts has been substantial job losses over the years, especially in production. The automation of production and its relocation to more cost-effective locations abroad have contributed to this trend. Digital technologies will now also bring about significant rationalisation in administrative and R&D fields. In response to sustained cost pressure companies will be forced to adopt such measures over the coming years. The development of largely independent production networks in the three major global markets of Europe, North America and Asia is continuing apace, and the Covid-19 pandemic has accelerated this transformation. In light of this strategy, automotive industry sites in Baden-Württemberg, which will be aligned towards the stagnating European vehicle market, will probably be unable to derive any further benefit from market growth in Asia.

<sup>1</sup> | Effects from synfuels were not taken into account in the calculations.

Cluster segment		2022	Effects of electric mobility, including general industry developments			Effects of automated driving	
			2030 BAU scenario	2030 PROG scenario	2040	2030	2040
<b>Cluster core – value creation directly dependent on cars</b>							
OEM	Components	21,200	17,400	13,000	3,900	500	710
	R&D	19,300	17,500	15,800	11,200	500	600
	Assembly	42,500	39,400	39,400	35,500	1,000	1,400
	Administration	13,500	12,600	12,600	11,300		
<b>Manufacturers of car bodies, superstructures and trailers</b>		6,100	5,700	5,700	5,100		
<b>Suppliers of car components and parts</b>	Components and parts	91,500	99,800	91,600	68,300	2,100	3,100
	R&D	30,500	27,600	24,900	17,700	700	1,000
<b>Other branches of manufacturing industry</b>	Components and parts	37,700	38,300	36,200	28,900		
	R&D	16,100	12,600	11,700	8,900		
<b>Development service providers</b>		16,100	14,600	13,200	9,300	400	500
<b>Temporary workers</b>	General	8,600	8,000	8,000	7,200		
	Power train dependent	10,900	4,600	3,800	2,200		
<b>In-house services</b>		1,500	1,400	1,400	1,300		
<b>Cluster core total</b>		315,000	299,500	277,300	210,800	5,200	7,310
<b>Extended value-added cluster – value creation indirectly attributable to automotive industry</b>							
<b>Other manufacturing</b>	Components and parts	22,100	20,500	20,500	18,400		
<b>Mechanical engineering companies as equipment suppliers</b>		29,300	26,500	23,900	17,000		
<b>Non-product-specific services for OEMs and suppliers</b>		14,700	13,700	13,700	12,300		
<b>Value-added cluster total</b>		381,600	360,200	335,400	258,500		
<b>Overall automotive cluster – other car-dependent jobs</b>							
<b>Motor vehicle retail, repair and aftermarket trades</b>		91,300	71,000	64,000	55,000		
<b>Fuel supply</b>		6,000	4,900	4,500	1,900		
<b>Charging infrastructure and power supply</b>		1,200	7,300	10,200	10,200		
<b>Baden-Württemberg automotive cluster</b>		480,100	443,400	414,100	325,600	5,200	7,310

Source: DLR and IMU own calculations, 2023

Table 2: Quantified employment effects across the overall cluster

# 03

## Options for Action for the Transformation of the Baden-Württemberg Automotive Cluster

The options for action set out in the 2023 Structural Study focus on Baden-Württemberg as an automotive industry location. They encompass the entire automotive-related value chain. Their goal is to ensure that the automotive cluster remains a leading provider of electric mobility and automated driving. The options for action are based on the findings of the current study and of earlier studies.

The recommendations for action given in this section are intended to provide politicians and business with concrete measures to ensure that the location remains viable in future and to successfully manage the transformation of the value-added cluster for the electric power train. The recommendations are divided into three stages and highlight the respective spheres of responsibility of politicians and business. Implementing these recommendations should lay the foundations for a sustainable and competitive automotive industry in Baden-Württemberg. The challenges demand a comprehensive package of measures and change management with broad participation by politics, business and the wider society.

### 1st Stage of Action: Maintaining and expanding the fundamentals

- Availability of (internationally) competitive industrial location
- Electricity from renewable energy sources at internationally competitive prices
- Expansion of charging/refuelling infrastructure for electricity and hydrogen
- Financing

### 2nd Stage of Action: Transforming value-added clusters for the electric power train and automated driving

- Expanding electric power train production capacity
- Promotion of the commercial vehicle segment
- Promotion of medium-volume industrial series production facilities
- Electric mobility qualifications campaign
- Qualifications campaign for digitalised vehicles
- Expansion of R&D capacities

### 3rd Stage of Action: Ensuring future viability

- Availability of hydrogen as an energy source for vehicles
- Recycling traction batteries as the next and central component in a circular economy
- Facilitating the implementation of automated driving

The options for action are briefly outlined below. A detailed discussion of the recommendations for action can be found in the [full study](#). It is crucial that politicians and business collaborate closely on implementing the proposed measures, thereby enabling us to meet the challenges of the future. Only through a coordinated and targeted approach can we ensure that BW strengthens its position as an industrial location and establishes itself as a leading supplier and lead market in the field of electric drive technologies.

## 1st Stage of Action: Maintaining and expanding the fundamentals

During the 1st Stage of Action, politicians in particular will be called upon to maintain and expand the foundations and framework for industrial value creation in Baden-Württemberg. This concerns the availability of industrial space, electricity from renewable energy at internationally competitive prices, expanding the charging infrastructure and producing hydrogen, as well as setting up the infrastructure needed for a resilient hydrogen supply as a central component of the energy transition. Financing infrastructure and business activities also form part of the fundamentals.

### Availability of (internationally) competitive industrial locations

The availability of suitable industrial sites is a central challenge for the transformation of Baden-Württemberg's automotive sector. Factors such as shortage of space, infrastructure and workforce potential influence location decisions. Increasing space requirements arising from the parallel production of ICE and electric vehicles, plus the production of automated driving components, mean that strategic planning and support will be needed, especially for small and medium-sized enterprises.

In the new state development plan, special areas for the automotive industry and the industrial production of hydrogen, fuel cells, synthetic fuels and battery cells should be considered more systematically, for instance by setting up dedicated working groups). In the short term, faster information exchange and coordination between the administrative levels involved is required and, as the central business promotion agency, Baden-Württemberg International (BW\_i) is already active in this field.

In parallel, the aim is to develop best-practice examples for highly space-efficient production, most importantly including the repurposing of existing production facilities and land recycling. New concepts for space-efficient industrial production and land recycling could be developed in cooperation with architects and urban planners at Baden-Württemberg's universities. Financial support to assist SMEs in implementing these concepts could also be considered.

### Assessment

The short-term focus when assessing the availability of industrial sites is on a central overview of suitable space and when it will be or become available. Here, actors in the state government (Ministry of Regional Development and Housing), in regional associations, and above all in the municipalities holding the planning powers, could coordinate better, possibly by means of an industrial spaces working group.

In the medium term, the automotive industry's space requirements will have to be taken into account when revising the state development plan over the next two to three years. This will overlap with the remit of the working group proposed above, which must nevertheless gather and summarise information relating to business concerns here. This should also be addressed by Strategiedialog Automobilwirtschaft BW (Strategic Dialogue for the Automotive Sector in Baden-Württemberg, SDA).

In the medium to long term, space-efficient industrial uses and land recycling will become indispensable. The proposed working group can address this issue and bring other actors on board.

The options for action are primarily aimed at political actors and administrative bodies. For the development of concrete measures, cooperation with other experts and, above all, the involvement of business will be necessary.

### Risks

The limited availability of space complicates the transformation of the automotive cluster by hampering both production conversions by existing companies and the relocation of businesses which could bring in new technologies to reinforce the cluster. However, room for manoeuvre is limited given the nature of the landscape and high levels of competition between different land uses.

### Electricity from renewable energy at internationally competitive prices

For the automotive industry in particular, reliable and internationally competitive electricity prices are crucial to the switch to renewable energy. CO<sub>2</sub>-neutral production is becoming increasingly important, as the examples of Mercedes-Benz and Bosch show. However, suppliers, who account for around 80 % of value added, face major challenges. Renewable energy can be a decisive location criterion and is indispensable for the switch to electric mobility. Battery-electric vehicles have a clear CO<sub>2</sub> advantage over combustion engine vehicles, especially if they are produced and operated with electricity generated from renewable energy sources.

In terms of gross generation of electricity from renewable energy, though, Baden-Württemberg remains below the German and European average. Alongside the expansion of renewable power generation, also important is the development of a hydrogen supply for heat-intensive processes and of electricity generation capable of delivering base load power.

The expansion of renewable energy is being delayed by strictly regulated and bureaucratic approval processes. Accordingly, the energy transition will require the accelerated expansion of electricity generation and grid capacities. To accelerate expansion and increase the share of gross electricity consumption to 80 % by 2030, the German Erneuerbare-Energien-Gesetz (= Renewable Energy Sources Act, EEG) has been amended. In addition, the state government has set up a task force to accelerate the expansion of renewable energy and is prioritising the issue of “Renewable BW” at KEA Klimaschutz- und Energieagentur Baden-Württemberg GmbH (Climate Protection and Energy Agency Baden-Württemberg GmbH, KEA).

Another field of action is the energy transition hardware that will be needed to achieve the goal of a 65 % reduction in CO<sub>2</sub> emissions in Germany by 2030 as against 1990. In Germany this will require many times the current stock of hardware.

	As of 2021	2030 target	Annual change needed up until 2030
<b>Solar</b>	59 GW installed capacity	200 GW installed capacity	15.7 GW new additions p. a.
<b>Offshore wind turbines</b>	7.8 GW installed capacity	30 GW installed capacity	2.5 GW new additions p. a.
<b>Onshore wind turbines</b>	58 GW installed capacity	100 GW installed capacity	4.9 GW new additions p. a.
<b>Heat pumps</b>	approx. 1.2 million installed heat pumps	4.1 to 6 million installed heat pumps	0.4 million new installations p. a.
<b>CO<sub>2</sub> emissions</b>	772 Mt CO <sub>2</sub> equivalent	438 Mt CO <sub>2</sub> equivalent	-37.1 Mt CO <sub>2</sub> equivalent p. a.

Table 3: Changes needed in Germany for solar energy, onshore and offshore wind farms, and heat pumps to achieve the 2030 climate target

Source: McKinsey according to PV Magazine, 2022

**Assessment**

Measures for the expansion of renewable energy have very high priority, given the very slow pace of planning and approval processes. In parallel, the connection or expansion of high-voltage lines linking Baden-Württemberg to the wind energy generated in Northern Germany and the acceleration of planning and approval processes must also be promoted. The medium-voltage grid also needs to be expanded. Agreement must be reached with the KEA task force that the energy needed for the automotive industry and to operate electric vehicles must be taken into account in the country's renewable energy expansion plans. Political actors must create the framework within which the task force can also achieve its goals in relation to the automotive industry's needs. This applies directly to politics in Baden-Württemberg and indirectly to political activities at federal and EU levels.

**Risks**

If electricity generation and supply are not converted to renewable energy, to achieve CO<sub>2</sub>-neutral production companies in Baden-Württemberg will either have to generate their own electricity or use CO<sub>2</sub> certificates to offset emissions. This will lead to higher burdens on companies and may influence relocation planning. It is also possible that companies will choose not to locate in Baden-Württemberg.

**Expansion of charging/refuelling infrastructure for electricity and hydrogen**

The expansion of the charging infrastructure is crucial for the ongoing rollout of electric mobility and the phasing out of combustion technology. The charging infrastructure is expected to be fully in place by 2040, with the focus on a nationwide, needs-based infrastructure, not just numbers of charging points. This accelerated expansion will require cooperation between a range of actors and will include measures such as standardisation, approval processes and hardware production. For example, to date fast charging stations have had a lead

time of up to 18 months. The provision by municipalities of land for charging stations is vital and is being supported by national and regional institutions. Baden-Württemberg Ministry of the Environment, Climate Protection and Energy Sector and the various infrastructure operators have signed an agreement designed to accelerate the expansion of infrastructure.

**Assessment**

The further expansion of the charging infrastructure has high priority and must be pursued without delay. It is a key criterion for the successful market ramp-up of battery-electric vehicles. Politicians provide financial support, but just as important are further coordination and standardisation of charging and payment processes throughout Europe. Baden-Württemberg political actors can advocate this at federal and EU level. It will only be possible to remove licensing and bureaucratic obstacles to the construction and operation of charging infrastructure through close cooperation between politics, administration and business.

**Risks**

If the charging infrastructure expands more slowly than the market ramp-up of electric vehicles this will jeopardise acceptance of electric vehicles. This could hamper decisive change in this field.

Expanding the charging infrastructure is crucial for the success of battery-electric vehicles. In Baden-Württemberg and Germany, support is provided by subsidies such as the BW-e-Solar voucher and the innovation premium. The elimination of the environmental premium could reduce the market share of small vehicles, so its continuation might make sense. When procuring vehicles government agencies should favour electric vehicles. For goods transport, fast-charging stations with performance up to the megawatt range and a dense charging network with corresponding energy infrastructures will be required along motorways and at logistics locations.

For commercial vehicles in particular, it will be necessary to build up a hydrogen infrastructure including local production,

import from other federal states and countries, and nationwide distribution of hydrogen at filling stations. Baden-Württemberg has therefore drawn up a hydrogen road map which sets out suitable measures, and is also planning its connection to the European transmission network. Integrated planning involving all stakeholders will be important. The Platform H2BW supports networking and planning. Collaborations with countries such as Chile, Brazil, Scotland, Spain and North African countries are being put in place in order to meet the demand for hydrogen. If these fundamental decisions are not made, it will be impossible to establish a decentralised supply of hydrogen to business and end customers within the next decade. Furthermore, there is a second reason why we must prepare for all this today.

### Assessment

Due to the long lead time there is an urgent need to make fundamental decisions concerning hydrogen technologies, relating to connection to the European Hydrogen Backbone's large-scale hydrogen pipelines, the establishment of local hydrogen production hubs and cooperation with countries where hydrogen production operations can be set up particularly cheaply and efficiently. The Platform H2BW can help drive and accelerate integrated planning through coordination between the public sector, automotive companies, chemical companies and energy suppliers, so that building up a decentralised hydrogen infrastructure in the 2030s runs more smoothly than the deployment of the charging infrastructure for BEVs has done. A parallel endeavour should be the establishment of a decentralised hydrogen infrastructure. Key decisions are currently being made at federal and European level. To maintain the state's attraction as an industrial and mobility location, it will be important for positions already formulated for Baden-Württemberg to be vigorously represented. Also being exploited is a degree of room for manoeuvre at state level. The window of opportunity is favourable for securing the necessary space for (refuelling) infrastructure in the new state development plan. However, looking forward, the modification, optimisation

and simplification of approval processes and elimination of information gaps will also be important levers for promoting the hydrogen ramp-up.

### Risks

Over the medium to long term, hydrogen is expected to provide a key energy source in applications going far beyond transport, for example in energy-intensive industries and system-stabilising power generation. Failure to develop the hydrogen supply will mean that transport will lack a vital complement to battery-electric drives, especially in segments that cannot be electrified. Insufficient hydrogen infrastructure will hamper the transition to CO<sub>2</sub>-neutral production in many areas.

### Financing

Transforming the automotive industry requires major investment. Some €255 billion annually is needed for EU-wide climate neutrality under the Green Deal, of which €20.4 billion is earmarked for car transport. Financing these investments poses a challenge, as the automotive industry chiefly funds its investments from profits made in the traditional vehicle segment. The rapid transition to electric mobility requires faster investment in the transition phase, during which revenues from electric vehicles will not cover the costs. However, in the future highly automated production and rising sales should ensure similar profits to those registered for sales of classical combustion engines.

Financial institutions such as Landesbank Baden-Württemberg (Baden-Württemberg State Bank, LBBW) are already pursuing climate neutrality goals and reducing their dependence on combustion engine technologies. For companies that still rely on internal combustion engines this can make it difficult to access capital, as banks and the Kreditanstalt für Wiederaufbau (Credit Institute for Reconstruction, KfW) are increasingly giving preference to financing more sustainable products and production methods. The KfW has programs for sustainable mobility and charging stations. In Baden-Württemberg, LBBW is even less focused on the automotive industry. However, Transformationswissen BW (Information centre for the transformation of the automotive sector in Baden-Württemberg)

offers comprehensive funding information and financing opportunities, especially for SMEs in the supplier sector and the motor vehicle retail, repair and aftermarket trades, etc.

What is needed is a detailed analysis of the automotive industry's financing requirements, set against available subsidies, as well as an examination of the role of private and foreign investors. LBBW and BW-Bank could place greater emphasis on the transformation, supported by the majority shareholders Baden-Württemberg and Stuttgart.

### Assessment

The measures have been assigned medium priority vis-a-vis safeguarding the automotive cluster. For individual suppliers, though, the present situation may be drastically exacerbated after years of falling sales and increasing prices of raw materials, intermediate products and energy, as a result of which, in individual cases, the issue of financial support has become a matter of urgency. If investment and credit decisions are founded on climate-related criteria, they will drive forward the transformation of the automotive industry.

Players from Baden-Württemberg can influence LBBW's business strategy, with the aim of ensuring that it plays a more energetic role as a financing partner for automotive companies undergoing transformation. It might be easier for SMEs to seek out information on financing if the overview page at Transformationswissen BW, featuring business examples or "Questions and answers", were to provide clearer information on access to financing. Moreover, political actors at federal and EU level can also advocate access to "transformation capital" going well beyond what is possible purely at state level in Baden-Württemberg.

### Risks

Making capital available would ensure the survival of suppliers in acute economic difficulties, but the overall risk to the industry is difficult to assess.

## 2nd Stage of Action: Transforming value-added clusters for the electric power train and automated driving

The options for action set out in the 2nd Stage of Action are primarily aimed at companies that need to establish the new technologies in an environment, fostered by the politicians, that is conducive to entrepreneurial activities. The central components of the conversion are the development of electric power train production facilities, the promotion of the commercial vehicle segment, the promotion of medium volume industrial series production involving new components, as well as a qualifications campaign for electric mobility and digitalised vehicles coupled with the expansion of corresponding R&D capacities.

### Expanding electric power train production

Manufacturers and suppliers are focusing on the electric power train. Support measures range from securing materials and supply chains to the digitalisation of production. It is particularly important to safeguard the future of Baden-Württemberg sites. Politicians and business must create a framework (corresponding to the 1st Stage of Action) conducive to the conversion of sites to climate-neutral drive systems and the implementation of long-term strategies.

### Promotion of the commercial vehicle segment

Under the scenarios we have examined the commercial vehicle segment has shown stronger growth than the passenger car segment, which means that its promotion is a relevant option when it comes to safeguarding jobs. Baden-Württemberg is a central location for commercial vehicle production, and suppliers benefit from higher margins on corresponding parts. Unlike the stagnating passenger car market, the commercial vehicle sector will continue to grow, supported by increasing freight traffic. Specific needs can be tested through pilot projects and further training, with the focus on climate-neutral drive systems and testing fast-charging stations. New business areas beckon for companies that develop and manufacture charging solutions such as high-power charging (HPC) and megawatt charging systems. In the long term, additional hydrogen refuelling infrastructure will be needed (see 3rd Stage of Action).

### Assessment

One approach to promoting the commercial vehicle segment is the Arbeitsgruppe Nutzfahrzeuge (Working Group Commercial Vehicles), which is jointly organised by e-mobil BW and the Institute of Vehicle Systems Technology at the Karlsruhe Institute of Technology.

To strengthen the commercial vehicle segment in the medium term, contacts with business and research institutions should be made now, with a view to cooperating on the development of a research and implementation strategy. This approach should be long-term in nature and expanded in line with the desired growth of the network.

Another option would be for Strategiedialog Automobilwirtschaft BW (Strategic Dialogue for the Automotive Sector in Baden-Württemberg) to set up an agile working group tasked with looking into additional funding needs for commercial vehicles.

### Risks

The commercial vehicle segment can stabilise employment in the automotive cluster and round off the automotive cluster's product range. Failure to fund this segment will slightly compromise the cluster's stability.

### Promotion of medium-volume industrial series production facilities

Shifting from low volume to industrial production could be difficult for the established automotive industry, possibly due to financing issues or a lack of medium-volume production facilities. This could hamper the development of production facilities in Baden-Württemberg. Meanwhile, there will be opportunities for SMEs active in flexible contract manufacturing and able to collaborate with start-ups. Two Strategiedialog Automobilwirtschaft BW research projects, AgiloBat and Agilo Drive, are looking into flexible manufacturing in the fields of batteries and electric motors. A review will be needed to determine whether the transition from small batch production to medium production poses an obstacle. The starting point for this can be "mobilibees BW", the start-up network of e-mobil BW.

### Assessment

A short-term option is an exploratory study to assess scaling up small series and pilot production operations into industrial mass production, initially involving medium volumes. Only then can further options for action be considered, such as promoting cooperation between start-ups and SMEs in Baden-Württemberg. Thematically, this study could be taken on by the Ministerium für Wirtschaft, Arbeit und Tourismus (Ministry of Economic Affairs, Labour and Tourism), or by e-mobil BW.

An initial assessment of whether it makes sense for SMEs to support start-ups, and what measures could be used to achieve this, could be done in the networks managed by e-mobil BW.

### Risks

In order to maintain industrial production, the products and production processes developed in Baden-Württemberg must be transferred from pilot/small series to large-scale industrial production. If this does not succeed, the production set-up will be jeopardised, especially regarding automated driving components.

### Electric mobility qualifications campaign

The model indicates that job losses in the combustion engine sector can be at least partially compensated for by the development of electric mobility and automated driving, provided employees are suitably qualified. These qualifications need to be broad-based and to reflect the specific requirements of different fields of work. Although some qualification measures have already been introduced, there is a major need for special human resources development concepts. Companies bear the responsibility here, but they will need support as the training needed exceeds what they have the capacity to offer internally. Current laws have extended eligibility for further education subsidies. A wide range of training courses are already available, both for production personnel and developers.

Companies are required to train their employees for new tasks, but they will need support in doing so. In-house training will be needed for approx. 25,000 production employees in the power train and for about half of the 66,000 developers, who will need to familiarise themselves with new areas of technology. The training required may extend to several years in the case of postgraduate study courses. Various initiatives, such as the Strategic Dialogue for the Automotive Sector in Baden-Württemberg, the *fortbildung-bw* training platform, the *Transformationswissen BW* (Information centre for the transformation of the automotive sector in Baden-Württemberg) and the Transformation Team at IG Metall, have already devised recommendations for action and further training offers.

The aim is to present a joint qualifications initiative for Baden-Württemberg as an automotive location. Company representatives, works councils and parties to collective agreements could develop models for the financing of further training that might be helpful for smaller companies. Collaboration with universities and further education providers will be needed in order to devise suitably targeted further education programmes. Existing programmes in Baden-Württemberg could serve as a basis, while a review of possible funding by employment agencies will be required. Companies could make financial contributions here, given that they benefit from their employees' training. An up-to-date overview of educational opportunities in Baden-Württemberg regarding electric mobility and automated driving would be useful.

### Assessment

The electric mobility qualifications campaign has high priority since it forms the basis for maintaining employment during the transformation. Companies have a duty to systematically augment their employees' skills in new technologies. A very wide range of in-house training activities is provided. Some companies are satisfied with an overview of the new products, whereas others offer much broader training opportunities, for example when switching from mechanics to electronics or when working on high-voltage systems. Even determining the need for suitable qualifications requires considerable effort. Support with in-house training may be offered through cooperation between further education providers, associations and research institutions, which may, for example, develop further education pathways for common occupational groups, with corresponding further education opportunities. Political actors in Baden-Württemberg can encourage stakeholder cooperation here. We should also assess how to ensure that the subsidies provided by employment agencies can reach companies more efficiently. This will involve matching subsidised training activities with operational needs, for instance regarding the minimum duration of subsidised training or degree-level further education offers, and improved the use of financial support by SMEs. Another challenge is the implementation of academic further education at state universities, which is in competition with students' basic education. The qualification's level of relevance could for instance be highlighted by staging a high-profile event.

### Risks

Switching to new fields of work cannot take place without appropriate qualifications. Moreover, employee training ensures a high level of competence within the innovation cluster, which lays the foundations for product innovations and the market leadership of Baden-Württemberg companies.

### Digitalised vehicles qualifications campaign

Digitalisation is radically changing the car, from automated driving to the platform economy, and this means IT and software development specialists are required. Given the labour shortage, recruiting personnel for the Baden-Württemberg automotive industry must be a joint task for business, the state and municipalities. Measures aimed at counteracting this [shortage] include marketing initiatives and the development of a research and study focus on automated driving at local universities. Further training opportunities and cooperation with companies also create important networks within the cluster.

#### Assessment

If the employment opportunities created by automated driving are to be exploited, the qualifications campaign for digitalised vehicles must be given high priority. The initial step in particular will require rapid implementation. This is to take stock of existing study and further education opportunities and compare them with automotive companies' requirements regarding qualifications and skilled workers. In terms of organisation, this can be assigned to the Strategiedialog Automobilwirtschaft BW (SDA), while employers' and employees' associations and business should all be involved in its implementation. As with electric mobility, universities and colleges in particular are called on to offer further academic education in addition to basic academic training.

#### Risks

Failure to expand automated driving skills will mean that from 5,100 to 7,400 job opportunities in research and development, as well as in the development of production in Baden-Württemberg, will remain unexploited.

### Expansion of R&D capacities

The automotive cluster in Baden-Württemberg is characterised by close connections between industry, service providers and associated research institutions. To orient themselves towards the new propulsion technologies, these institutions need to expand their capabilities in fields such as battery cell manufacturing, semiconductor production and software development. This will include the development at universities, research institutions and companies of skills in battery technologies, electrical machinery and software. Particular attention must be given to energy density, power density and battery service life, as well as increasing the efficiency and power density of electric machines and replacing rare earth metals. Meanwhile, automated cell and battery assembly production capabilities will need to be developed, as well as capacity for the winding and assembly of electrical machines. The ever greater digitalisation and automation of vehicles means that software development is becoming increasingly important. Consideration must also be given to obtaining raw materials in Baden-Württemberg, in particular the extraction of lithium from deep water in the Upper Rhine Rift Valley. An existing geothermal plant near Bruchsal is being expanded by EnBW to include a lithium chloride production facility.

Baden-Württemberg's innovation network of research, development and production focuses on new technologies, with OEMs and suppliers already building up research capacities. The state government supports this by setting research priorities and conducting an electric mobility and automated driving qualifications campaign. Special advisory formats and cooperation projects ensure that SMEs, too, can benefit from this build-up of skills. For example, prompted by the 2019 Structural Study, a Baden-Württemberg electric motor production working group has been set up in the Cluster Electric Mobility South-West, and the current "Scale-up E-Drive" project supports small and medium-sized suppliers in expanding production for vehicles' electric power trains.

Commercial vehicles could lead the way in implementing automated driving functions, thus enabling Baden-Württemberg to further raise its profile as a commercial vehicle industry location. Consideration is now being given to the idea of focusing on commercial vehicles within the framework of the Strategic Dialogue for the Automotive Sector in Baden-Württemberg. From a cluster perspective, high-power charging (HPC) and megawatt charging systems offer major market opportunities, especially in comparison to the car charging infrastructure, and open up

new lines of business. The rapid production ramp-up of plants and components for the energy transition could create a new line of business for small and medium-sized suppliers, as exemplified by Robert Bosch GmbH, which generated sales of €4 billion in 2021.

Companies in Baden-Württemberg are already in a position to assess whether they can use their production expertise to supply parts and components for hydrogen technologies. Transformationswissen BW<sup>1</sup> and the Plattform H2BW<sup>2</sup> provide central access to a technology overview and detailed technology offers, as well as to studies on possible applications and hydrogen demand in Baden-Württemberg.

#### Assessment

For business, products from a decarbonised energy supply represent a new line of business where the supplier industry's skills in metal-working, air conditioning technology and large-scale production are facilitating a rapid expansion of production. Here we may consult with business to assess the extent to which making the switch is possible and how quickly it might succeed. Various options are conceivable here, including feasibility studies for production conversion by automotive suppliers, a working group involving interested companies and product developers and cooperations between research institutions and companies to set up pilot production plants.

#### Risks

Electric mobility is reducing the volume of work, especially for power train (part and component) suppliers. If they fail to seek out new lines of business at an early stage, employment and location risks will arise.

### 3rd Stage of Action: Ensuring future viability

The 3rd Stage of Action outlines the measures needed to maintain the long-term viability of the Baden-Württemberg automotive cluster: the availability of hydrogen as an energy source for vehicles, the circular economy including the recycling of traction batteries as the next and central building block, and the implementation of automated driving.

#### Availability of hydrogen as an energy source for vehicles

Hydrogen is considered the second key energy source for the decarbonisation of mobility and industry, especially for commercial vehicles, large cars and other means of transport such as trains, planes and ships. Accordingly, in the long term a nationwide hydrogen refuelling infrastructure will be needed, especially to promote the commercial vehicle segment in Baden-Württemberg. Here, the focus could initially be on motorways and logistics centres. Although the share of hydrogen drives under the scenarios is expected to increase to just 1.6 % by 2040, the infrastructure must be developed in good time in order to avoid market entry delays. The role of the public sector and its collaboration with the automotive industry and energy suppliers throughout this process still need to be clarified. In case efforts do come about to advance hydrogen propulsion for road transport, we should be preparing to develop the infrastructure right now, in coordination with the various stakeholders.

#### Recycling traction batteries as the next and central building block of a circular economy

Recycling traction batteries from electric vehicles is a key component of the circular economy. As part of the SDA BW initiative, €13 million in funding was provided for a project to test the automated dismantling and reprocessing of batteries. Manufacturers such as Volkswagen and Mercedes-Benz are setting up their own recycling plants, which permit a high recycling rate for lithium-ion batteries. This contributes to raw material efficiency and climate-friendly production. Dismantling and reprocessing (batteries) is expected to generate around 8,000 jobs throughout Europe. Recycling will increase from the 2030s onwards, in parallel with growing use

1 | [www.transformationswissen-bw.de](http://www.transformationswissen-bw.de)

2 | [www.plattform-h2bw.de](http://www.plattform-h2bw.de)

of electric vehicles. The value chain will have to be in place by 2040, since the conversion from combustion engines to electric vehicles will have been completed by then. A general framework for the recycling will have to be set up now in order for the necessary investment to be planned and implemented in good time.

The EU Directive concerning battery product life cycles, which is currently being amended, forms the legal foundation for recycling traction batteries. Manufacturers are obliged to accept returned batteries. However, an open question is how strongly the dismantling and reprocessing should be centralised, or possibly carried out in other European countries. Germany is currently home to 17 battery recycling projects, which is almost half the European total.

Alongside the recycling of traction batteries, the aim is to recycle large vehicle parts such as metals and plastics in order to reduce strategic dependencies. Metals can be recycled indefinitely, and EU recycling rates for crude steel and aluminium currently run at 32 % and 14 % respectively. However, in the “MaterialLoop” project, Audi achieved rates of 85 % and 60 % respectively, while BMW has unveiled a fully recyclable vehicle. At Deutz in Ulm, some 4,000 old engines a year are completely overhauled under the Xchange project, and this, too, might serve as a model for automotive component processing.

### Assessment

Developing a recycling system is a medium-term prospect, but has high overall priority. Not until the 2030s will traction batteries exist in such volumes that large-scale collection, dismantling and reprocessing operations will have to be set up. However, the ground is already being prepared for these developments, with individual companies currently setting up pilot plants.

Their challenge now is to put in place facilities, processes and procedures which can be scaled up as necessary when battery volumes increase. It remains unclear what conditions will allow the creation of economically viable business models and which sectors recycling will establish itself in. Will this, for example,

take place with the involvement of the vehicle retail, repair and aftermarket trades?

To facilitate value and job creation within Baden-Württemberg and help reduce strategic dependencies on critical materials, the state's automotive industry should establish a recycling loop for batteries.

There must be political support for the construction of recycling plants, especially in face of competition from seemingly more attractive land uses. This falls within the sphere of influence of Baden-Württemberg's elected representatives. Provisions such as the EU Directive provide companies with a clear framework within which to orient their business models. Accordingly, efforts should be made at federal and EU level to bring the directive into force.

### Risks

The first recycling plants which will be upwardly scalable to cope with the future volume of old traction batteries are currently under construction. There is a major risk that large recycling plants will be built directly in low-cost countries. This would mean that value creation and employment potential will not be realised in Baden-Württemberg, as well as entailing high battery transport costs. Moreover, locating cell production facilities and recycling plants in close proximity to each other is a good way of closing material cycles. The absence of recycling plants would mean the loss of a locational advantage for cell production.

### Facilitating the implementation of automated driving

Implementing automated driving is crucial if Baden-Württemberg as an industrial location is to be considered a lead market and location for the production of the corresponding components. Otherwise, production might be relocated abroad. Technological and legal issues in this respect, such as liability and data protection issues, must be clarified, as must the infrastructure, in particular a 5G network. Baden-Württemberg could define operating areas for fully automated driving in order

to promote production. Technological issues aside, the speed at which automated driving is introduced is a social and political decision, but one with a direct impact on jobs and value creation in Baden-Württemberg. Under the right conditions, the projected employment effect of 5,100 to 7,400 jobs in Baden-Württemberg could be realised.

In 2020, the state government of Baden-Württemberg drew up a strategy for automated and networked mobility, which will be updated by 2024. The focus is on real-world laboratories, including the Testfeld Autonomes Fahren (Test Area Autonomous Driving) and projects such as RABus and Ameise, as well as vehicle development projects including U-Shift. To coordinate stakeholders in the digital and automated mobility sector, e-mobil BW launched the Intelligent Move network format in spring 2023.

#### **Assessment**

Options for action by companies include further investment and R&D as well as expanding the production of automated driving components in Baden-Württemberg. Here they can undertake extensive testing of the functions under varying road conditions.

Politicians are supporting business by setting up further research projects and, most importantly, autonomous driving testing facilities in Baden-Württemberg. These activities are being networked at federal level, since Germany as a whole aims to be a pioneer in the fields of automated driving and connected mobility (BMDV, 2021).

#### **Risks**

If Baden-Württemberg companies fail to take the lead on automated driving technology, there will be no initial increase in employment. However, the prospect then is that vehicles made in Baden-Württemberg will lack key functions for future networked mobility, which will have to be purchased from other locations.

# 04

## Summary

The automotive cluster is the core of Baden-Württemberg's economy. With the transition to the electric power train, the volume of work in many segments of the cluster will decrease significantly. By 2030 the cluster may have shrunk by 8 to 14 %, depending on the market share of electrified vehicles. This would correspond to between 37,600 and 66,900 employees. This high figure makes clear the urgent need for action to support the automotive cluster. The figure already incorporates the assumption that R&D and production capacities for new technologies (electric drives, automated driving) will have been built up in Baden-Württemberg by 2030. This will compensate for part of the decline in employment due to the phasing out of the internal combustion engine. However, this will require the thoroughgoing retention and conversion of the state's automotive sites, which calls for corresponding investments which must be directly pushed through by politicians and business.

The central recommendations for action are:

- addressed to the political world as matters of urgency: the availability of industrial land, the supply of electricity from renewable energy sources, the expansion of the charging infrastructure for electricity and hydrogen, and the financing of entrepreneurial activities;
- addressed to the business world as matters of urgency: the conversion of the value-added cluster to electric mobility, new components for the development of medium-volume industrial series production, a qualifications campaign for electric mobility and digitalised vehicles with an accompanying expansion of R&D capacity;
- in the medium term, the assured availability of hydrogen as an energy source for vehicles, the expansion of the circular economy to include recycling traction batteries, and the implementation of automated driving.

In the context of this study, the options for action formulated here place a strong emphasis on the automotive cluster and the companies belonging to it. The scope and complexity of the transformation will only become clear over time. It follows that there is an urgent need for action, including the expansion of the cluster to include energy production and supply as well as the development of the circular economy. Given the timing of the market ramp-up of electric mobility and lead times, for example in the case of energy supply, some of the options for action are more urgent than others, as the following chart shows.

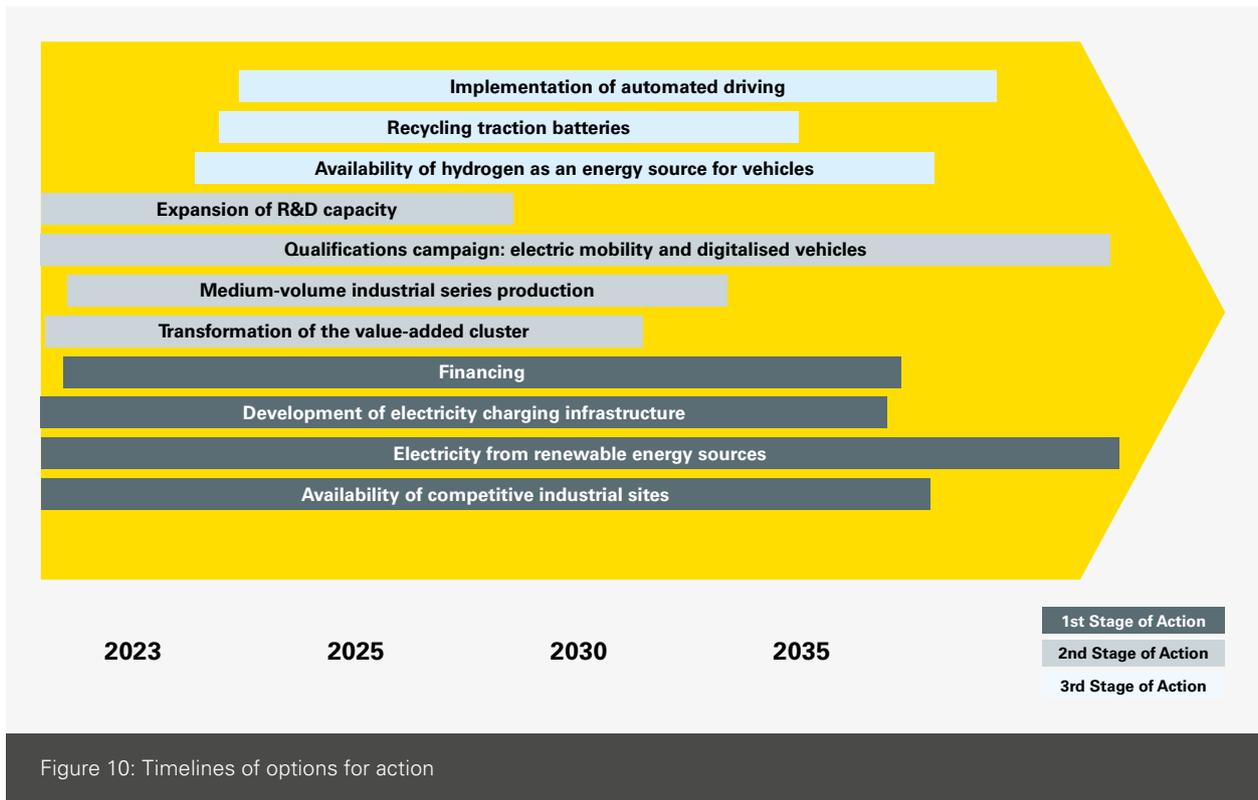


Figure 10: Timelines of options for action

The success of this transformation will depend on the development of an accompanying model for social and economic change involving no loss of prosperity, in which all actors – business, politics, civil society, research – participate. Baden-Württemberg can and must redefine itself as a successful industrial location and raise its profile as a new location for sustainable industry and business.

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For reasons of readability, in this study the masculine form is always used in conjunction with composite personal nouns. In the spirit of equal treatment, any such terms apply to all genders. The abbreviated linguistic form is used for purely editorial reasons and does not entail any value judgement.

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