2021 TOMORROW'S MOBILITY – A HOLISTIC DESIGN

NPM
NATIONAL PLATFORM
FUTURE OF MOBILITY

RESULTS REPORT

NATIONAL PLATFORM FUTURE OF MOBILITY – RESULTS FROM 3 YEARS OF THE NPM (2018 TO 2021)

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RESULTS REPORT 2021

INTRODUCTION

Dear readers,

it is now three years since the National Platform Future of Mobility was established, and the mobility world is changing rapidly. The fleet of electric vehicles on the road is growing with the charging infrastructure in the public, private and commercial sector, because policy makers have created the right framework conditions and the automotive industry is offering attractive vehicle models that everyone can afford. However, to ensure a successful and holistic mobility transformation it is also clear further important strategic policy decisions are required, and they must be put into action more quickly.

There is a consensus among all parties that the mobility system of the future will be sustainable, socially compatible, affordable and attractive, and will also ensure a competitive edge remains within the industry. However, there is not always a consensus on how we do this, and also ultimately when this will happen.

Visionary ideas and concepts for the mobility of tomorrow have been made possible, not least due to digitalisation, and they capture and waken aspirations. They are the driving force behind innovations, and the emergence of new products and business models. We need them, and must also test them at the earliest opportunity in practical everyday situations - as is the case in the real-world laboratory for digital mobility in Hamburg, for example. Yet this is just one aspect; in the coming years mobility must also align itself with the ambitious climate objectives defined in German legislation, European regulations and the international commitment to the 2030 and 2050 milestones. We have no more than nine years left to reduce CO_2 traffic emissions to 85 million tonnes – a reduction of 65 percent compared to 1990 levels, and this in the context of increasing transport services.

This cannot simply be achieved by making huge investments; all the measures and instruments we have identified in the NPM must be rapidly implemented, and possibly also expanded. In the NPM, which has 240 members, we have compiled more than 50 reports which explain what needs to be done. We have shown where we currently stand technologically and from a market economy perspective, what action is required, and the red lines that demarcate the mutual understanding between the interest groups.

We must continue to accompany the transformation of the mobility system in the coming years. After all, if the required steering effect is not present to the necessary extent, this can and must be rectified by corrective intervention and more rigorous action.

How the future of mobility is shaped will have profound effects on Germany as an industrial location, the creation of value, and employment. The economy is willing and able to make the necessary investments, but also needs reliable framework conditions and clear policies that define exactly where the journey is heading. Despite priority being given to climate protection in our country, competitiveness, our position as lead supplier and lead market in the area of mobility, jobs and social fairness are fundamental themes connected with the reorientation of the mobility system.

In the last three years, the National Platform Future of Mobility has prepared the way for making mobility fit for the future. I would like to thank all those involved who participated on a voluntary basis and brought their expertise in a wide range of mobility sectors to bear on this topic. I would also like to extend a huge thanks to the leaders of the six working groups, the members of the steering committee and the advisory commission, and also the staff at the field office. The work of the NPM would not have been possible without the recognition of the German government and support of the federal ministries. Thank you for your enormous vote of confidence.

We must continue the dialogue, remain actively engaged and identify the best solutions for the mobility of tomorrow, and last but not least we should also not shy away from taking action.

Prof. Dr. Henning Kagermann,
Chair of the NPM Steering Committee

WHAT INSPIRED YOU DURING YOUR TIME WITH THE NPM?

"I have been inspired by the need and sense of urgency to put climate protection into practice more rapidly in the mobility sector."

Franz Loogen
Head of WG 1

"The challenge to reach out to users with a range of technologies to make a significant contribution to the reduction of CO_2 emissions by 2030."

Prof. Dr. Barbara Lenz
Head of WG 2

“The possibility of shaping the mobility of tomorrow today, assisted by experts in the fields of science, economy, administration, and in local and civil society associations. But above all the far-reaching concern to move things forward in the mobility sector and digitalisation in Germany by working together.”

Frank Weber
Head of WG 3

“Qualification is the key to securing employment. This, combined with establishing future added value potentials, is the basis for an environmentally-sound and socially aware mobility transformation.”

Jörg Hofmann
Head of WG 4

“The NPM is a forum that gives us the opportunity to think ahead, to shape the mobility transformation. As the field of electromobility is in a high state of flux, it is all the more important to develop the right forward-thinking concepts in good time.”

Kerstin Andreae
Head of WG 5

“As an engineer, knowing that technology and innovation is the key to sustainable mobility of the future, which is also a crucial building block in the transformation towards a carbon-neutral society, is something that motivates and inspires me.”

Roland Bent
Head of WG 6

1 EXECUTIVE SUMMARY

Mobility concerns the movement of people and goods and ensures social and economic development. The mobility system links different modes of transport, by road, rail, water and air. It is a complex system supported by a wide range of different stakeholders. This system is currently undergoing a process of fundamental change which requires both political and social support.

The transformation of mobility must be supported by specialist expertise

Born out of the German National Platform for Electric Mobility, the National Platform Future of Mobility expanded its vision to include the entire mobility system. The Federal Government commissioned the NPM to prepare the mobility system for the future, taking into account Germany's competitive position as an industrial location and the sustainability criteria of transport. Over the last three years the NPM has completed important preliminary work which has been embraced by the government and taken into account in political decision making processes. The NPM took part in the top-level talks of the Concerted Action for Mobility (KAM) initiative and provided templates for national decisions in the transport sector. The NPM reflects the complexity of the mobility system by bringing together stakeholders from economics, science, politics and civil society. Each of these is active in the field of mobility and together they represent the widest possible range of social, political and economic perspectives and requirements in relation to the mobility system. The NPM takes into account the interests of all mobility stakeholders.

The future of mobility is a shared mission: society, politics and the economy are working together to design a holistic and sustainable mobility system that promotes innovation

Climate action and digitalisation are today's megatrends. They are changing the population's attitudes and fresh habits are taking shape as a result of new mobility options, e.g. sharing models. At a political level, the megatrends in Germany and Europe have led to a large-scale provision of state resources, initiated the adaptation of the regulatory framework and resulted in measures such as climate change mitigation laws, fleet target values, a hydrogen strategy, CO_2 pricing and the German Act on Autonomous Driving. In the mobility industry these megatrends have accelerated previously initiated transformation processes which put businesses under tremendous pressure to act and demand high levels of flexibility and investment.

The future of mobility is in a holistic mobility system encompassing all modes of transport which focuses both on the needs of users and on Germany as an industrial location. The NPM is committed to a sustainable mobility system which is socially, environmentally and economically balanced. Technological innovations leading to new products and business models as well as social innovations reflected in behavioural changes (e.g. sharing instead of owning) create the required scope for creative development.

Urgent need for action in the transport sector: consistent and rapid implementation of existing courses of action is required to combat climate change

Despite significant technical progress, the transport sector has not been able to reduce CO_2 emissions in the last few years. The need to act is more urgent than ever since the volume of traffic is increasing, particularly in goods transport, while at the same time climate action targets are becoming more stringent. The switchover from fossil fuels to renewable energies in transport plays a vital role and requires enormous effort. By 2030 there must be up to 14 million electric vehicles on Germany's roads to make an adequate contribution towards achieving the transport sector's climate action targets, which were increased again in June 2021. Road transport is responsible for 95 % of CO_2 emissions in the transport sector, with two thirds of this from passenger vehicles and one third from freight transport. Despite the measures and instruments across all modes of transport, such as modal shifts and the expansion of walking, cycling and public transport provision, road traffic will be the most important lever for CO_2 savings. Road passenger and freight transport has potential savings of 33 to 45 million tonnes of CO_2 by 2030. We must make better use of all relevant areas of action, particularly digitalisation, and implement them in the context of climate action in transport. Politics and industry must come together to take the next steps and pair the commitment to achieve climate action targets with the requisite levels of activity, speed and drive to implement measures. This requires support for

the market ramp-up and the implementation of the roadmaps developed and instruments rated by the NPM.

Roadmaps and instruments for alternative drive systems and fuels point the way towards more climate action in transport

The NPM began its work in 2018 based on Germany's national climate action targets of 2016. The stipulations of the Federal Climate Change Act and the new targets of the 2021 European Green Deal were swiftly taken into account as it became clear that the existing framework and previously established routes for reducing CO_2 in individual measures would demand an ambitious approach. The discussions within the NPM showed to what extent there is a societal consensus on individual measures and where points of contention exist. The more ambitious configuration of the targets has further increased the challenges associated with their realisation. We must develop joint solutions to win over societal groups and secure their participation in this demanding task.

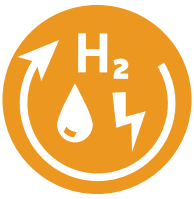
For the transformation to be successful, a mix of technology is required: the specific advantages of various types of drive system must be purposefully combined and employed with regard to different usage patterns. The battery electric drive system is the most developed solution for passenger cars and also promises the largest CO_2 reduction. There is not yet a stand-out technology preference for heavy goods vehicles (HGVs), but electrification (batteries, fuel cells, overhead lines) also offers significant potential for this sector. However, a clear focus should be defined here by 2025 at the latest. The 2030 Climate Action Programme states that in 2030 a third of the mileage of heavy goods transport must be electric or powered by electricity-based fuels. Modal shifts to rail and the further electrification of rail transport are an equally important lever in reducing CO_2. In terms of urban mobility, the potential for reducing CO_2 lies in the promotion and accelerated expansion of local public transport, cycling, multi-modality, electrification and the further configuration of framework conditions for modal shifts.

In 2030 there will still be many millions of vehicles with combustion engines on the road. For this existing fleet and for drive systems that cannot be electrified, alternative fuels provide an opportunity to reduce CO_2 emissions. However, significant amounts of these fuels will be required, particularly to meet the needs of aviation and shipping. The course for an environmentally

FOCUS AREAS FOR THE NPM

AG 1

Transport and climate change



AG 2

Alternative drive technologies and fuels for sustainable mobility

AG 3

Digitalisation in the mobility sector

AG 4

Securing Germany as a place for mobility, production, battery cell production, primary materials and recycling, training and qualification

AG 5

Connecting mobility and energy networks, sector integration

AG 6

Standardisation, norms, certification and type approval

friendly drive system transformation must now be set across Europe as well.

It will not be possible without the expansion of renewable energies

Carbon neutrality assumes that all sectors – as far as possible – replace the use of fossil fuels with renewable energy sources. With the ramp-up of battery electric and fuel cell electric drive systems as well as electricity-based fuels, the transport sector is seeing a greater need for sustainably produced electricity. To meet this need, a close link between the electricity and transport sectors (sector integration) is required, as well as the extensive expansion of renewable energies and solutions for energy imports. There are already signs of increasing competition between sectors for green electricity: the industrial sector (steel, cement and chemicals, in particular) and the building sector (especially heat generation), which emit significantly more CO_2 than the transport sector, will also need to switch to renewable energies if they are to meet their climate action targets.

Dynamic expansion of charging and fuelling infrastructures that are fit for the future

The use of alternative drive systems requires a needs-based and cost-effective infrastructure which can be operated sustainably and without long-term subsidies. Technological concepts for vehicles and infrastructure must be jointly developed. Recent years have seen a substantial expansion of the charging infrastructure for electric cars, but due to the low uptake to date, it can only be run economically in a minority of cases. In the hydrogen (H_2) fuelling infrastructure, anchor clients such as freight forwarding companies and local public transport operators can offer perspectives on cost effectiveness, especially in the initial phase. To establish a needs-based and economical charging infrastructure, the NPM developed a dynamic demand model. This not only relates the establishment of the infrastructure to the ramp-up of vehicle numbers, but also takes into account customers' usage patterns and the share of the rapid charging and normal charging infrastructure.

Improving tomorrow's mobility through digitalisation

The use of digitalisation offers unprecedented opportunities to transform mobility. It offers more diverse transport options, improves the mobility services in urban and rural areas and increases the incentive to switch to environmentally friendly alternatives. Different modes of transport will be linked within a network, enabling attractive multi- and inter-modal mobility services, e. g. via self-driving shuttles. Achieving this target requires an ecosystem of mobility data which is fed with data from users, modes of transport and the transport infrastructure as a whole. This ecosystem creates appropriate interfaces and data exchange formats on non-discriminatory, digital mobility platforms. As the digital twin of the physical infrastructure and mobility services, the platforms guarantee a high level of data protection and cyber security.

The NPM's real-world laboratory for digital mobility in Hamburg, RealLabHH, puts the recommendations for the digitalisation of mobility into practise in everyday life, demonstrating which specific benefits they can generate for society and actively involves citizens in the testing of the new mobility services.

Standards and norms ensure a successful transformation of mobility

Standards and norms are the key to connecting the subsystems within the mobility system. They create a reliable framework upon which companies can base their developments. The NPM has submitted standardisation roadmaps on central topics for the transformation of the mobility sector – on intelligent load management, automated and connected driving as well as the implementation of inter-modal mobility. In addition, the NPM's priority roadmap "Sustainable mobility" demonstrated how standards and norms, such as in the area of environmental impact assessments or the transparency of supply chains, can promote the market viability of innovations for sustainable mobility. The platform's work also makes clear that standards and norms must be established and implemented internationally to have a positive effect on innovation.

New value creation cycles and future-proof jobs are key elements for Germany as an innovative location for mobility and industry

The transformation of mobility poses significant challenges to Germany's position as an industrial and economic location, particularly in light of the large number of workers and affected regions whose prosperity is currently still dependent on existing business models and technologies. However, there are major opportunities to emerge from the transformation stronger, to anchor Germany's role as a future top provider and leading market, as well as to create good, future-proof jobs in Germany and Europe. However, the successful transformation of the mobility industry is by no means inevitable. Active support from politics is required in many areas and at all levels. Success is strongly dependent on the competitive and sustainable manufacturing of components for new drive concepts on a large industrial scale within Europe and on their circulation in a closed-loop cycle. New

value creation chains must also be developed in Germany and Europe and existing gaps must be closed. Additionally, targeted support of research and development in the relevant fields is essential and framework conditions for new fields must be correctly determined, e.g. in battery production, electronics and hydrogen technology. The transformation of the mobility sector also brings changes to job profiles and skills requirements for staff. Companies and employees need support for this transition. New training requirements must be identified at an early stage to allow for the necessary adjustments. Businesses should engage in strategic personnel planning to prepare themselves and their staff for these changes in advance. Politics can help in the areas of change by bringing together companies, trade unions, training providers and workers to prevent unemployment caused by the reduction in existing demands and by qualifying the workforce specifically for future requirements.

Thinking ahead for the future of mobility: continually realigning the system and accelerating implementation by constantly gaining knowledge

Since the NPM was established in autumn 2018 the transformation of mobility has been proceeding apace and the development of a sustainable, needs-based, secure and affordable mobility system has been and remains a Herculean task for all involved. Over the coming years this will involve strengthening the resilience of the mobility system, observing and adjusting the effects of measures to reach the climate action targets for transport, as well as bringing alternative drive systems and fuels to the market in various applications and expanding public transport and cycling provision. It will also be necessary to link different modes of transport, improve the mobility system on the basis of collected data, promote sector integration, establish appropriate charging and fuelling infrastructures, create a reliable mobility system using standardisation and maintain Germany's competitiveness as an industrial location and job provider. Managing the challenges and tasks is feasible but requires great speed and accelerated implementation. A solution-focussed, structured, expert-level dialogue with policy makers based on scientific and practical knowledge, as set up in the NPM, can serve as a blueprint for the future support of the mobility transition. A consultation process of this kind should be pursued and supplemented by a wide-ranging social dialogue to strengthen the link between technical expertise and social communication and to satisfy the requirements of the transformation.

FOR A MOBILITY OF THE FUTURE

The NPM is tasked with bringing together different perspectives to take a systemic look at mobility and to develop it further. The NPM is addressing a wide variety of topics. However, the aim is clear: the transition to the future of mobility is to be shaped together.

TECHNOLOGICAL CHANGE

SOCIETAL CHANGE

FOCUSSING ON USERS

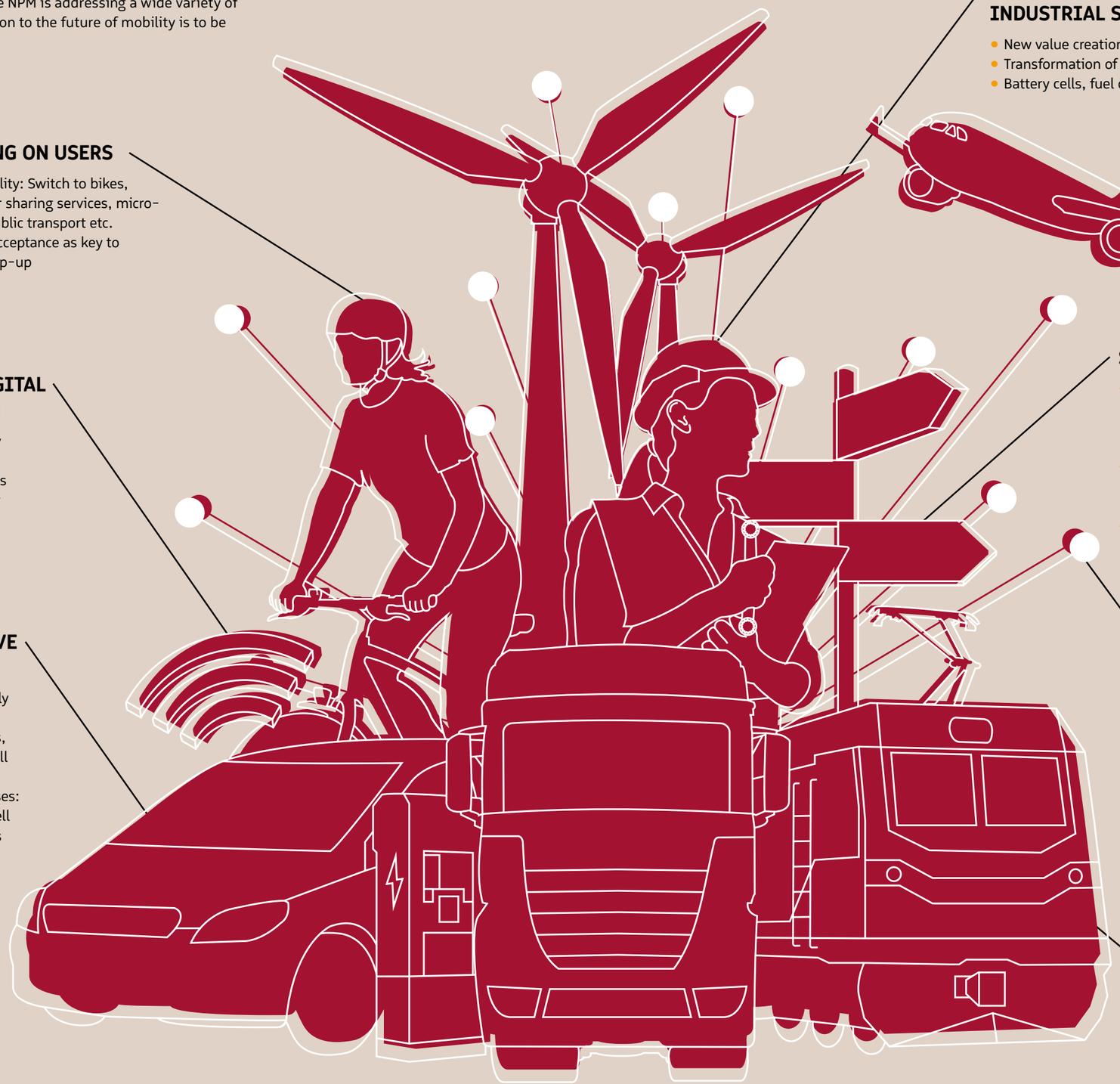
- Urban mobility: Switch to bikes, walking, car sharing services, micro-mobility, public transport etc.
- Customer acceptance as key to market ramp-up

ACCELERATING DIGITAL TRANSFORMATION

- Multi- and intermodality
- Autonomous mobility
- Digital mobility platforms
- Digitalisation of mobility infrastructure

PROMOTING ALTERNATIVE DRIVE SYSTEMS

- Switch to environmentally friendly drive systems and fuels ...
  - in cars: battery electric vehicles, plug-in hybrid vehicles, fuel cell vehicles
  - in commercial vehicles and buses: battery electric vehicles, fuel cell vehicles, overhead line vehicles
  - H_2 fuelling infrastructure for commercial vehicles
  - in rail transport: hybrids with electric drive systems and batteries or hydrogen/fuel cells
  - in air and sea transport: regenerative fuels, fuel cells/hydrogen



MODERNISING INDUSTRIAL STRUCTURES

- New value creation networks
- Transformation of training and education
- Battery cells, fuel cells, recycling

SETTING STANDARDS

- Standardisation requirements for all technological components and interfaces, e. g. interface between vehicle and infrastructure
- Standardisation requirements for consistent IT connections between all modes of transport
- Standardisation for sustainability

INTEGRATING SECTORS

- Charging infrastructure for cars and commercial vehicles
- Intelligent load management and grid stability
- Development of renewable energies

SUSTAINABLE LIFESTYLE

- Action to reduce emissions
- Action to increase efficiencies
- modal shift to more climate friendly options

2 THE NPM AT THE INTERFACE BETWEEN SOCIETY, POLITICS AND THE ECONOMY

Mobility is more than just transport and its various forms: mobility acts as the backbone of society and the economy. It is a basic human need and a prerequisite of participation in society. Mobility is fundamental, ubiquitous and is subject to constant change.

The mobility needs of different user groups are diverse and for the most part only depict partial aspects of the system as a whole. People living in urban environments have a different perception of mobility and alternative requirements to those in rural areas. The mobility needs of commuters differ from those of retirees, while people with reduced mobility have different requirements than families. And it is not just people we need to consider here, goods are also on the move – by road, rail, water or air. Alongside the facts and relevant arguments, discussions about mobility also emphasise requirements and specific interests. After all, each of us is "affected" by mobility in one form or another. That is why an integrated approach to the mobility system and its modes of transport, various stakeholders and intricately linked mobility issues is so essential.

This is exactly where the National Platform Future of Mobility (NPM) has come in over the last three years, carrying out preliminary work and describing how the transformation can lead to a future-proof, affordable, secure and sustainable mobility system. The NPM was commissioned by the Federal Government to examine the mobility system with a clear focus on the topics of sustainability and competitiveness. Originally the German National Platform for Electric Mobility (NPE 2010–2018), it was decided that due to the incipient and fundamental structural changes to the mobility industry, electric mobility should no longer be addressed separately. Instead it was evident that the mobility system should be understood from a much broader and more holistic perspective, evaluating mobility needs and user requirements across all modes of transport, as well as putting into context the drive system technologies and effects on Germany as a place for mobility. And all of this under the premise that the transport sector must also meet its climate targets. The cabinet decision of 19 September 2018 implemented the coalition agreement's mandate to reshape the NPE into a "Future of Mobility" platform.

From the cabinet decision of 19 September 2018:

„The aim of the platform, taking into account politics, the economy and civil society, is to develop concepts and recommendations for action on future issues in order to ensure competitive businesses and jobs for the future, as well as an affordable, sustainable and environmentally friendly mobility system. Alongside this task, for the duration of the legislative period and by the end of 2018 if possible, specific measures should be developed for achieving the targets of the 2050 climate action plan in the area of transport. The focus of the platform spans all modes of transport."

The NPM, consisting of around 240 members, has engaged with technological as well as political, economic and social developments in the field of mobility. At the forefront of the technological developments were the alternative types of drive system and fuels, as well as the comprehensive digitalisation of the mobility system with linked networks, autonomous driving and new, platform-based mobility services. In addition to this, extensive questions arose concerning the increasing integration of the transport and energy sectors through electrici-

ty and hydrogen and the shift towards rail transport, as well as the increase in cycling provision. The NPM's political guidance focussed on climate action and the configuration of the regulatory framework for a forward-looking, multi-modal mobility system. The economic issues concerned jobs and employment, Germany as a place for mobility and an industrial location, the market ramp-up of electric mobility with the expansion of the charging infrastructure, in addition to the preparation and development of new mobility markets and adjacent markets. In terms of social developments, the remit was to continually seek to understand the users' perspectives and include issues of acceptance and changes to mobility habits. Even though, according to its commission, the NPM primarily considered the mobility system from a national perspective, international and European elements were also taken into account and established, especially in the area of standardisation. Through the Dutch-German Sustainable Mobility Cooperation the NPM advocated cross-border activities in the field of electric and hydrogen mobility.

2.1 REVEALING CONNECTIONS IN THE MOBILITY SYSTEM

It is extremely difficult to obtain a complete overview of the mobility system. Not only should transport by road, rail, water and air be considered, but also the requirements and interests of the various mobility stakeholders, as well as the intricately connected issues and dependencies. In terms of the public interest and social cohesion we must ensure that mobility always remains affordable and suitable for everyday use across all sections of the population. Companies need an environment in which they can rapidly develop and successfully market products and business models. The proceeds can be invested in the future and in progress. The political aspects of mobility are just as significant: they reach from international specifications (e. g. the Paris Climate Agreement, standards) to European agreements (e. g. fleet target values, quotas for the use of renewable energies in transport) and to establishing a framework and the effects at a national, federal state and local level (e. g. motorway service areas, noise pollution control, parking management). Last but not least, mobility is subject to constant change through technological and social developments which must also be factored in.

TRANSFORMATION OF THE MOBILITY SECTOR DRIVEN BY CLIMATE ACTION AND DIGITALISATION AND ACCELERATED BY THE COVID-19 PANDEMIC

In the course of the last three years climate action and digitalisation – the latter heavily accelerated by the COVID-19 pandemic – developed into megatrends which have become dominant driving factors across the board, not just in the field of mobility. This is made clear by the rapid market ramp-up of electric mobility, accompanied by an accelerated expansion of the charging infrastructure, increasing interdependency and automation. Every sector, every industry, every organisation is faced with digitalisation and the effects are becoming more and more evident in social, political and economic developments. The regulations and proposed legislation concerning climate action at a European and a national level, in addition to the initiatives and strategies for digitalisation and data sovereignty, comprehensively change the mobility system and affect Germany as a place for mobility.

Part of the population is sceptical about the rapid changes in the field of mobility and behaves cautiously towards the developments.[1,2] In contrast we see confidence, a belief in progress, a spirit of optimism and the readiness to engage with change.[3] Both sides must be taken into account because the path towards the future of mobility can only be successful if the majority of society is prepared to accept the transition and respond favourably.

SOCIETY AND MOBILITY: CHANGING ATTITUDES AND HABITS

Users of the mobility system are essential stakeholders as they influence, shape and change the system through their mobility habits. Environmental protection and climate action play an unprecedented role in mobility[4], but only bring marginal changes to the system in the short term, since existing mobility needs must continue to be met. It is only when people start to deliberately engage with aspects of sustainability in the mobility context that learning effects and behavioural changes are generated in large sections of the population and organisations, particularly when environmentally friendly mobility services are added. The increasing infiltration of digital technologies into everyday life also influences user behaviour. Additionally, ground-breaking laws, regulations and large-scale funding programmes support and accelerate these processes.

The success of forward-looking mobility technologies and concepts such as electric mobility with batteries and fuel cells, alternative fuels, digital mobility services and automated driving, but also the expansion of walking, cycling and public transport provision and modal shifts, is highly dependent on being accepted, perceived as safe and suitable for everyday use by both rural and urban users.[5] Information and dialogues are needed to accurately answer the many questions associated with the future of mobility in a way which everyone can understand, to dispel any misconceptions and convert concern into confidence. These are also features of the project for digital mobility in the metropolitan region of Hamburg (RealLabHH).

Through RealLabHH, NPM's working group 3 initiated a project in spring 2020 with around 30 partners which serves as a test space for platform-based and interconnected mobility concepts. Hamburg's residents play an active role in the project and contribute valuable feedback on the everyday suitability of the new mobility concepts and services. The Hamburg project makes clear that the NPM has established a practical foundation alongside the examination of issues and the creation of reports. This is also evident in the study initiated by WG 2 on customer acceptance of electric mobility and WG 4's further development of the strategic personnel planning tool 'PYTHIA' for small and medium-sized enterprises.

1 Cf. acatech (2021): Mobilitätsmonitor 2021 [Mobility Monitor 2021].
2 Cf. Bündnis sozialverträgliche Mobilitätswende (2021): Wie wir das Klima schützen und eine sozial gerechte Mobilitätswende umsetzen können [How we can protect the climate and implement a socially just transition to sustainable mobility].
3 Cf. German Aerospace Center (2019): Veränderungen im Mobilitätsverhalten zur Förderung einer nachhaltigen Mobilität [Promoting sustainable mobility through changes in mobility behaviour].
4 Cf. Federal Ministry for the Environment (2021): 25 Jahre Umweltbewusstseinsforschung im Umweltressort [25 years of environmental awareness research at the Ministry for the Environment]. URL: https://www.bmu.de/download/25-jahre-umweltbewusstseinsforschung-im-umweltressort/ [Accessed: 08/09/2021]
5 HUK-COBURG: Mobilität heute und in der Zukunft: Das zählt für die Deutschen [Mobility today and in the future: what matters to Germany]. URL: https://www.huk.de/fahrzeuge/ratgeber/mobilitaetsstudie.html [Accessed: 08/09/2021]

POLITICS AND MOBILITY: CREATING A SUITABLE FRAMEWORK

In the last three years, both at a European and a national level, the regulatory framework for climate action, the ramp-up of electric mobility, the digitalisation of the transport system and the transformation of the mobility system in general, has been massively extended and amended. Reliable specifications and a framework promoting innovation are important so that the path towards the future of mobility can be laid out in a binding manner and so suitable means and measures for implementation can be defined.

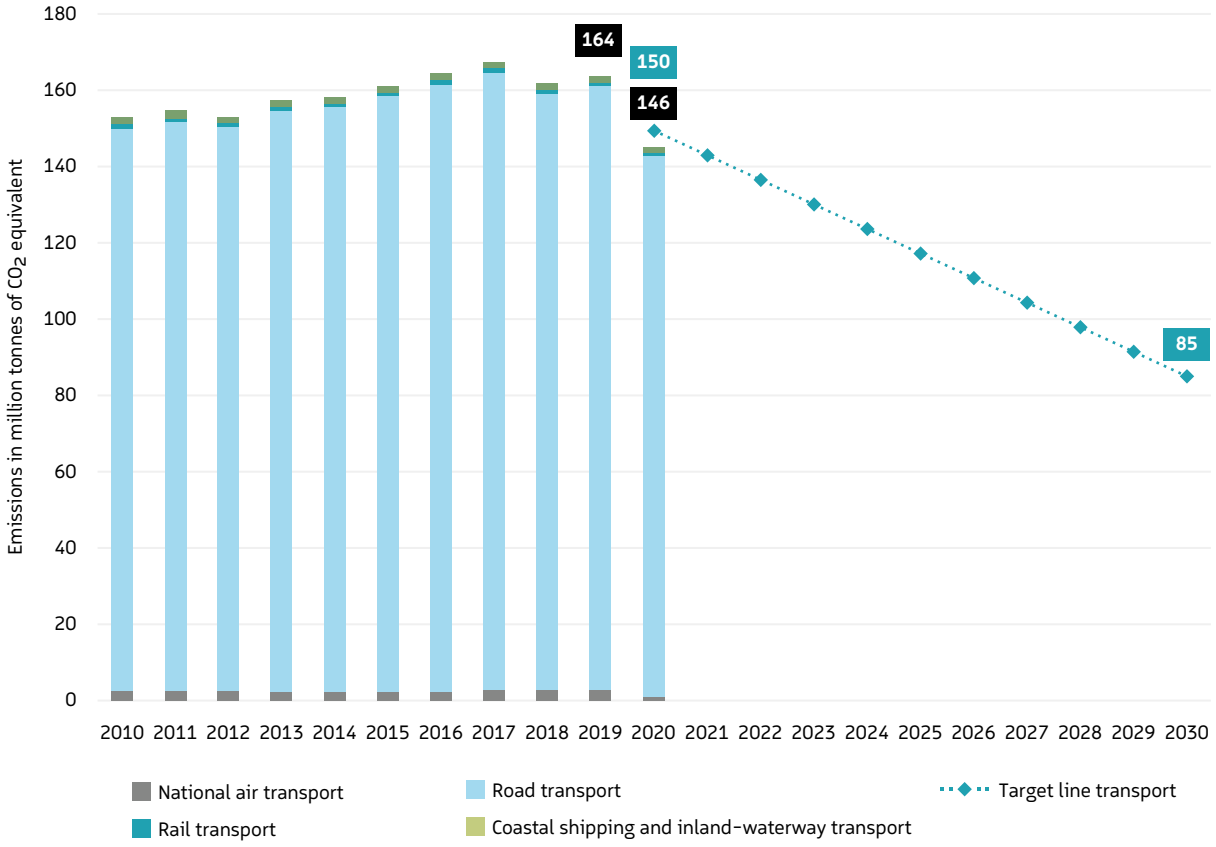


Figure 2: Climate action targets at a national level (Source: NPM)

The legislation on amending the Federal Climate Change Act stipulates that the existing 2030 climate action target of a 55 % reduction in greenhouse gas (GHG) emissions compared to 1990 levels should be increased to 65 % and that GHG neutrality should be reached as early as 2045. For the transport industry, a reduction of GHG emissions by 10 million tonnes of CO_2 equivalent is planned, with 2030 levels therefore at 85 million tonnes of CO_2 equivalent. The European Commission's "Fit for 55" package proposes measures to increase the fleet-wide targets to 55 % (from 37.5 %) for passenger cars and 50 % (from 31 %) for light commercial vehicles by 2030. By 2035, emissions must be reduced to 0 g CO_2 per kilometre driven. Extensive funding programmes and coronavirus support at an EU, national, federal state and local level should help to achieve the ambitious climate targets in the transport sector.

Table 1 contains some of the new regulations, laws and draft legislation which have been proposed and adopted in the last three years, as well as initiatives which affect the mobility system:

2018/2019	2020	2021
EU: The recast Renewable Energy Directive (RED II) entered into force (12/2018)	EU: New CO_2 fleet target values	CO_2 pricing entered into force (Fuel Emissions Trading Act, BEHG)
Small Electric Vehicles Act (eKFV) (06/2019)	EU: Green Deal	Amendment to the Battery Act (BattG) (01/2021)
Climate Action Programme 2030 (10/2019)	Amendment to the German Regulation on the Approval of Road Vehicles (StVZO) entered into force (01/2020)	New Energy Industry Act (EnWG) (02/2021)
Charging Infrastructure Master Plan (11/2019)	Coronavirus recovery package (06/2020): • Increased financial incentive to buy electric cars • Simplified short-time work scheme regulations	Amendments to the Energy and Electricity Tax Act (StromStG) (03/2021)
German Federal Climate Change Act (12/2019)	Hydrogen strategy introduced (06/2021)	Building-Electric Mobility Infrastructure Act – GEIG (03/21)
Act on Further Tax Incentives for Electric Mobility and Amending Further Tax Provisions (12/2019)	Amendment to the Electric Mobility Act (EmoG) (06/2020)	Cabinet decision BEHG Carbon Leakage Regulation – BECV (03/2021)
	Amendment to the Car Sharing Act (CsgG) (06/2020)	Revision of the Charging Station Regulation (LSV) (03/2021)
	Incentive programme for private charging infrastructure (since 11/2020)	Passenger Transport Act (PBefG) (04/21)
	Condominium Modernisation Act (WEMoG) (entered into force 12/2020)	Amendment to Road Traffic Act (StVO) (04/2021)
	EU: Planned revision of the batteries regulation which should enter into force in 2022 (12/2020)	EU: Climate Law (04/21)
		Act on Autonomous Driving (05/2021)
		Fast-Charging Infrastructure Act (SchnellLG) (05/21)
		German Constitutional Court ruling on the Federal Climate Change Act (05/21)
		First act amending the Federal Climate Change Act (Climate Act amendment) (08/21)
		Renewable Energy Sources Act (EEG 2021) (should enter into force in 10/2021)

Table 1: Legal framework of the mobility system (Source: NPM)

In their main focus areas, the NPM working groups have defined various areas of action and described numerous specific recommendations for action. These have been taken into account in various different Federal Government activities. They include ground-breaking regulations such as the Climate Action Programme 2030, the Charging Infrastructure Master Plan and the Act on Autonomous Driving. At the end of this chapter, all of the NPM's achievements are fully illustrated.

MOBILITY AND THE ECONOMY: CHALLENGES FOR COMPETITIVENESS AND EMPLOYMENT

Against the background of the transformation of mobility, important questions arise for Germany and Europe as industrial locations in relation to value creation, employment and competitiveness on the international stage. High levels of investment are also associated with this. Germany's position as a place of industry is closely linked to the automobile and supply industries, which account for a large proportion of wealth and gross national income. Germany's domestic industry is among the leading global providers of vehicles and components. We can assume that this leading position will continue in future if the structural transformation is successful and German and European companies can cover significant parts of the value creation of electric mobility such as batteries, fuel cells, power electronics and software. To achieve this, companies need expert staff who have been trained in advance in the necessary qualifications. Workers affected by the structural change need to be qualified for the new tasks and social partners in the affected regions must be brought on board.

The COVID-19 pandemic has further accelerated the transformation processes in the industry. Across the globe, supply chains were interrupted and product demands changed drastically. This is currently most evident in the lack of semiconductors for the automobile industry. The decline in demand for vehicles as a result of the pandemic meant that the semiconductors intended for vehicle production were redirected to areas such as consumer electronics and digital equipment, which experienced a huge increase in demand during the pandemic. Now that vehicle sales are increasing again, vehicle production is missing these semiconductors.

But other mobility stakeholders are also affected by the transformation and the effects of the pandemic. Public transport by road and rail must not only become more attractive and more flexible, but due to the desired and planned modal shifts, must also expand its capacity and modify its operational processes. Public transport faced significant declines in bookings and passenger numbers during the pandemic, since many public transport users opted to travel by car or bike instead. We must observe and take counter measures against the increased car traffic, particularly in cities and metropolitan regions, if – against all expectations – this development becomes permanent after the pandemic.

In spring 2020, the German Federal Government reacted early to the economic consequences of the pandemic and launched a 130 billion euro coronavirus recovery package. The package was closely linked to climate action and the promotion of innovative technologies and was socially balanced. The acceleration of the transformation processes of the automobile and supply industry triggered by the COVID-19 pandemic led to further, intensive discussions between the Federal Chancellor, her ministers and representatives of the mobility industry and trade unions. The NPM also took part in these top-level talks within the Concerted Action for Mobility (KAM) which was initiated in the context of the transition to sustainable mobility long before the pandemic.

2.2 THE NPM APPROACH: HOLISTIC, SUSTAINABLE, PROMOTING INNOVATION

Due to the increasing complexity and the associated need to consider and design mobility in context and with a holistic approach, we need objective, higher-level bodies such as the NPM which bring together mobility experts from different areas of society, politics, economics and science. Collectively and encompassing all interests, the NPM can harmonise the different expectations of stakeholders in tomorrow's mobility with the challenges faced by Germany as an industrial location and place for mobility and with actual developments. From this basis, political guidance can be derived.

The NPM represents openness to all the different kinds of technology available to avoid premature commitments which lead to path dependencies. However, this does not rule out developing a focus on a particular technology. Decisions about mobility technology must be made in light of the field of application, market readiness and the possible ramp-up of production capacity. Deciding which technology to focus on by the middle of this decade seems key, particularly for freight and heavy goods transport, for example, since there is neither the financial means nor the time available to pursue all technologies simultaneously.

THE NPM MAINTAINS AN OVERVIEW OF THE ENTIRE MOBILITY SYSTEM

Taking a holistic view of the mobility system means including all forms of transport and the various modes of transport, while also prioritising the needs of the users and, especially in Germany, taking into account the economic and industrial policy aspects of mobility.

The members of the organisations involved in the platform have diverse opinions and bring a wide range of expertise from politics, economics, environmental groups and trade unions, as well as affected regions and communities.

The NPM's aim was and remains to take a comprehensive, long-term and forward-looking approach to the mobility system and to consider as many aspects and contexts of a mobility system shaped by different interests, strategies and technologies as possible. Despite the range of positions on the future of mobility, the working groups – as far as possible – develop a common understanding of mobility issues and identify any remaining disagreements. On this basis, differences of opinion can be presented in a transparent manner, tailored recommendations for action can be derived and prepared in thematic reports which can provide political guidance.

THE NPM IS COMMITTED TO A SUSTAINABLE MOBILITY SYSTEM

All NPM stakeholders agree that it is critical that the mobility system of the future is sustainable. To visualise the topic and make it tangible, the NPM considers sustainable mobility from the perspective of social, environmental and economic aspects. When the NPM's working groups encounter issues concerning sustainability, they always base their specific mobility topics on these three dimensions.

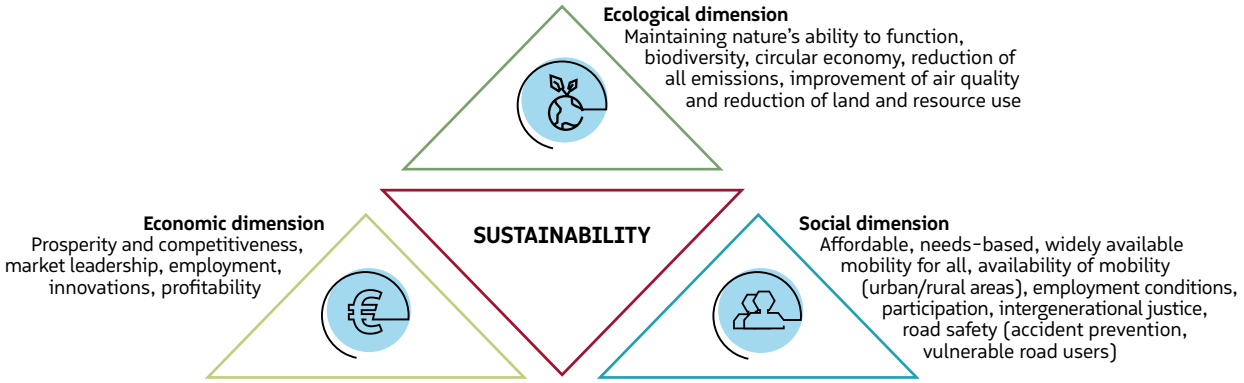


Figure 3: Dimensions of sustainability (Source: NPM)

THE NPM FOCUSES ON INNOVATIONS FOR THE FUTURE OF MOBILITY

In the field of mobility the increase of digitalisation and the ambitious climate action targets trigger innovations on a broad scale, which are critical to the future viability of the sector. These include technological innovations as well as social innovations shaped by individual and societal behavioural changes. Developments in technology and new processes provide the basis for new products and business models. They also contribute to improving the competitiveness of German and European providers in global mobility markets or even to them achieving the role of leading provider with all the associated benefits in new markets. Behavioural changes arise when, for example, more and more users reduce their private car use through car-sharing opportunities and the expanding digital transport network.

Innovation enables the necessary progress towards more sustainability in transport and is the prerequisite for the repositioning of the mobility system. Innovations are also an important lever for economic recovery after the pandemic: new drive systems and fuel technologies affect the way in which vehicles are designed and manufactured, fuelled and charged, and thus change the existing mobility and energy systems. Without the harmonisation and collaboration of the transport and energy sectors (key phrase: sector integration) and the steady expansion of renewable energies, it will not be possible to create a successful and sustainable future for mobility. The digitalisation of vehicles and transport infrastructures, the resulting network, the possibilities of autonomous driving and the exchange of data and information all lead to new approaches to mobility, new business models and new mobility products – in

short, to new ecosystems. These ecosystems must be defined and established for the benefit of the general public.

Innovations can expand existing markets and tap into new ones. The development of internationally recognised standards and norms is an essential part of this, since mobility needs must be met globally and transport is not restricted by borders. Common standards and norms create a framework which accelerates innovations and secures investments. For the future of multi-modal, sustainable and interconnected mobility, it also means that new stakeholders must be included in negotiations and significantly more complex demands must be met.

THE NPM'S ACHIEVEMENTS

The NPM's achievements – whether large or small – have set the wheels in motion towards a sustainable future of mobility.

Standardisation activities identified and initiated

Wide range of **recommendations for action** developed

Unique **array of perspectives:** 240 members working together to promote the future of mobility in Germany

Development of an **SME tool** for strategic personnel planning

Participation in the **Concerted Action for Mobility (KAM)**

Initiation of **RealLabHH**

RealLab Hamburg

Initiation of **competence hubs**

NPM insights and recommendations formed the basis of **climate policy decisions** (e.g. 2030 Climate Action Programme)

Contribution to BMVI publication **"An overall approach to climate-friendly commercial vehicles"**

Raising attention for the topic area of **hydrogen**

Contribution to BMVI publication **"Charging Infrastructure Master Plan"**

More than **50 reports** produced

3 THE NPM'S SIX WORKING GROUPS

3.1 EFFECTIVE CLIMATE ACTION: ALL MODES OF TRANSPORT AND TECHNOLOGIES ARE NEEDED

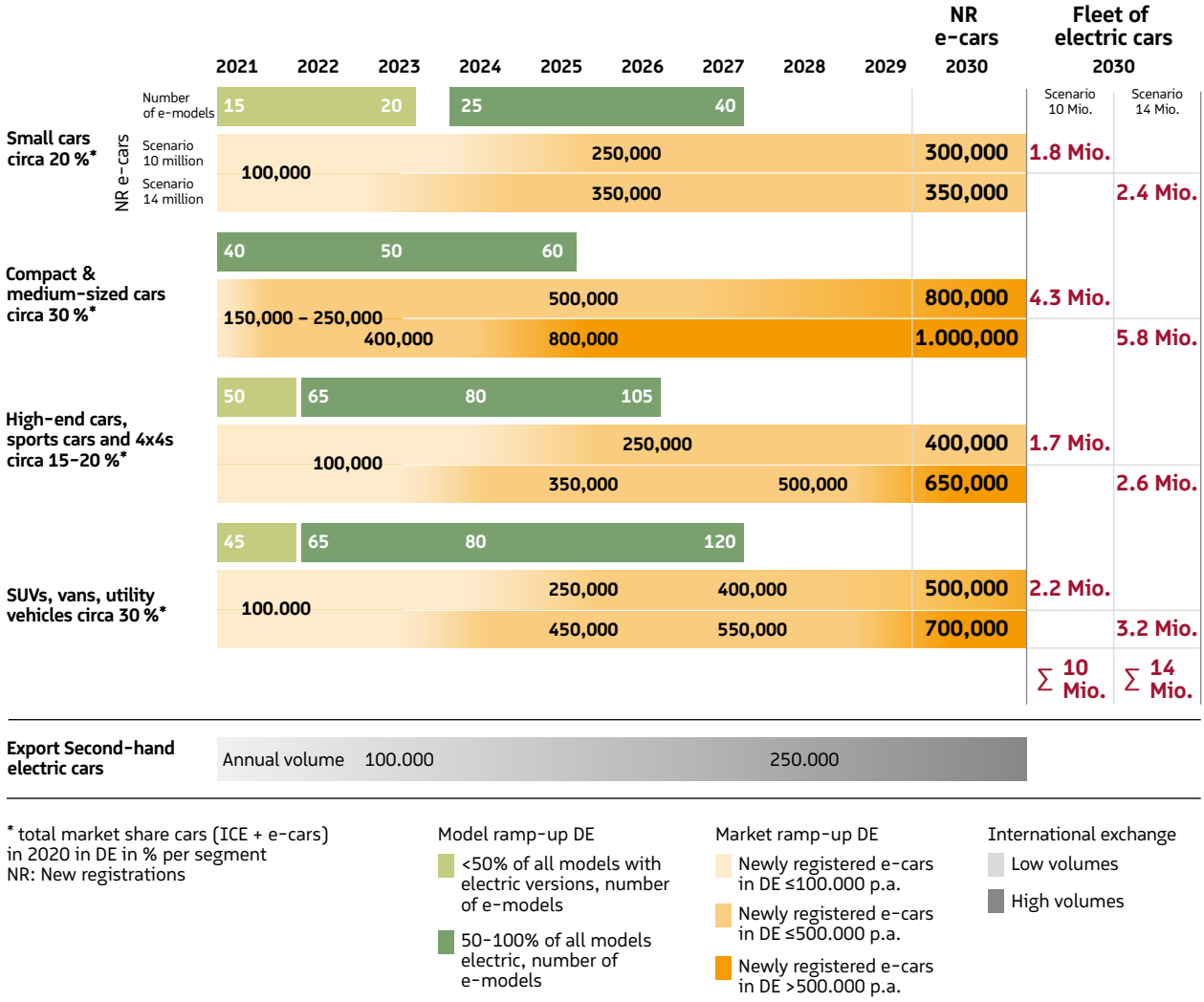
KClimate action is one of the most important issues of our time and is highly significant for current and future generations. Germany has acknowledged its responsibility for climate action and has made international commitments to permanently reduce carbon dioxide (CO_2) emissions. Despite its considerable technical progress, the transport sector has not been able to achieve a reduction in emissions since 1990, partly due to the strong increase in traffic volumes. It was not until mobility behaviour changed in 2020 during the COVID-19 pandemic that the sector saw a reduction in emissions. However, these partly temporary effects do not call into question the need for an accelerated transition of the mobility system towards sustainable transport. Significant challenges remain.

In order to utilise the potential for reducing CO_2 to achieve targets, extensive and highly ambitious measures should be adopted and implemented at the same time in all topic areas identified by working group 1 (WG 1). All modes of transport are needed alongside the appropriate technologies and connected social innovations. The associated investments in technologies, production capacity and infrastructures must be made urgently since the required market ramp-up and the application of environmentally friendly technologies and modes of transport could otherwise be delayed and the targets for 2030 not met. The aim, therefore, is to enable a climate-friendly mobility system that is affordable for all, improves Germany's competitive position as a business location, maintains employment levels and takes into account ethical aspects and issues of resilience. Early planning and investment security in the business location of Germany and the promotion of social acceptance from the outset are critical requirements here.

The NPM's reports demonstrate ways in which the transport sector can achieve the 2030 climate targets and examine how the current measures in the individual topic areas can be further accelerated and expanded. This will be outlined in brief below.

Drive system change for passenger cars: The automobile industry had previously planned for a fleet of 7 to 10 million electric cars in 2030. However, with current manufacturer announcements and the European Commission's planned tightening of fleet target values, a fleet of around 14 million electric cars in 2030 is now thought to be more realistic and may be essential to meet the climate targets.[6] WG 1 has produced two detailed roadmaps – one illustrating two target scenarios for the market ramp-up to a fleet of 10 or 14 million electric cars in 2030 and the second outlining the necessary technological development of electric cars.

6 New registrations in all member states count towards achieving the European fleet target values. The fleet in Germany has significant influence on the country reaching its national climate targets. Both targets must be met.



* total market share cars (ICE + e-cars) in 2020 in DE in % per segment
NR: New registrations

Model ramp-up DE
- <50% of all models with electric versions, number of e-models
- 50-100% of all models electric, number of e-models

Market ramp-up DE
- Newly registered e-cars in DE ≤100.000 p.a.
- Newly registered e-cars in DE ≤500.000 p.a.
- Newly registered e-cars in DE >500.000 p.a.

International exchange
- Low volumes
- High volumes

Figure 5: Two target scenarios for the market ramp-up and relevant influencing factors for a fleet of 10/14 million electric cars in 2030 (Source: NPM)

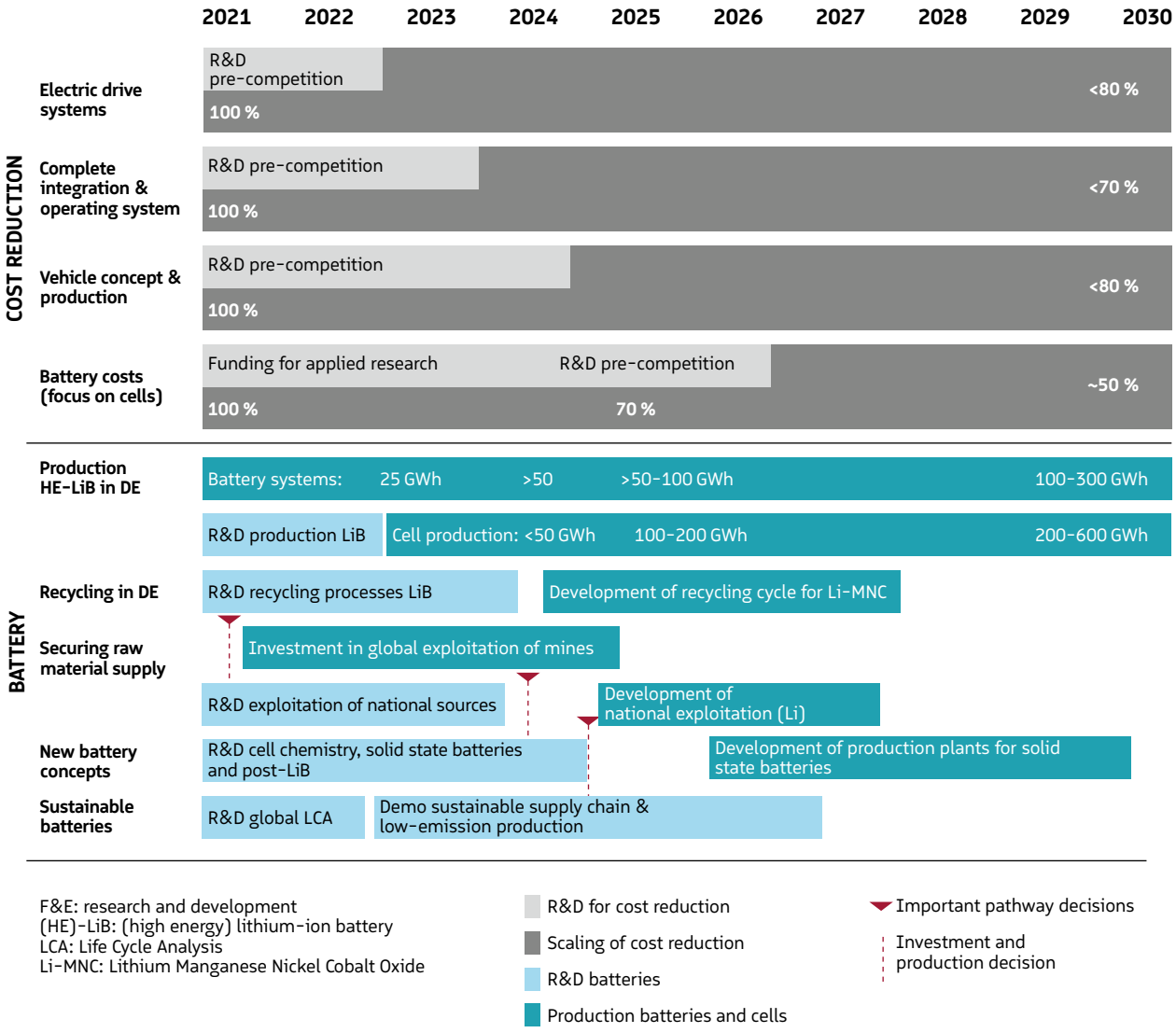


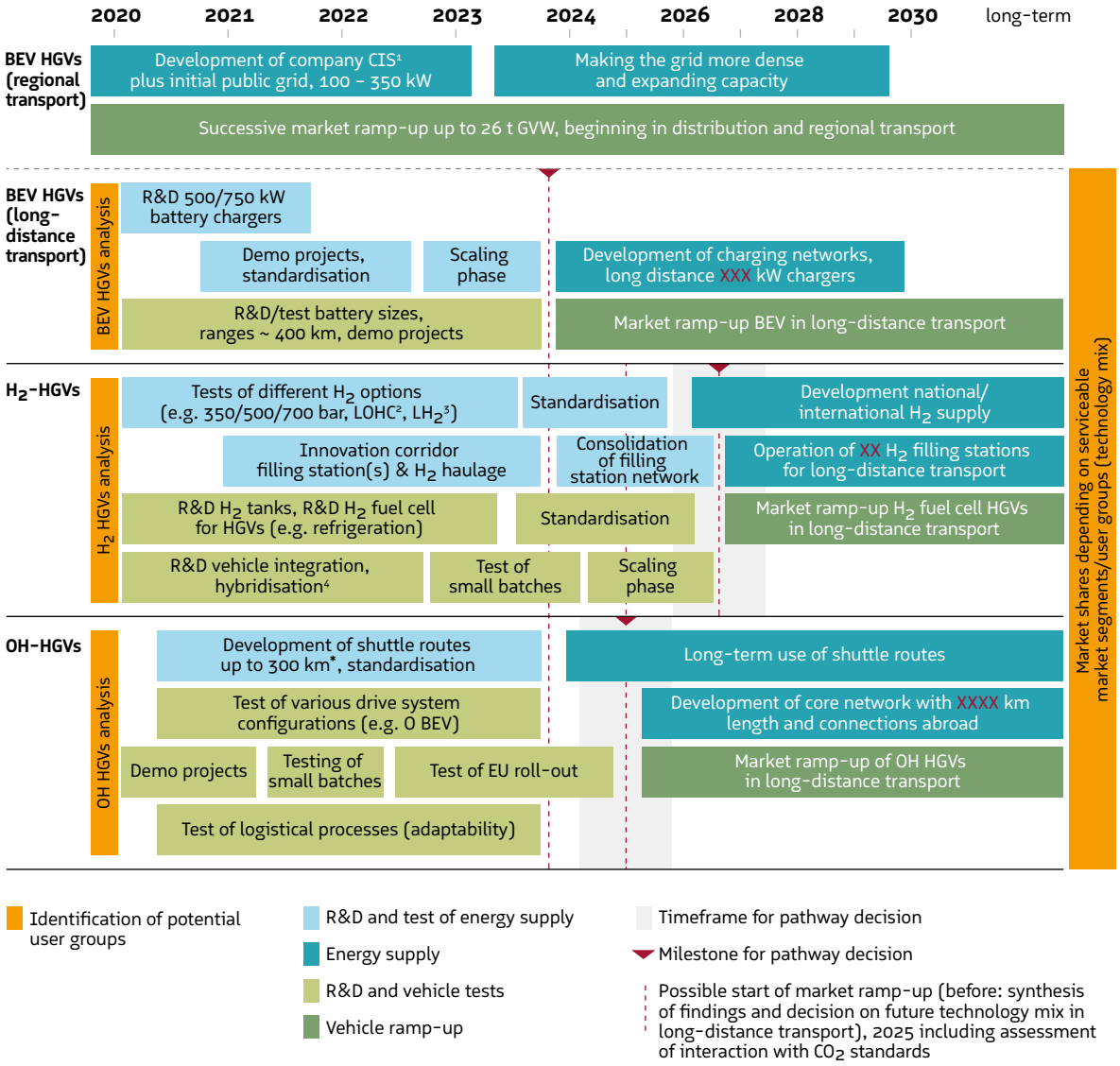
Figure 6: Target costs and focus areas for the technological development of electric cars (Source: NPM)

Compared to the baseline of 3.4 million electric cars, a ramp-up to a fleet of 10 million electric cars (a third of which being plug-in hybrid vehicles, or PHEV) would result in a GHG reduction in 2030 of over 13 million tonnes of CO_2 equivalent. A ramp-up to 14 million electric cars (at least a quarter of which being PHEV), would lead to a reduction of almost 22 million tonnes of CO_2 equivalent. To achieve the EU fleet target values and a widespread use of electric vehicles, the participation of all EU member states is essential, particularly in establishing an efficient, needs-based and economical charging infrastructure.

Drive system change for commercial vehicles: After an open approach to the further development of technology for heavy goods vehicles with battery-electric drive systems (BEV HGVs), hydrogen fuel cell technology (FCEV HGVs) and overhead line technology (OH HGVs), a focus on a particular technology must be developed by 2024/2025. In addition to the necessary effect on CO_2 levels, this should also take into account economic feasibility and a consistent approach across Europe.

Alongside regulatory instruments (a CO_2-based toll, influencing of energy costs), other important levers are vehicle funding and a needs-based expansion of infrastructures and economies of scale through increased research and development. Of key importance here is the acceleration of standardisation processes in order to scale-up the technology options at a European level. A four phase roadmap for the ramp-up of BEV HGVs, FCEV HGVs and OH HGVs illustrates the necessary steps in the process.

The GHG reductions concerning commercial vehicles are distributed between light commercial vehicles (LCVs), medium commercial vehicles (MCVs) and heavy-duty commercial vehicles (HCVs). In total, commercial vehicles can achieve a GHG reduction of around 13.5 to 16.5 million tonnes of CO_2 equivalent by 2030.



1 CIS: Charging infrastructure
2 LOHC: Liquid Organic Hydrogen Carrier
3 LH_2: Liquid Hydrogen
4 H_2-ICEs are also tested, but are not listed here as no electric drive system is used
* Not endorsed by all members of the WG 1.

Figure 7: Illustration of various technology options and necessary steps for the market ramp-up: a possible roadmap for achieving the targets of the 2030 Climate Action Programme (Source: NPM)

Alternative fuels: Alternative fuels may be an important lever in successfully reducing emissions in the transport sector. In principle, there are very different views within WG 1 about to what extent and in which areas of application biomass- and electricity-based alternative fuels can or should contribute to the reduction of CO_2 in the transport sector. It is beyond dispute that considerable amounts of these will be needed to provide a carbon neutral solution for the energy requirements of aviation and international shipping. However, opinions still differ over the issue of developing the availability of renewable energies at a global level and particularly about whether electricity-based fuels should be used in road traffic. To illustrate the various technology options and the necessary steps for the market ramp-up of alternative fuels, WG 1 has developed two possible roadmaps – power-to-liquid (PtL) and biomass-to-liquid (BtL).

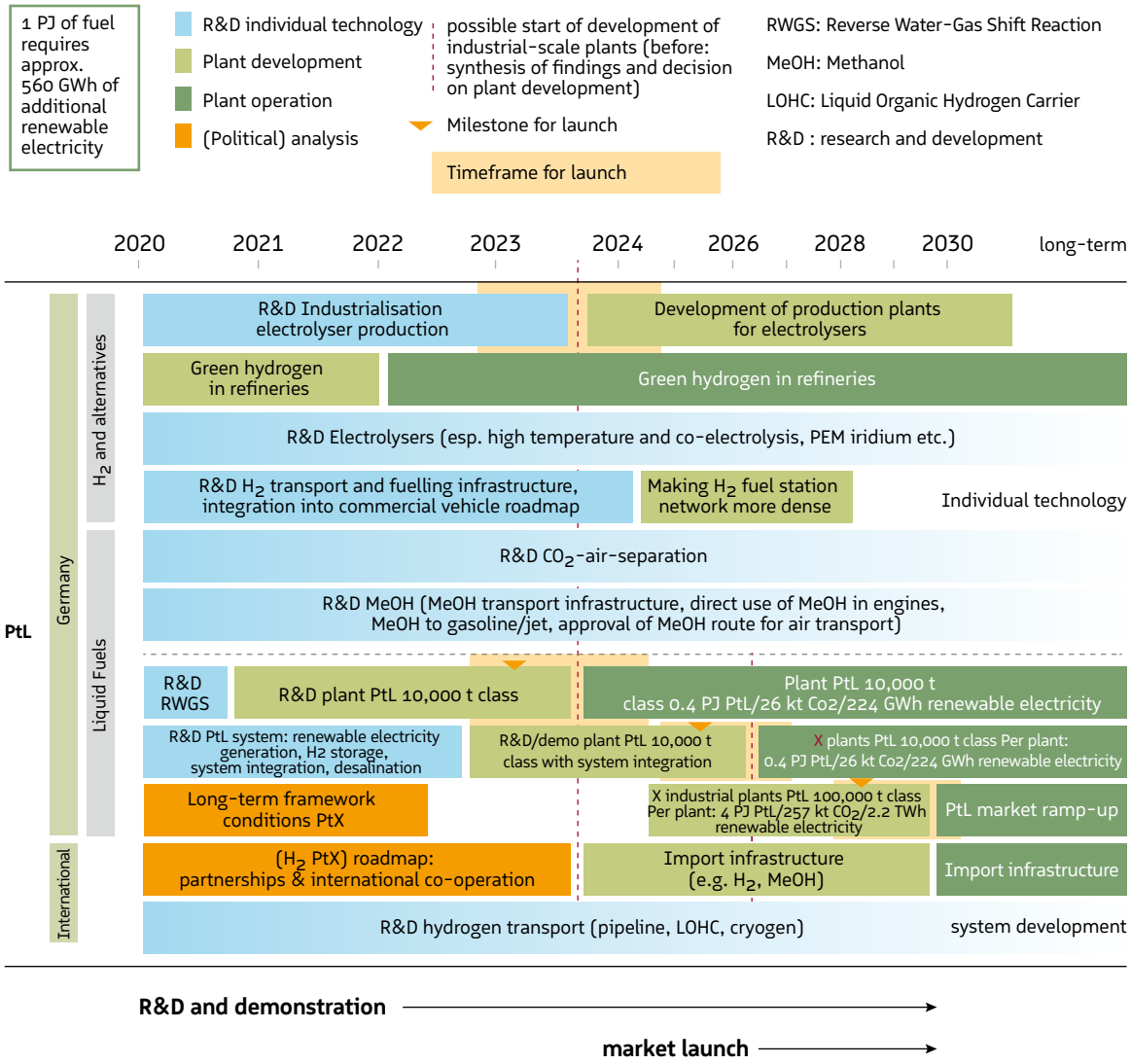


Figure 8: PtL roadmap to achieve the 2030 Climate Action Programme targets: steps for the market ramp-up of electricity-based fuels (Source: NPM)

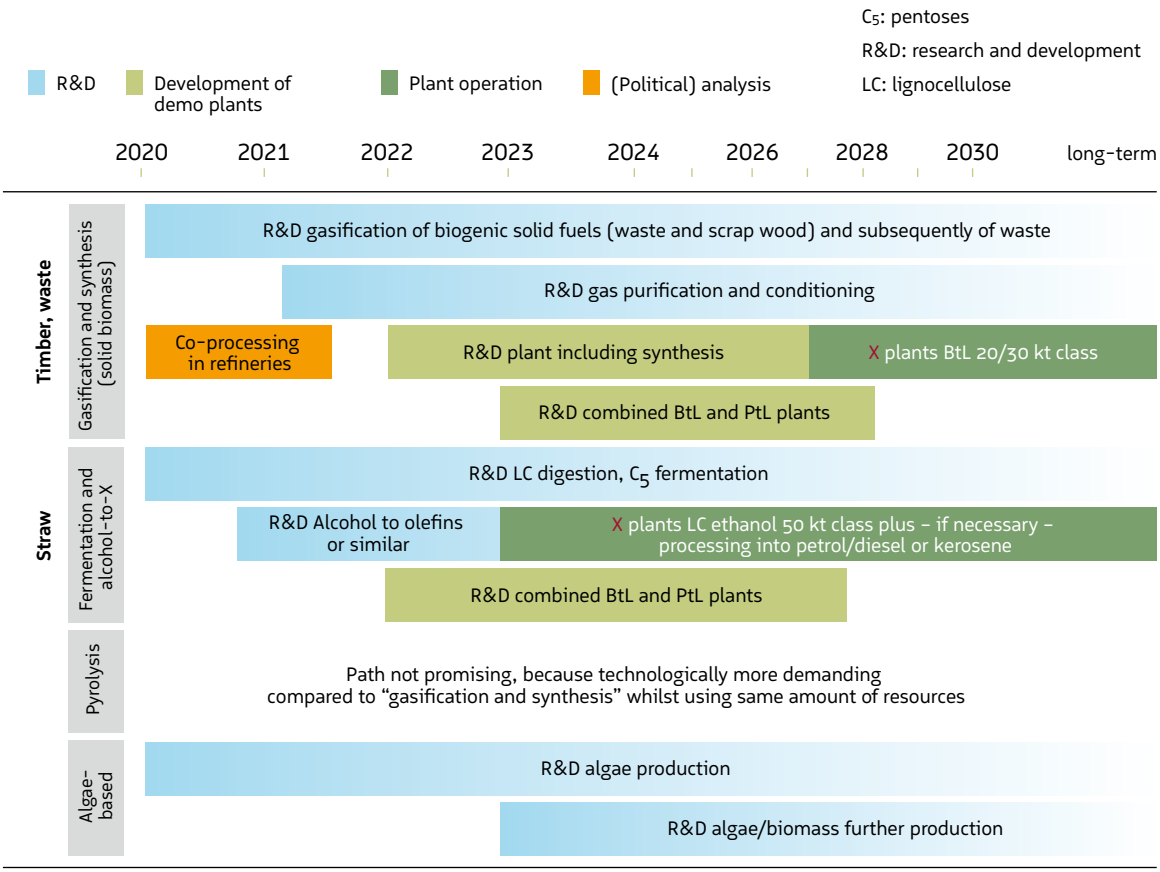


Figure 9: BtL roadmap to achieve the 2030 Climate Action Programme targets: steps for the market ramp-up of biogenic fuels (Source: NPM)

The reports by the Institute for Applied Ecology (Öko-Institut)[7] and Prognos[8], commissioned by the Federal Ministry for the Environment (BMU) and the Federal Ministry for Economic Affairs and Energy (BMWi), which evaluated the Federal Government's adopted measures as of January 2020, estimate that alternative fuels could reach a range of emission reductions from 0 to 3 million tonnes of CO_2 equivalent.

7 German Environment Agency (2020): Abschätzung der Treibhausgasminderungswirkung des Klimaschutzprogramms 2030 der Bundesregierung [Assessment of the effect of the Federal Government's 2030 Climate Action Programme on GHG reduction]. URL: https://www.umweltbundesamt.de/sites/default/files/medien/5750/publikationen/2021-03-19_cc_33-2020_klimaschutzprogramm_2030_der_bundesregierung.pdf [Accessed: 08/09/2021]

8 Federal Ministry for Economic Affairs and Energy (2021): Energiewirtschaftliche Projektionen und Folgeabschätzungen 2030/2050 [Projections and impact assessments for the energy industry 2030/2050]. URL: https://www.bmwi.de/Redaktion/DE/Publikationen/Industrie/energiewirtschaftliche-projektionen-und-folgeabschaetzungen-2030-2050.pdf?__blob=publicationFile&v=18 [Accessed: 08/09/2021]

Rail transport: A significant reduction of CO_2 emissions in the transport sector can be achieved through the electrification of the railway and particularly through the modal shift of traffic to rail. This potential can be exploited by consistently increasing the railway's capacity, services and appeal. The expansion of capacity is the decisive factor in many subsectors. Digitalisation, electrification, resource development in companies and by regulators, and funding ramp-ups for construction and improvement are all essential for a consistent implementation of the previously initiated and politically anchored portfolios from the 2030 Climate Action Programme (CAP 2030) and the rail transport master plan. Working group 1 has published two roadmaps in relation to this. One relates to the implementation of instruments from CAP 2030 and the rail transport master plan and the other details further quantified, accelerated and additional instruments.

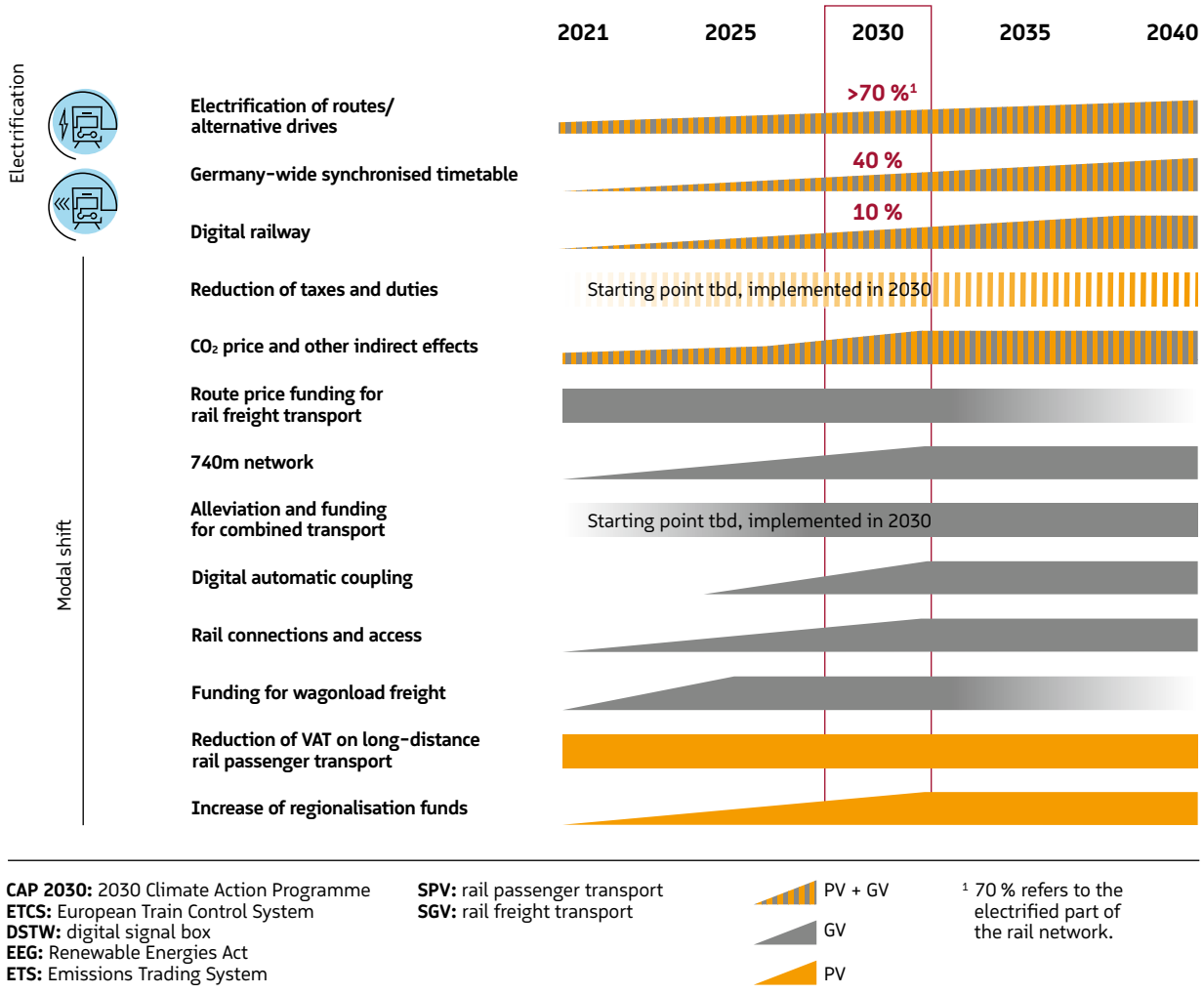


Figure 10: Analysis of the established instruments from CAP 2030 and the rail transport master plan with the specific level of implementation (Source: NPM)

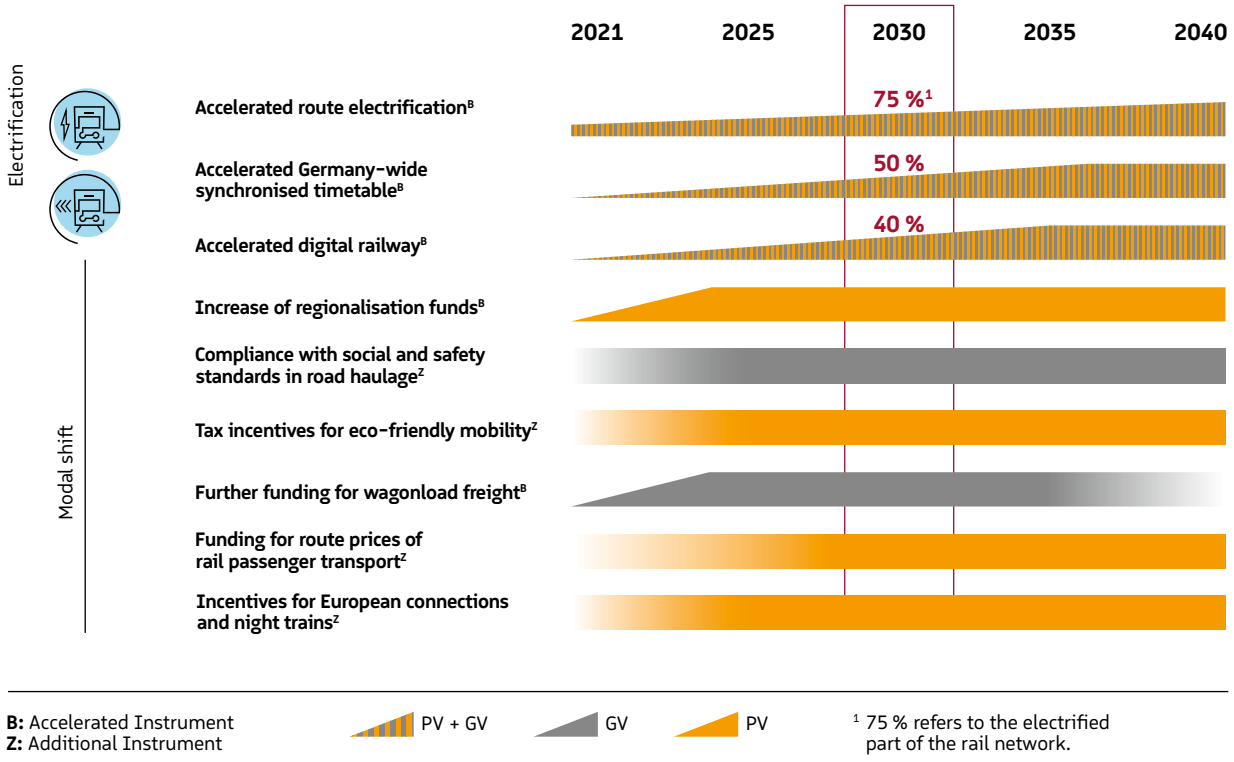


Figure 11: Analysis of the accelerated and additional instruments with the specific level of implementation (Source: NPM)

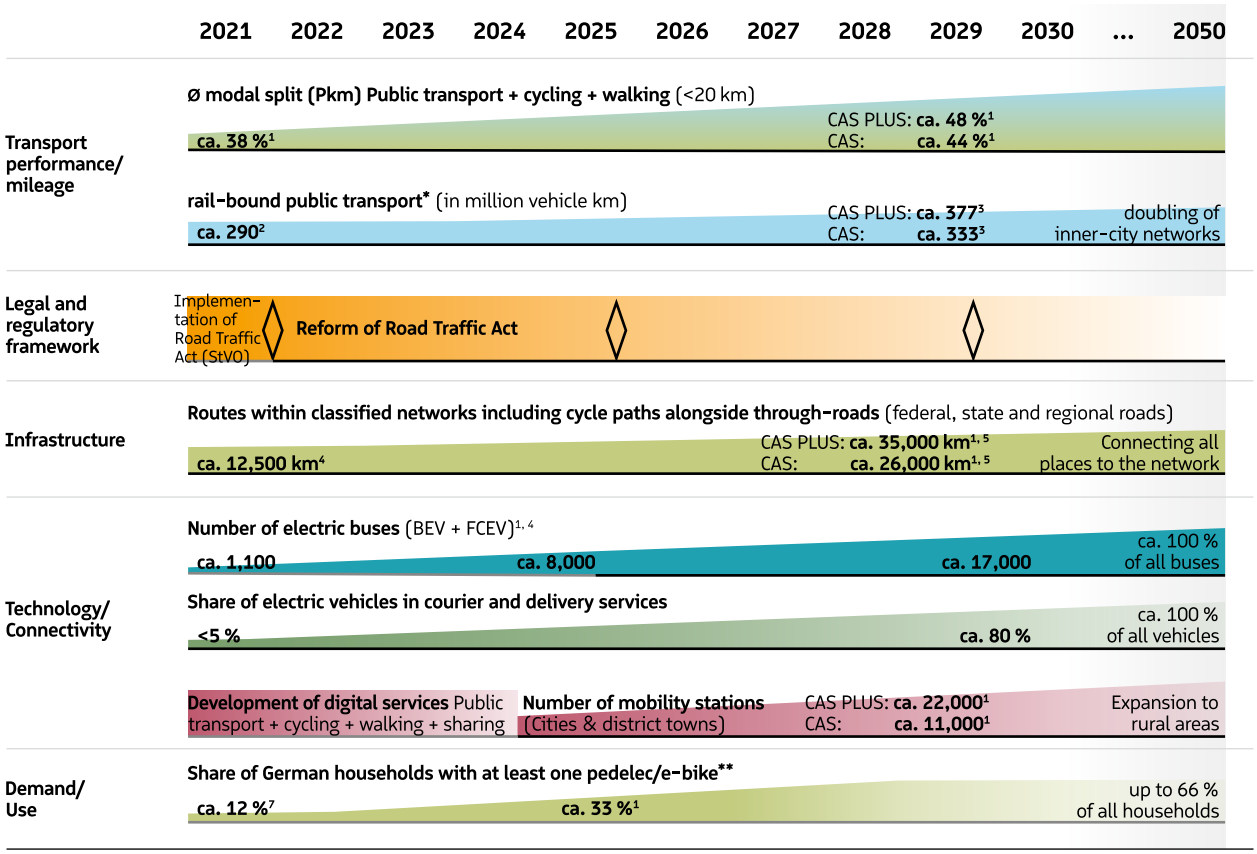
The assessed instruments of these roadmaps comprise a total CO_2 reduction of 6.5 million tonnes of CO_2 equivalent. Additional instruments without quantified effects are also illustrated.

Urban mobility: In the area of urban mobility, the greatest potential for reducing CO_2 lies in the funding, expansion and acceleration of local public transport, cycling provision and multimodality, in electrification and defossilisation, as well as in the configuration of a broader framework for a modal shift[9] (including via push and pull factors). The integrated implementation of all instruments also produces synergistic effects, therefore the topic area's potential for CO_2 reduction results from different scenario building and the emphasis of individual levers.

The roadmap drawn up by WG 1 shows that the individual steps must be taken soon to guarantee a swift implementation. The promotion and implementation of sustainable mobility trends can also act as a signal and have a positive impact on longer distance journeys which go beyond the field of view of urban mobility (e. g. travel).

Depending on the scenario and inclusion of traffic flow optimisation, the CO_2 reduction ranges between 4.3 and 7.0 million tonnes of CO_2 equivalent.

9 In transport planning, 'modal shift' refers to a relocation of traffic to increase sustainability, generally from private motor vehicle transport to more environmentally friendly options such as local public transport or walking and cycling.



[1] M-Five/PTV, own modelling
[2] VDV statistics 2019
[3] BVWP 2030, VDB assessment
[4] BMVI/StB 2020
[5] BAG 2021
[6] Destatis 2020
* trams, over- and underground trains
** any type of bike assisted by electric engines

Instrumentenbündel:

- funding for public transport, car sharing and multimodality
- development of bike and pedestrian traffic
- legal & administrative framework, regulatory policy
- regular parliamentary elections
- electric drive structures
- urban logistics
- digitalisation, connectivity & traffic management
- quantified impact progression
- qualitative impact period
- ongoing development
- additional elements

Figure 12: Possible roadmap for achieving environmentally friendly urban mobility (Source: NPM)

A SYSTEMIC PERSPECTIVE FOR HOLISTIC CLIMATE ACTION IN TRANSPORT

The need for action continues to rise as a result of the increasing requirements of climate protection regulations at a national and a European level. The measures should therefore be implemented as soon as possible in all areas according to the more stringent EU target values. An individual analysis of sectors and topic areas is essential for this operationalisation of measures for climate change mitigation. However, it also necessitates a systemic perspective which takes into account the mutual dependencies between the individual sectors and topic areas. In this way, unwelcome rebound effects can be identified promptly and addressed accordingly. A sector-wide perspective also allows for better identification of competition between individual sectors for scarce resources, such as biomass or green hydrogen. Politics bears the responsibility for an iterative approach to laying the groundwork which directs Germany's mobility and transport sector along a sustainable path of innovation, strengthens its location and enables it to attain a leading market position for innovative, environmentally friendly mobility solutions.

Report WG 1

Ways for more climate protection in transport

Report WG 1

Workshop Report Alternative Fuels

Report WG 1

Workshop Report Drive Change Commercial Vehicles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3.2 SUSTAINABLE MOBILITY: OPPORTUNITIES ARISING FROM ALTERNATIVE DRIVE SYSTEMS AND FUELS

SHAPING THE TRANSITION TO ALTERNATIVE DRIVE AND FUEL TECHNOLOGIES FROM THE USER'S PERSPECTIVE

Private and commercial users each have their own requirements and preferences for a drive system and fuel portfolio of the future. The various technology options offer potential for different areas of application, cars and HGVs, ships, rail vehicles and planes. These options were considered in a technology-neutral manner for a comprehensive representation of technological potential, the consensus being that it will not be possible to use every technology sensibly in all areas of application.

The particular focus is on road traffic. This causes the majority of traffic-related CO_2 emissions in Germany, the proportion being around 95 %. The reason for this is the large proportion of road transport (modal split) and the use of energy and fuels from fossil resources. The first step in achieving our climate action targets is to significantly reduce dependence on fossil fuels and then completely eliminate it. The development of technological electromobility concepts is far advanced in road traffic and especially for cars. With other technologies, the developments are currently being significantly intensified, with the result that the transformation process is already underway. With cars, the technology transformation in practice meets the preferences of the end customers. In their reports[10] on the change taking place, the WG 2 of the NPM has therefore not only adopted a technological perspective but also addressed matters from a customer point of view.

BATTERY ELECTRIC VEHICLES: A MATURE TECHNOLOGY FOR CARS

When it comes to cars, battery electric vehicles are the most developed alternative drive technology to date to achieve the reduction in emissions being aimed for, while at the same time taking into account the requirements for individual mobility. On the one hand, the number of new registrations for electric vehicles, supported by funding measures, is currently experiencing exponential growth. On the other hand, potential users still have reservations concerning electromobility, with concerns about a higher purchase price, the limited range of electric cars with long charging times at the same time as well as the expansion of a public charging infrastructure.[11] The currently valid funding instruments will have to be constantly checked in the coming years so that the electromobility market can be self-sustaining in the long term and at the same time continue its dynamic development. Checkpoints should be introduced in 2024, 2028 and 2030 to check whether the market ramp-up of electromobility is progressing fast enough. Using quantitative data, they aim to check whether or to what extent the market

10 NPM WG 2 (2019): 1. Kurzbericht der AG 2. Elektromobilität. Brennstoffzelle. Alternative Kraftstoffe – Einsatzmöglichkeiten aus technologischer Sicht [1st brief report from WG 2. Electromobility. Fuel cells. Alternative fuels – possible applications from a technological perspective];
NPM WG 2 (2020): 2. Kurzbericht der AG 2. Einsatzmöglichkeiten unter realen Rahmenbedingungen [2nd brief report from WG 2. Possible applications under real-life conditions];
NPM WG 2 (2021): Roadmap – Markthochläufe alternativer Antriebe und Kraftstoffe aus technologischer Perspektive [Roadmap – Market ramp-ups of alternative drive systems and fuels from a technological perspective];
NPM WG 2 (2021): Kundenakzeptanz als Schlüssel für den Markthochlauf der Elektromobilität [Customer acceptance as the key to the market ramp-up of electromobility].
11 Acatech (2020). Mobilitätsmonitor 2020 [Mobility Monitor 2020].

share of BEV has fallen below expectations so that timely countermeasures can be taken.[12] It is also important to focus on the second-hand car market, which is important from a customer perspective, to get electric vehicles established there, too.[13]

Against the backdrop of the necessary technological and usage-specific framework conditions, plug-in hybrid vehicles act as trailblazers for electromobility and can help to introduce customers to electromobility. They are also of significant benefit to the climate if the electric driving mode is used sufficiently and, in conjunction with the use of renewable fuels and frequent battery charging, can further improve their environmental impact. The production of plug-in hybrid drive systems also supports the employment policy transformation in the automobile industry.[14]

CUSTOMER ACCEPTANCE OF ELECTRIC VEHICLES

The NPM "customer acceptance" focus group was able to identify the main reasons for buying electric vehicles (BEV or PHEV), taking as their basis a research project involving group discussions, interviews with experts and an online survey asking why people buy a new purely battery electric vehicle (BEV), a plug-in hybrid (PHEV) or a vehicle with an internal combustion engine (ICE). During the group discussions it was revealed that the buyer's premiums (environment bonus and innovation premium), the carbon footprint perceived as positive, the enjoyment experienced while driving an electric vehicle and the fact that an already well-known brand is bringing an electric vehicle to market, had a positive effect on buying intention. Individual experts such as infrastructure providers and car salespeople have also concluded that there is still a lot of uncertainty among potential customers and a need to educate them. A quantitative online survey based on these group discussions and interviews with experts was able to provide the following accurate picture indicating why people consider buying an electric car.

12 NPM WG 2 (2021): Roadmap – Markthochläufe alternativer Antriebe und Kraftstoffe aus technologischer Perspektive [Roadmap – Market ramp-ups of alternative drive systems and fuels from a technological perspective], p. 13.
13 NPM WG 2 (2021): Roadmap – Markthochläufe alternativer Antriebe und Kraftstoffe aus technologischer Perspektive [Roadmap – Market ramp-ups of alternative drive systems and fuels from a technological perspective], p. 15.
14 NPM (2020): Empfehlungen zum optimierten Nutzungsgrad von Plug-In-Hybridfahrzeugen. [Recommendations for optimised utilisation of plug-in hybrid vehicles].

WHAT ARE THE REASONS PEOPLE CONSIDER BUYING AN ELECTRIC CAR?

NPM focus group "Customer acceptance", quantitative survey, selected reasons, figures as percentages

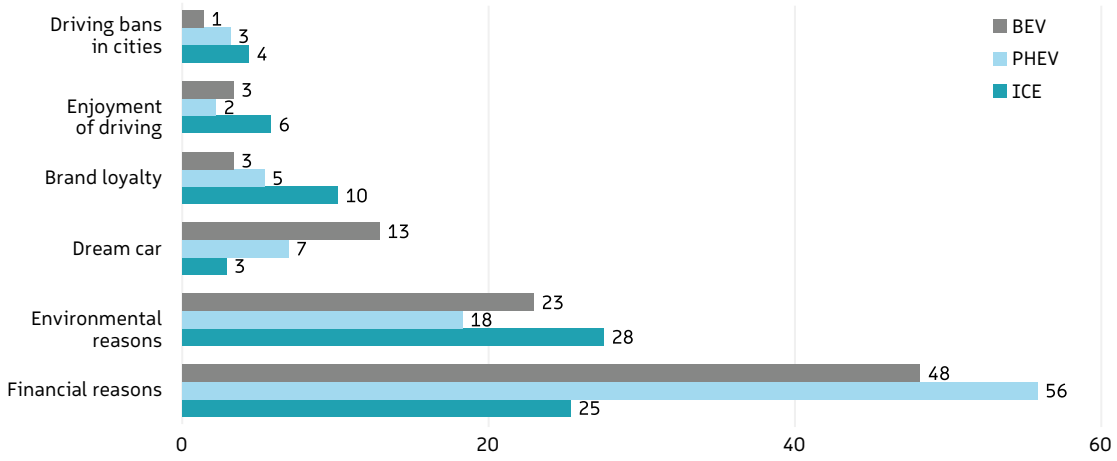


Figure 13: Reasons for buying an electric car (Source: NPM)

COMMERCIAL VEHICLES AND TRADESPEOPLE: SOLVING DIFFERENT REQUIREMENTS WITH A MIX OF TECHNOLOGIES

The commercial use of alternative drive systems and fuels ranges from large vehicle fleets of heavy goods vehicles (HGVs) for provision of transport logistics services to regional tradespeople who mostly have light goods vehicles. Battery and hybrid electric drive solutions are already available to these lighter goods vehicles now, just as they are for cars. Commercial car owners are put under a lot of competitive pressure, which is why new drive systems must have similar overall costs from a user perspective compared to vehicles with internal combustion engines. Purchase support must therefore also be introduced for these categories of buyers. The tax advantages of company cars being electric cars have already shown that commercial users are already contributing to the rapid expansion of the market ramp-up.[15]

A considerable number of alternative technologies for a change in drive system has been developed by manufacturers for heavy goods vehicles and users are currently putting them to the test. These developments include electric drive systems with batteries (BEV HGVs), fuel cells (FCEV HGVs) and overhead lines (OH HGVs) as well as HGVs with internal combustion engines that use renewable liquid or gaseous fuels.[16]

15 NPM WG 2 (2021): Roadmap – Markthochläufe alternativer Antriebe und Kraftstoffe aus technologischer Perspektive [Roadmap – Market ramp-ups of alternative drive systems and fuels from a technological perspective], p. 17.

16 NPM WG 2 (2021): Roadmap – Markthochläufe alternativer Antriebe und Kraftstoffe aus technologischer Perspektive [Roadmap – Market ramp-ups of alternative drive systems and fuels from a technological perspective], p. 26.

BATTERY ELECTRIC HGVS SHOW GREAT POTENTIAL TO REDUCE EMISSIONS – OVERHEAD LINE AND FUEL CELL HGVS IN THE TESTING PHASE

Because of their advanced technological development, battery electric commercial vehicles have great potential to reduce emissions in the short and medium term. At the same time, there continue to be huge challenges ahead, particularly for heavy goods vehicles, which usually require a high daily mileage from the trucks. This means that the battery must have appropriate capacity and have the size and dimensions to match and, for it to be appropriate for the user and for flexible use, there must not only be an option to charge it at depots and logistics sites but also a network of public fast charging infrastructure. Overhead line HGVs are currently being field tested as part of a number of research projects and on the sections of the route with direct power consumption offer great potential to reduce emissions. This means that users can currently try out this new technology.[17]

The hydrogen fuel cell is also being pushed forward with vigour by some vehicle manufacturers as a drive system option for HGVs. The high energy density of hydrogen makes it a good option, especially for heavy goods vehicles with high daily range requirements. However, these HGVs have yet to be developed into a marketable commodity. Moreover, green hydrogen is not yet available at a hydrogen filling station network (in the form of pressure and if necessary also liquid hydrogen). It has to be built and expanded at the same time as new registrations of these HGVs increase.[18]

ALTERNATIVE FUELS FOR THE EXISTING FLEET AND FOR MEANS OF TRANSPORT NOT DIRECTLY ELECTRIFIABLE

It can be assumed that many people will continue to use cars powered by internal combustion engines in 2030. For this existing fleet and for the means of transport that cannot directly be equipped with battery electric components such as planes and ships, renewable fuels can be a vital component in reducing CO_2 emissions. When it comes to renewable fuels, a distinction is made between biomass-based and electricity-based fuels. Advanced 2nd generation biofuels are based on waste and residual materials and are basically compatible with conventional vehicles powered by internal combustion engines. They are currently still in the testing phase, for example in air travel, and economical production facilities are still to be created, meaning that their production upscaling should have more political support.[19] Great potential is attributed to electricity-based fuels (e-fuels) to reduce emissions by being a substitute for fossil fuels, with upscaling of production facilities yet to be actively addressed here too.[20] The necessary requirements for this are political frameworks and the encouragement for first-time applications.

Figure 14 shows the choice of different technology paths that are available to users. The respective energy provision is also illustrated.

17 NPM WG 2 (2021): Roadmap – Markthochläufe alternativer Antriebe und Kraftstoffe aus technologischer Perspektive [Roadmap – Market ramp-ups of alternative drive systems and fuels from a technological perspective], p. 27.
18 NPM WG 2 (2021): Roadmap – Market ramp-ups of alternative drive systems and fuels from a technological perspective, p. 29.
19 NPM WG 2 (2020): 2nd brief report from WG 2. Possible applications under real-life conditions, p. 33.
20 NPM WG 2 (2021): Roadmap – Markthochläufe alternativer Antriebe und Kraftstoffe aus technologischer Perspektive [Roadmap – Market ramp-ups of alternative drive systems and fuels from a technological perspective], p. 33 f.

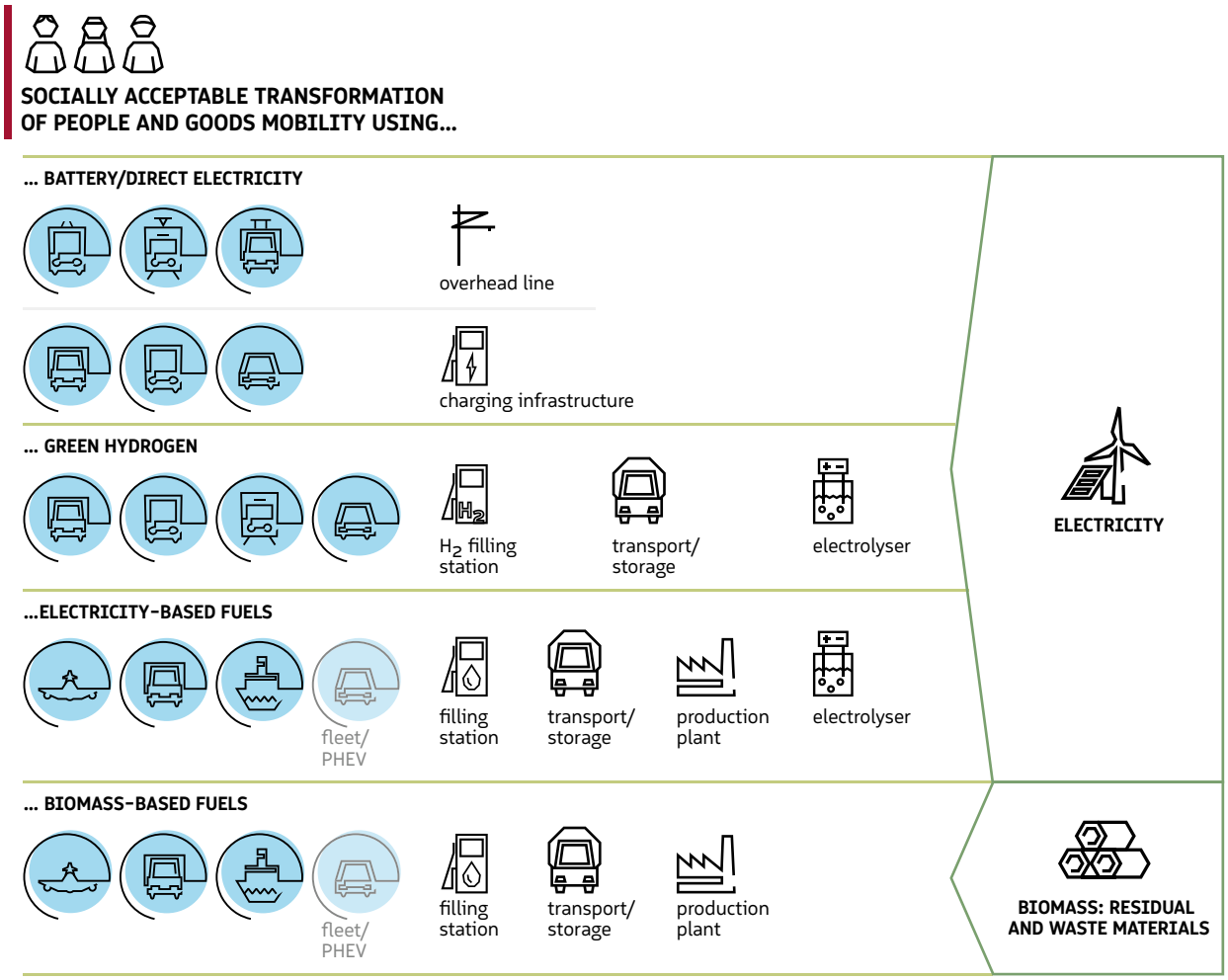


Figure 14: Overview of alternative drive systems and fuels (Source: NPM)

CLIMATE-FRIENDLY AND INNOVATIVE DRIVE AND FUEL TECHNOLOGIES HAVE TO BE ESTABLISHED IN THE LONG TERM AND WITH THE USERS

With its holistic approach, the NPM has considered both alternative drive and fuel technologies and the needs of the users. After all, alternative drive systems and fuels will only be established in the long term so that the transformation can be successful when people feel that they are being involved in the process and their mobility needs considered. To this end, a number of recommendations for action have been drawn up for policy-makers. With this framework and the involvement of the users, climate-friendly and innovative drive and fuel technologies can be established effectively and sustainably.

Report WG 2

Roadmap "Market ramp-ups of alternative drive systems and fuels from a technological perspective"

Report WG 2

Customer acceptance as the key to the market ramp-up of electromobility

3.3 DIGITALISATION IN THE MOBILITY SECTOR: ENABLING A BETTER TRANSPORT SYSTEM

Digitalisation offers Germany the potential to shape the mobility of the future to be healthier, more climate-friendly, more efficient, more convenient and more affordable. The vision of a multi- and intermodal mobility was taken as a basis for this – the availability and use of different modes of transport at different times or combined within one route make our transport services more varied, the supply better and thus provide the decisive incentive to switch more often to alternatives that are better for the environment and the climate. Autonomous mobility is an important component of a multimodal system. Driverless shuttles in multimodal applications are used more, connect to public transport and rail transport better and take up less public space at the same time.

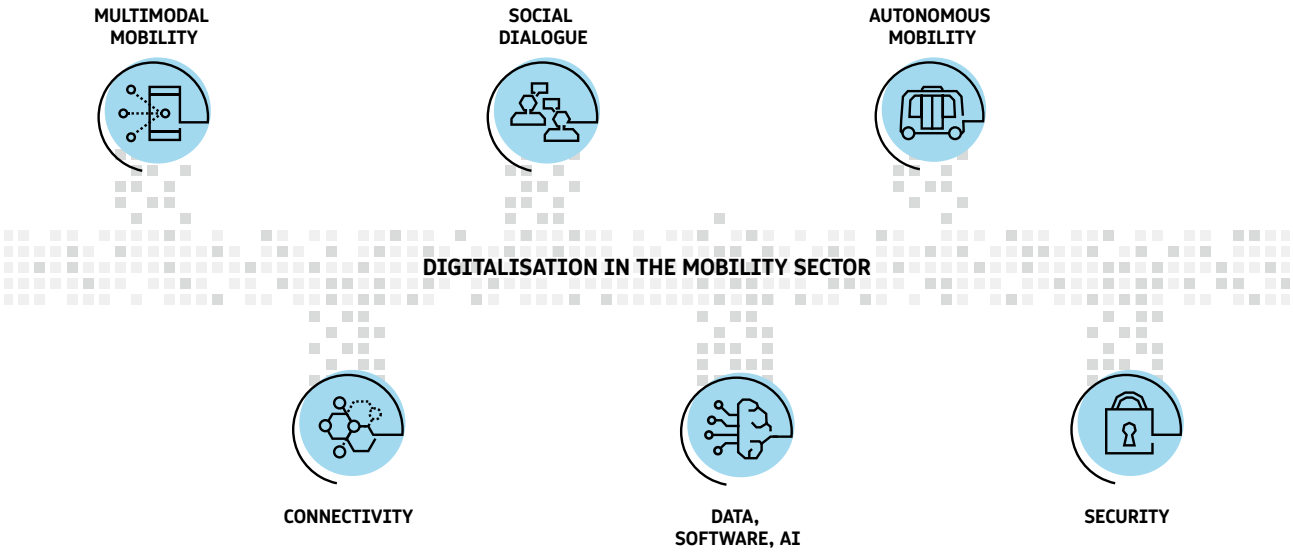


Figure 15: Topic overview from WG 3 (Source: NPM)

Key enablers have been identified to put the vision into practice. An essential requirement for the implementation is the networking of the modes of transport and an appropriate ecosystem of mobility data that makes available the different options and the associated data silos across all modes of transport for more efficient traffic and route planning. Data protection and traffic and cyber security undoubtedly play a crucial role here. Last but not least, it is important to develop innovative mobility concepts together with the local population for the benefit of everyone.

SUCCESSFUL CONSULTATION AND TESTING CARRIED OUT BY WG 3

WG 3 has looked at the relevant subject areas in six interim reports, identified key areas where action is needed and made appropriate recommendations for action for digitalisation in the mobility sector. In addition, a research project funded by the Federal Ministry of Transport and Digital Infrastructure (BMVI) was initiated from within WG 3 with broad entrepreneurial initiative. The Reallabor Digital Mobility Hamburg, a real-world laboratory working on digital solutions, implemented ten wide-ranging sub-projects on all the essential aspects of a digitalised mobility system and gained practical experience in no time at all. The work carried out by WG 3 and the real-world laboratory shows that the networking of technologies and all relevant stakeholders is essential for targeted implementation of the technologies and services. If everyone from the world of politics, industry and civil society invests together in this task for the future, knowledge can be gained and solutions found to overcome the huge challenges of digitalising the mobility sector. In their work, activities running in parallel such as the mobility data room project, the federal government's data strategy and Gaia-X were continuously taken into account and incorporated in the development of the recommendation for action and design.

DIGITALISATION REQUIRES DATA AND CONNECTIVITY TO ENABLE INNOVATIVE MOBILITY OPTIONS

Platform-based inter- and multimodal mobility

Digital, volume-based traffic control and multimodal and autonomous mobility options or the option of a mobility budget from employers serve to manage the traffic more efficiently, better connect the modes of transport and set incentives for the use of alternatives, especially in cities with a high volume of traffic. Conversely, access to mobility is often restricted in rural areas. Here it is important to ensure a needs-based, appropriate supply of mobility by connecting the modes of transport with one another. It is necessary for mobility providers – who have equal rights and equal obligations – to be able to provide mobility services for users in a meaningful way for society as a whole while safeguarding their own business interests. Here, equal participation for all mobility providers should be ensured through the provision of available mobility data while safeguarding IP rights, economic interests and cybersecurity requirements.

This requires standardised and binding interfaces to replace "in-house" interfaces. The communication standards for the operation of cooperative intelligent transport systems should be formulated in a technology-neutral manner at European level. Last but not least, the mobility system of the future must be safe – in addition to road safety, this also includes cybersecurity in particular.

Digitalisation of the transport infrastructure

Depending on findings gained from tests done in real traffic conditions, it may be necessary to forge ahead with the digitalisation efforts in the transport sector with a view to traffic safety and traffic control, with the focus being on physical elements of the transport infrastructure relevant to traffic (for example traffic lights, variable message signs (matrix signs), parking guidance systems and level crossings), which would then have to be able to make their dynamic states available in standardised formats, depending on the application, through direct and/or network-based digital data transmission. The data can also be used in digital representations of reality (digital twin). In the interests of reliability, the infrastructure-related data must meet certain quality criteria. Data provision via internet-compatible interfaces is recommended, among other things. The increased use of inter- and multimodal services can also be supported by the implementation of digitalised parking space management that is integrated in a user-friendly way into intermodal mobility chains.

Autonomous mobility

The German Act on Autonomous Driving which came into force mid 2021 allows for the timely market launch of autonomous driving in Germany provided vehicles at the right level of maturity are available. The provision of high-quality static and dynamic traffic infrastructure data (information between traffic lights and vehicle (for example redundant information for the safe crossing of intersections/traffic lights), information from variable message signs (matrix signs) and traffic signs, information about lanes, markings and roadworks) will accelerate the introduction of automated driving functions. It is important to

create uniform standards for exchanging mobility data. This is the only way to achieve simple and extensive networking of vehicles and their integration into a mobility ecosystem. As part of a regulation, local authorities and federal states must on the one hand be enabled to digitally record, process and make available static and dynamic traffic infrastructure data. On the other hand, the automobile industry must pass on the traffic safety-related data to which it has access in real-time. This requires the development of standards (including data exchange formats) and the creation of binding specifications to implement these standards including quality of service levels.

Data protection and security

The data exchange, connections and the mobility products must also meet the highest security requirements, otherwise they will not be accepted by the users in the long term. Appropriate guidelines for the reliable identification of those involved (mobility providers, users etc.), but also other assets worth protecting, such as contracts and business processes, must be developed – at least as far as necessary in the respective case (for example damage). Appropriate guidelines for the trustworthiness of the identification and also the processes for processing transactions must be developed for this. For this purpose, technical measures should also be used with which the purpose limitation in the use of services can be supported in a legally secure manner (see for example International Data Spaces Association (IDSA)). Mobility providers must ensure state of the art secure data transmission and storage.

Platform operators in turn must set up the data processing in such a way that data can be processed locally and redundantly if possible (means of transport or edge device, edge and cloud computing). If anonymised mobility data are used, clear requirements for anonymisation must be formulated and advanced protection concepts that largely reduce the risk of de-anonymisation must be developed. Direct access by third parties to the vehicles must be avoided, without this weakening the competition for consumer and innovation-orientated services. The regulatory framework to implement this requirement is to be defined. Technical guidelines from the Federal Office for Information Security (BSI) and international security standards to set up secure communication infrastructures must apply.

Report WG 3

Platform-based intermodal mobility and recommendations for action on data and security

DIGITALISATION REQUIRES PILOT PROJECTS AND THE APPROVAL OF LOCAL RESIDENTS

An implementation concept for a nationwide dialogue and participation strategy for digitalising the mobility sector could be developed based on experience with social dialogue and the participation of the local residents in the Reallabor, a real-world laboratory in Hamburg. The active involvement of the local population plays a key role in successfully shaping the digital transformation of mobility with viable business models. Dialogue and participation also prevent resistance in the long term. Decisions are communicated transparently and comprehensibly. To orchestrate the dialogue and participation process to digitalise the mobility sector and in particular to pool existing knowledge, the federal government should support the establishment of a higher-level dialogue initiative gathering a wide range of social stakeholders.

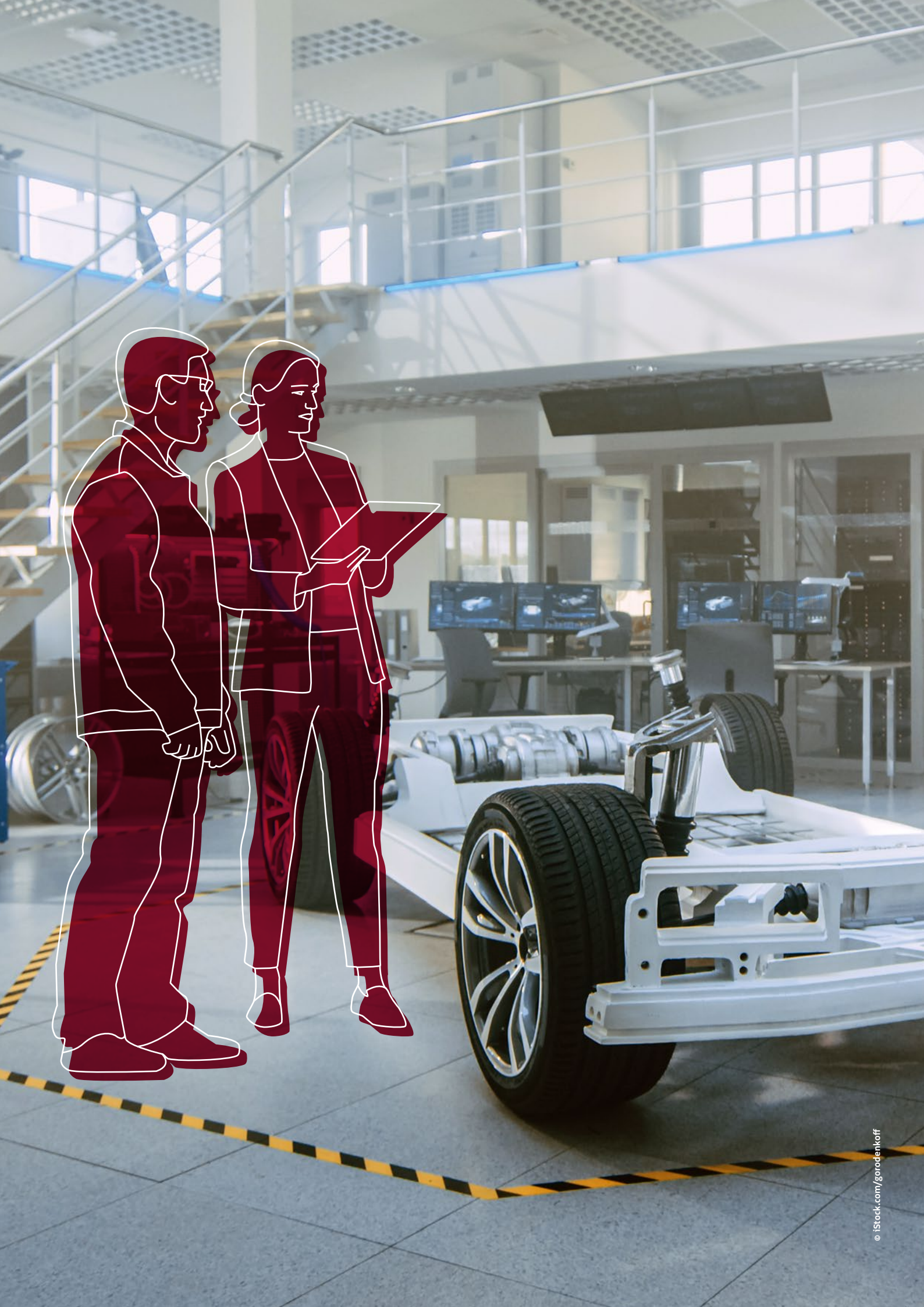
Further information

https://reallab-hamburg.de/en

THE NPM PRACTICE LABORATORY: REALLABOR DIGITALE MOBILITÄT, A REAL-WORLD LABORATORY IN HAMBURG WORKING ON DIGITAL MOBILITY SOLUTIONS

In the Reallabor Hamburg, a real-world laboratory, the digital mobility of tomorrow is being tested in the here and now of a future-orientated and innovative metropolis. The key aim of the RealLabHH project is to gain knowledge on new technologies and viable business models. The intention is for the findings to be used throughout Germany and recommendations for action for the redesign of the mobility system to make it better for the environment and the climate are to be derived from this, followed also by a quantified contribution to the goals of WG 3 – for example how actual changes in the mobility behaviour of people can be achieved. It also shows how a results-orientated and concerted collaboration between people from industry, civil society, government, federal states and local authorities can work.

Figure 16: Overview of sub-projects carried out at the real-world laboratory in Hamburg (Source: NPM)



3.4 INDUSTRIAL LOCATION OF THE FUTURE: ESTABLISHING NEW VALUE CREATION CYCLES, SHAPING CHANGE TOGETHER

HOLISTICALLY EQUIPPING THE INDUSTRIAL LOCATION OF GERMANY FOR THE FUTURE OF MOBILITY

The companies in the mobility sector, with several million employees, play an important role for Germany as a place of industry and business. The automobile industry, as part of this sector, is the industry with the highest turnover in the country, a complex value creation network made up of vehicle manufacturers of different sizes with more than 800,000 direct employees. It is also intertwined with a number of other industries. In order to achieve an ecologically sustainable and at the same time socially acceptable change in our mobility, the companies in the mobility sector must be set up for the future. This is a task for the whole of society, one that cannot be achieved by individual stakeholders alone. Rather, holistically preparing the industrial location of Germany for the future of mobility means:

1. Identifying the key areas for new industrial value creation, analysing them systematically and advancing the development of value creation cycles for climate-friendly technologies

and at the same time

2. actively supporting the resulting change in value creation and employment together with all partners at the different levels.

DEVELOPING VALUE CREATION CYCLES THAT ARE STABLE, INNOVATIVE AND MEET PEOPLE'S NEEDS

The success of the German and European automobile industry will depend on whether the components for new drive concepts can be manufactured competitively in the long term within Europe on a large industrial scale. For the automobile industry the focus is particularly on the core components of the electric drive system, battery (cell), fuel cell, power electronics and electric machine and the reorganisation of the existing production structures for internal combustion engines.

ANALYSIS OF VALUE CREATION NETWORKS

- Battery cell production and recycling
- Fuel cell
- Electric machine
- Power electronics
- Combustion engine drive systems

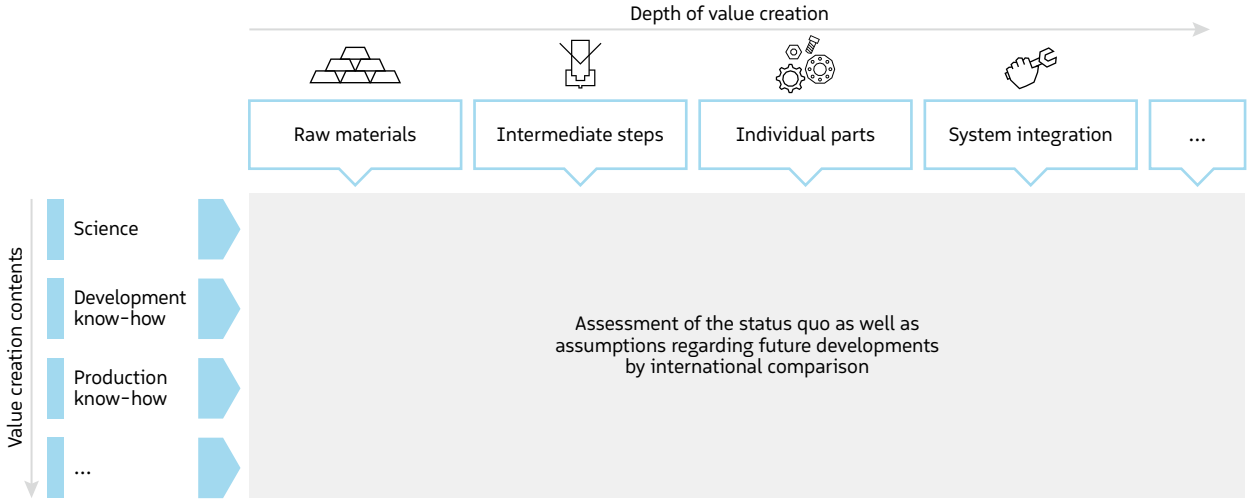


Figure 17: Analysis of value creation networks (Source: NPM)

For sustainable use of electromobility, the entire value creation chain of the core components should always be considered and the closed-loop circulation of components and materials taken into account from the very beginning. The closure of the value creation chain is not only of central importance from an ecological and social point of view. Because the material costs largely determine the overall costs of battery and fuel cells, closed value creation cycles can also become a competitive factor with the increasing spread of electromobility.

The basis for the competitiveness of the place of production and thus also for employment is therefore to build or expand, as completely as possible, stable and, in terms of sustainability, closed value creation cycles of future mobility technologies that meet people's needs in Germany and its European environment.

STRENGTHENING INNOVATIVE POWER THROUGH RESEARCH AND DEVELOPMENT PROGRAMMES

As a key pillar of the worldwide success of the German automobile industry, innovative energy remains a decisive lever for differentiation in international competition for the technologies of the future too – innovations to close the value creation cycles through the recycling of components and raw materials can just as much contribute to the competitiveness of the industrial location as innovations to increase the efficiency of raw material use, replace critical raw materials and reduce costs in production.

Compared to non-European competitors, German and European companies have some catching up to do in the areas of research, development and production of battery cells and materials, components of power electronics and fuel cell components and materials. Precompetitive, cross-company research, supported by state research funding, is crucial for Europe to be able to catch up with the international market leaders. To position the EU

as a forward-looking place of innovation and production in the international competitive environment, research and development (R&D) must continue to be supported in a targeted manner and intensified, especially in terms of scaling production for a cost-efficient mass production of fuel cell and battery technology and for alternative raw materials and materials in the development of new technology generations with the aim of greater independence from critical sources.

LOCATION FACTORS AND FRAMEWORKS FOR A COMPETITIVE PLACE OF INDUSTRY

The creation of future and planning security and thus incentivisation of investments in the development and expansion of production structures and in R&D for future technologies requires the right framework. This includes in particular setting international standards to ensure fair competitive conditions and market access, increasing the market attractiveness of technologies by expanding the charging or hydrogen refuelling infrastructure, making available sufficient energy from renewable sources and at competitive prices and making available qualified staff.

CHANGING EMPLOYMENT: RECOGNIZING AND PROACTIVELY SHAPING CHANGE

The mobility industry in Germany needs qualified experts and trained professionals to research, develop, produce, maintain and repair the vehicles with which we will be travelling in the future. However, job profiles and skills requirements shift with the change in drive system: jobs are being cut in the production of internal combustion engines, while there are new jobs in the growing production structures for electric vehicles and their components. This change in employment must be recognised and proactively shaped at all levels of the automobile industry, from the small and medium-sized companies to the regional and national economic structures to avoid a lack of qualified personnel for the new technologies as well as the loss of employment during the transformation. Strategic personnel planning in the companies and the joint organisation of qualification measures in the regions can help shape the change without going through a shortage of skilled workers and unemployment.

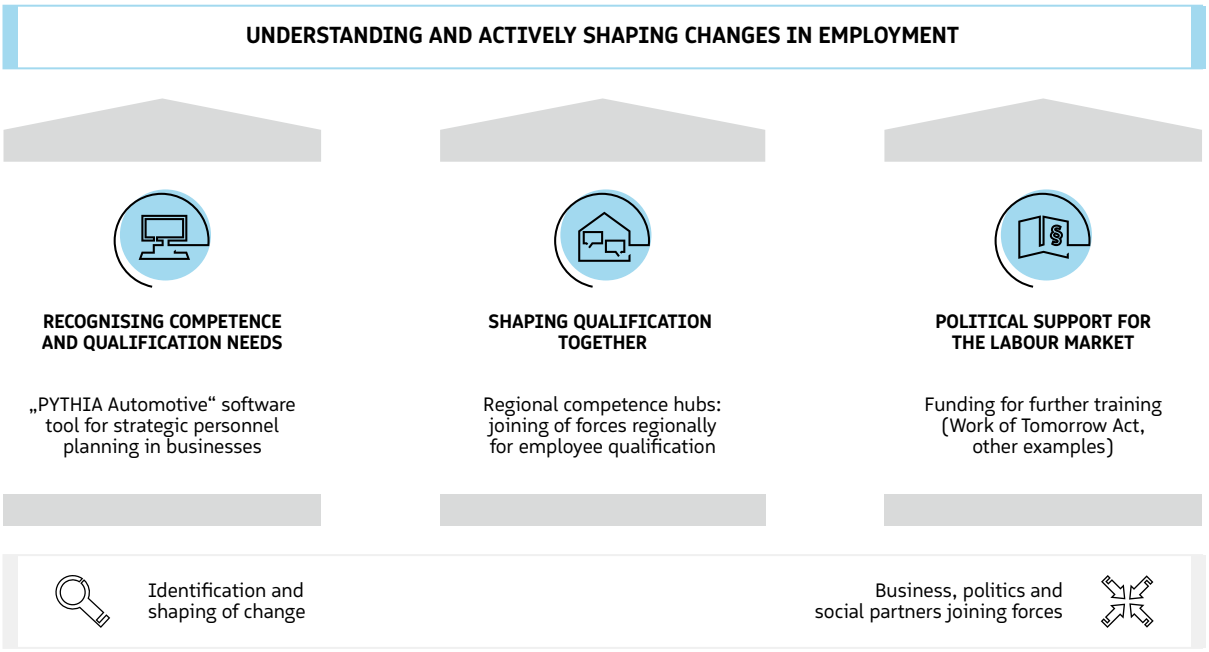


Figure 18: Understanding and actively shaping changes in employment (Source: NPM)

IDENTIFYING PERSONNEL NEEDS WITH A NEW SOFTWARE TOOL

Small and medium-sized enterprises (SMEs) make up over 90 %[21] of the supplier base of the automotive sector and are therefore of great significance for the German automobile industry. Because of its great capacity for innovation, the transformation of mobility can open up new opportunities for SMEs if they are able to actively deal with change and easily overcome typical barriers such as a lack of suitable qualified personnel. The development of the software tool "PYTHIA Automotive" for strategic personnel planning is intended to support SMEs to better understand their future personnel needs and identify targeted personnel and qualification measures to ensure competitiveness. In 2021, the Federal Ministry for Labour and Social Affairs, as a partner of the NPM, financed the sectoral adjustment of the cross-industry PYTHIA tool funded by funds from the Initiative Neue Qualität der Arbeit (INQA) (The Initiative New Quality of Work) for the advanced tool PYTHIA Automotive. This Excel-based tool enables companies from the supply industry and automotive trade and automobile service providers a free, uncomplicated introduction to the planning of their future personnel base and contains numerous incentives for users to engage with the impending change in the automobile industry. It allows an evaluation of the current workforce structure and the workforce structure needed in the future, depicts the gap between the two and provides opportunities to define measures to close the gap.

PYTHIA Automotive software tool

21 See Ifo Institut (2021): Strukturmerkmale Automobilindustrie [Structural features of the automobile industry) (accessed 29/04/2020, updated 23/02/2021) based on: Federal Office of Statistics; Federal Employment Agency; ifo business surveys; World Input Output Database (WIOD); Alipour et al. (2020). URL: https://www.ifo.de/sites/default/files/2020-05/strukturmerkmale_automobilindustrie.PDF [accessed 08/09/2021]

REGIONAL COMPETENCE HUBS: SHAPING QUALIFICATION IN THE REGIONS TOGETHER

Relevant stakeholders (companies, the federal employment agency, chambers of commerce and industry, educational providers, associations and professional organisations) can network with each other at federal state level to coordinate their activities and together overcome the challenge of educating and training employees for the mobility of the future with combined forces. As part of the competence hubs, specialists for digital transformation and change management can, for example, be trained, exchanging ideas with one another and with external partners within the framework of the hubs and forming a network of "key representatives" within companies for quick cross-company distribution of successful qualification strategies. Competence hubs can also fulfil the important function of regional hubs to shape the transformation to be future-proof and achieve the common goal of all stakeholders which is avoiding unemployment and instead enabling work-to-work changeover.

The NPM's concept of regional competence hubs has been in practice since the beginning of 2020 as an example in three federal states with very different starting positions. The competence hubs build on existing initiatives that already fulfil the function of networking in many places, promote synergies, from the point of view of the NPM bring in other necessary functions and only establish new initiatives where there has been no networking space so far. The findings from testing the pilot hubs can be used after completion to adapt the concept for different regional circumstances and make them usable nationwide as needed. The concept of further training activities in the network is also supported by the federal programme "Aufbau von Weiterbildungsverbünden" ("establishment of training networks") run by the Federal Ministry for Labour and Social Affairs.[22]

COMBINING FORCES AND ACHIEVING MORE TOGETHER

To ensure the most comprehensive view possible, but especially also so that knowledge and concepts were able to develop effectiveness in practice, there has been close networking with other projects and initiatives to support the transformation. This was how the position paper on battery recycling was created in cooperation with, among others, the Circular Economy Initiative Deutschland and the accompanying research from IPCEI-Batteries from the Federal Ministry for Economic Affairs and Energy (BMWi), carried out by VDI/VDE-IT. The findings from the WG work have, for example, been incorporated into the ongoing processes of the Concerted Action for Mobility (KAM) and in the transformation dialogue of the Federal Ministry for Economic Affairs and Energy (BMWi) and the associated four regional dialogues. They are also included in the debates within the expert panel on automobile future funds, Task Force 35c of the platform Industrie 4.0 and the *White Paper 35c „Technologietransfer als Schlüssel des Transformationsprozesses" ("Technology transfer as a key to the transformation process")* and the *"Ideenskizze zur Integration der Mitarbeiter- und HR- Perspektive in die Transformation der Fahrzeug- und Zuliefererindustrie" ("Idea sketch for integrating staff and HR perspectives into the transformation of the vehicle and supply industries")* involving the Fraunhofer IAO, Arena 2036, IG Metall and Continental. Important findings and recommendations from the analyses on employment change were incorporated into the legislation processes, for example to adapt the socio-political framework by opening up short-time work to attend training in the Work of Tomorrow Act.

Report WG 4

1st Interim Report on Strategic Human Resources Planning and Development in the Mobility Sector

Report WG 4

Position Paper "Qualitative Consideration of the Battery Recycling Value Creation Network"

22 In the funding guidelines published on 6th August 2021 „Aufbau von Weiterbildungsverbünden zur Transformation der Fahrzeugindustrie" ("establishment of training networks for the transformation of the vehicle industry"), funding is available in particular for relevant joint projects with a focus on the automotive sector. As part of the funding projects, coordination sites connect, among other things, the individual stakeholders of an association, provide the companies with specific information, identify further training needs, provide impartial advice and lend support in the content design of new further training programmes.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3.5 MOBILITY AND ENERGY: SECTOR INTEGRATION AS A FACTOR OF SUCCESS IN THE TRANSITION TO SUSTAINABLE TRANSPORT

A holistic transition to sustainable mobility requires a systemic approach and needs the transport and energy sector to be thought of together (sector integration). Sector integration is a key component of a sustainable mobility system and connects not only the vehicles but also the energy sources used, the required infrastructures and services. Sector integration is succinctly expressed by the new physical unit of the transport sector: the kilowatt hour (kWh). A success factor for sector integration is the close, cross-industry exchange on unresolved issues and regulatory recommendations for action, as is possible in the context of the NPM.

This exchange between the sectors ultimately supports the vision of WG 5 of a needs-based, i. e. technological, quantitative and timed development of both vehicle ramp-up and infrastructure expansion and thus also the sustainable and profitable development and operation of the charging and refuelling infrastructure.

CHARGING INFRASTRUCTURES AS DYNAMIC SYSTEMS

In order to make the development and operation of charging and refuelling infrastructure sustainable, demand is a crucial parameter. Looking at the charging infrastructure, this is not just a matter of the mere number of public charging points for example, but is based on the needs of the users. Who uses the public charging system and how many kilowatt hours are used? How many vehicles can charge rapidly and what output is needed? And how big is the range of vehicles and how far are their daily journeys? All these questions are critical to be able to best satisfy people's charging needs. It becomes clear that there is a great technological and user-driven dynamic in the demand that must always be taken into consideration when expanding the infrastructure. Since a fixed target value does not reflect this dynamic, a dynamic demand model is needed that takes into account the development of the number of vehicles, the vehicle technology, the areas of application and the charging and refuelling behaviour of the users. This dynamic understanding forms the basic idea of the work carried out by WG 5 and is clearly demonstrated in the dynamic model for a needs-based and profitable charging infrastructure (see Figure 19), where four scenarios are considered which differ in their parameters for the proportion of public and private charging and the proportion of normal AC charging stations and fast DC charging stations.

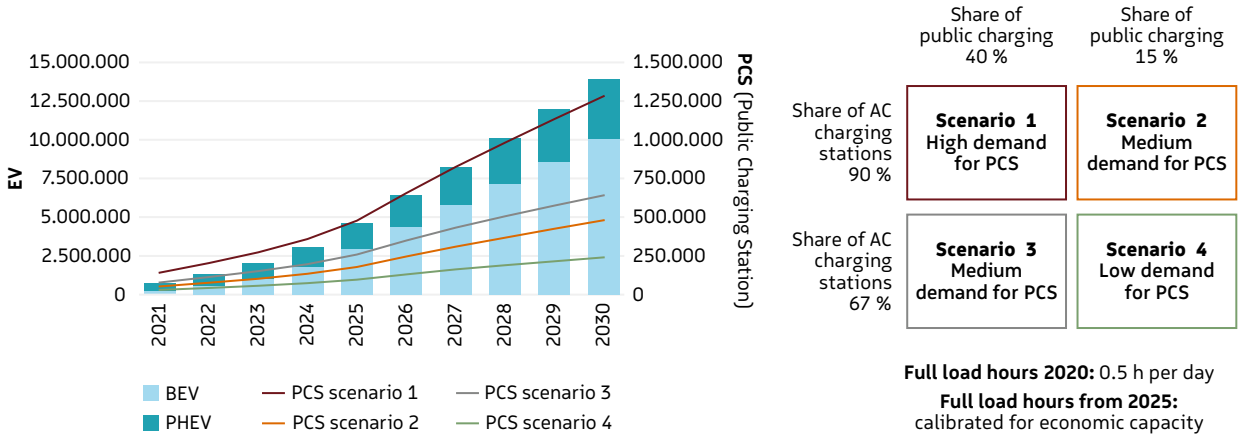

Figure 19: Ramp-up of electromobility in Germany and scenarios for the charging infrastructure need (Source: NPM)

SUSTAINABLE OPERATION INSTEAD OF PERMANENT SUBSIDIES

At the present time, public charging and refuelling infrastructures are not yet economically viable despite existing funding programmes. This is mainly due to a degree of utilisation that is too low, but also due to regulatory and technically driven, cost-intensive retrofits. To guarantee a needs-based and therefore sustainable infrastructure that does not have to be permanently supported by subsidies, taking account of the perspective of profitability is key. Only a profitably operated charging and refuelling infrastructure will ensure sustainable competitive and innovative drive in the market. With hydrogen mobility in mind, key customers, such as shipping agencies or public transport companies, can offer perspectives on profitability, especially in the initial phase.

The funding and financing programmes should always take into account that they are contributing to needs-based expansion and are designed for profitable utilisation, thus avoiding permanent subsidies.

MONITORING THE PROGRESS OF NATIONWIDE CHARGING AND REFUELLING INFRASTRUCTURE

A nationwide public infrastructure ensures that users of vehicles with alternative drive systems can cover the same distance as users of conventional vehicles. A decisive factor is the number of locations and their distribution and the option of either scaling or adding more filling stations/charging points to the network retrospectively at locations with high utilisation (as of mid-2021 see figure 20). Regular monitoring is needed to be able to determine which regions do not yet have any area coverage. Without this there is a danger of an infrastructure that is not needs-based or economically viable due to incorrect sizing or funding that bypasses charging requirements.

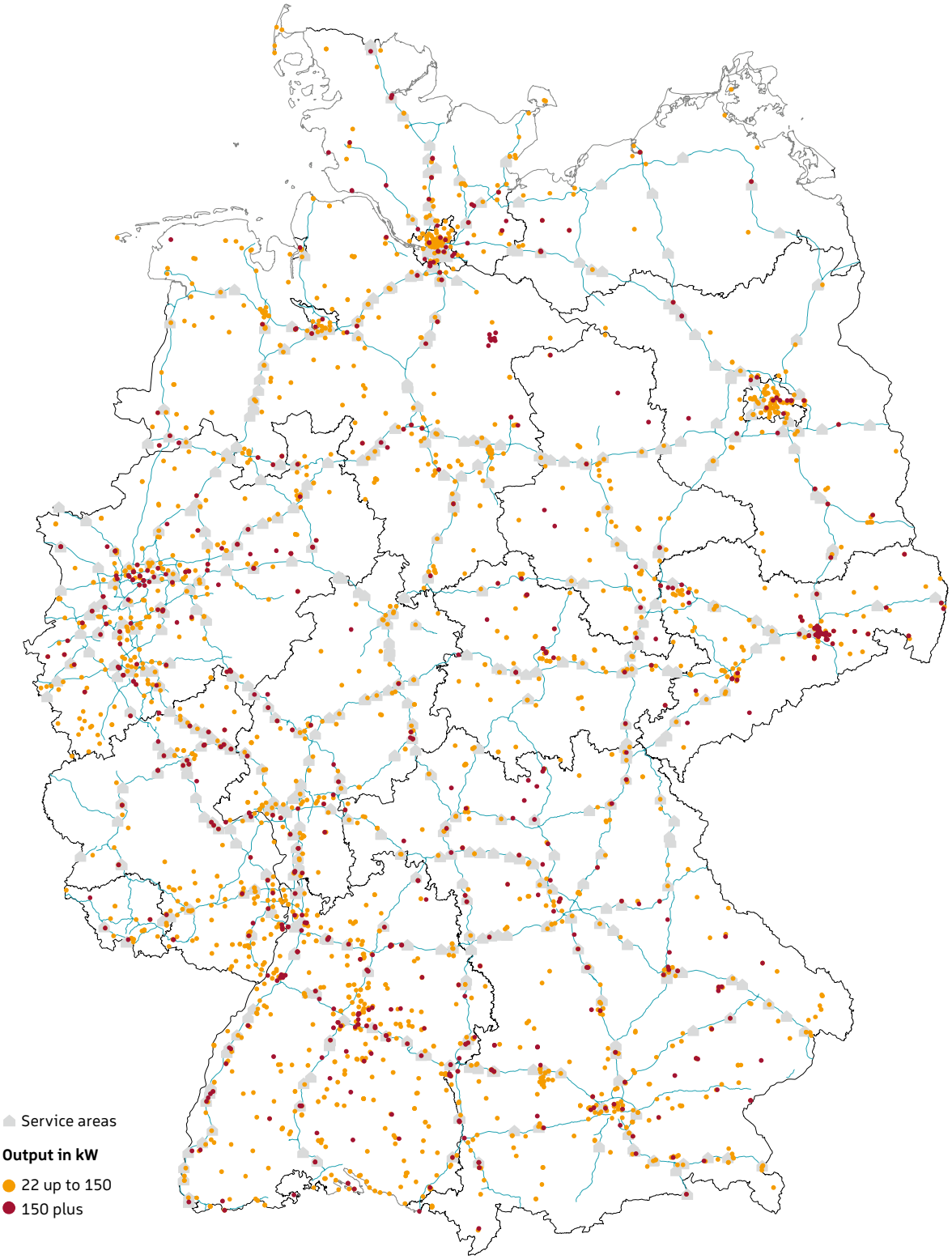

Figure 20: Publicly accessible charging points for electric cars (Source: www.ladesaeulenregister.de)

POWERFUL GRIDS FOR SUCCESSFUL SECTOR INTEGRATION

When it comes to the infrastructure, there is not only the issue of charging infrastructure requirements, but also the question of how electromobility can be successfully integrated into the power grid. It is clear that electromobility in the power grid represents a new "consumer type" in terms of load behaviour and its possible peak demand and going forward also a new storage type that can feed back into the grid. The analyses carried out by WG 5 show that a sharp increase in electromobility does not pose a problem in terms of area coverage thanks to the powerful grids in Germany, but that local bottlenecks may arise if many private charging stations are connected to a low-voltage line at the same time. In addition to the willingness to finance further grid expansion, the important thing here, therefore, is for the grid to be able to be expanded quickly on the one hand and on the other hand for there to be an explanation as to how the grid integration of electromobility should take place legally and technically. A key issue for WG 5 was therefore the development of a common understanding between the industries as to what the grid integration can look like and what is required for it (see Figure 20).

	GRID OPERATOR	CUSTOMER/SUPPLIER
GRID COMPATIBILITY	Grid operator does not influence output.	Customer's facility is operated within the contractually agreed obligations, if necessary, using load management.
GRID SERVICEABILITY (CURRENTLY PRIMARILY ON THE BASIS OF THE §14 A AGREEMENT)	As a result of load monitoring, the grid operator influences subscribers' load behaviour: a) time slots b) ad-hoc control signals c) financial incentives	Customer's facility implements information received from the grid operator.

Figure 21: Technical mapping of grid compatibility and grid serviceability (Source: NPM)

The key here is above all a common understanding of the issue of smoothing out possible peak demands. On the one hand, this can take place solely from the point of view of the customer and be geared towards compliance with the obligations contractually agreed with the grid operator. It would be "grid-compatible" in the sense that the grid is not used beyond the agreed output. On the other hand, the smoothing out of the peak demands can take place through the grid operator controlling the load behaviour of the party connecting into the grid, for example using time/load windows, ad-hoc control signals or financial incentives. This procedure is "grid-friendly" in the sense that it not only complies with the agreed obligations, but enables efficient grid expansion and can also support grid operation (see Figure 15). The vehicle-to-grid (V2G) technology or bidirectional charging, i.e. the needs-based feeding in and out of electricity from the battery, represents, according to this basic understanding, a possibility for grid-friendly charging. However, this needs a clearly defined framework and the legal and technical possibility of controlling the private charging infrastructure.

AMBITIOUS EXPANSION OF RENEWABLE ENERGIES

Regardless of whether infrastructure is expanded for electric or fuel cell vehicles, in both cases this is due to an increasing need for renewable electricity in the transport sector, which has to be initially generated and then transported from one place to another. Rapid expansion of renewable energies is essential for these new requirements to be met and requires greater expansion ambitions, more space, fewer bureaucratic hurdles and broader social acceptance.

CROSS-INDUSTRY COLLABORATION: A SYSTEMIC APPROACH IS CRUCIAL

The reports and results from WG 5 are based on the systemic idea of sector integration, i.e. linking the energy and transport sectors, with the kilowatt hour as the common physical unit. This systemic idea is also therefore important because the new ecosystem of electromobility, in particular, can only be understood holistically, for example the idea that charging is not the same as refuelling, but includes completely new functions and possibilities. This is central to the development of attractive products, infrastructures and services for users, and also to establishing the appropriate, supporting regulatory framework.

A prime example of the requirement to work together across industries when developing the electromobility ecosystem is the implementation of the communication standard ISO 15118. Depending on the version used, this supports a variety of functions, for example Plug & Charge and Vehicle2Grid. However, this communication standard and the business model it supports cannot be implemented unilaterally by one market role, but require the cooperation of the entire value creation chain. This not only includes technical issues. Rather, it must also be clarified for the new business models how the market roles can participate equally in these. This becomes clear just from the market issues that are to be clarified to ensure users' freedom of choice when using the Plug & Charge function – i.e. for the digital filing of charging contracts in their vehicles (see Figure 16).

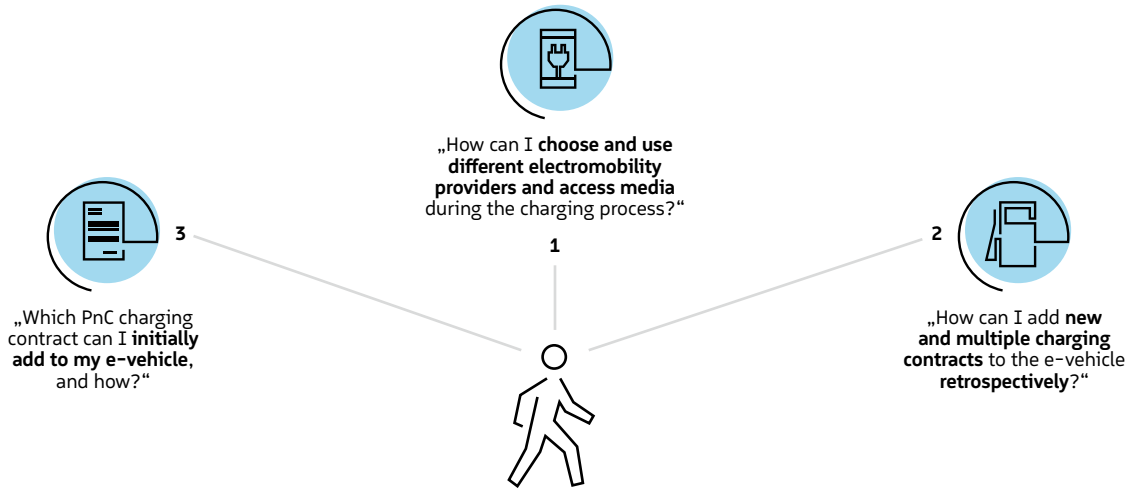

Figure 22: Needs of users when charging will be placed at the centre as ISO 15118 develops (Source: NPM)

The extremely complex hotchpotch affecting implementation was successfully recorded in a joint work package completed by WG 5 and WG 6 (see WG 6 chapter). The associated report forms a central basis for the further work to be done in the industries to implement ISO 15118.

The example shows that the exchange on unresolved issues across industries and regulatory recommendations for action, as is possible within the NPM, will, in light of the huge changes in the mobility sector, be a key factor for the success of the transition to sustainable transport.

Report WG 5

Demand-oriented and economical public charging infrastructure – plea for a dynamic NPM model

Report WG 5

Key Findings and Recommendations – Achievements and Open Issues

3.6 LIMITLESS MOBILITY: CHANGING REQUIREMENTS OF STANDARDS AND NORMS

The transformation of the mobility system brings with it a multitude of new requirements in standardisation. The cross-industry interlinking between automobile technology, electric and energy technology and information and communication technology is accelerating increasingly. The sectors of transport, buildings, industry, infrastructure and energy are growing together and must be intelligently linked with each other. Standards and norms play a crucial role at this point – they are the key to connected systems. The required compatibility, interoperability and the security of the diverse mobility systems and their linking with all other sectors of the economy and society can be produced via defined interfaces.

To meet this huge challenge, the NPM is pursuing a holistic approach in focussing on norms, standardisation, type approval and certification. The main themes were identified in a broad, cross-interest dialogue and initial standardisation requirements deduced.[23] This strategic guide formed the content framework for the focus roadmap that was developed where the individual inter-related themes were successfully examined and specific recommendations for action for further or new development of standards and norms were drawn up that serve as trailblazers for the future of mobility.

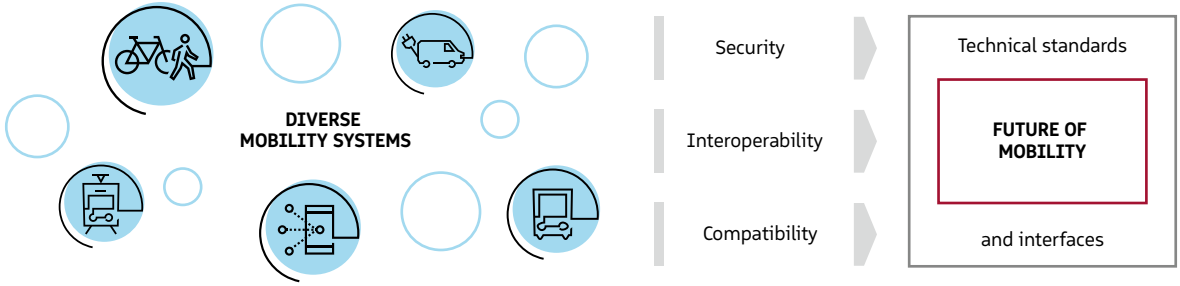

Figure 23: Standards and norms are trailblazers for the future of mobility (Source: NPM)

SUSTAINABILITY IS BECOMING A KEY THEME IN STANDARDISATION

The topic of sustainability and compliance with nationally and internationally agreed climate action targets is an overarching challenge of the entire mobility system of the future. For the first time, the NPM specifically examined and demonstrated what specific contribution standards and norms can make to creating a sustainable transport system,[24] with the recommendations going beyond merely considering the technical aspects and opening up a comprehensive view of the topic of sustainability. Standards and norms particularly offer added value by making sustainability measures assessable and comparable and enabling their transparency.

Accounting provides great leverage for example. It is an essential component for transparency in a sustainable mobility system. An international harmonised standardisation enables accounting according to globally standardised criteria. This is especially significant for globally distributed value creation chains as are used in vehicle construction, for example. The goal of accounting should be to develop a uniform

23 See NPM WG 6 (2019): White Paper Aktuelle Entwicklungen und Herausforderungen zur Zukunft der Mobilität [White paper on current developments and challenges for the future of mobility].
24 See NPM WG 6 (2020): Schwerpunkt-Roadmap Nachhaltige Mobilität – Standards und Normen [Focus roadmap on sustainable mobility – standards and norms].

system where the modes of transport can be compared depending on their use and taking into account the framework conditions and the associated emissions. In order to achieve this for the overall mobility system, standardisation activities are necessary to establish an accounting framework and create a standardised ICT architecture and organisation. Figure 18 shows a suggestion as to how such ICT architecture could be designed.

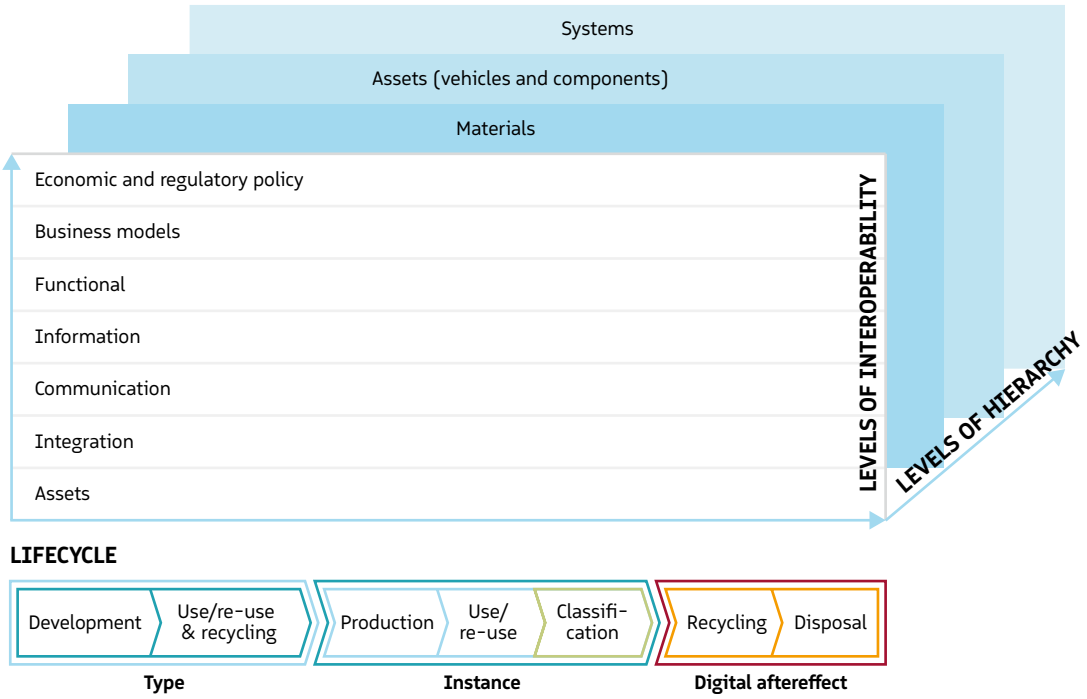

Figure 24: Suggestion for mobility reference architecture model (Source: NPM)

To achieve a sustainable life cycle assessment, the materials must be able to be re-used or recycled. Because of the complexity of today's products, consisting of a multitude of materials and substances, an integrated life cycle management is needed where the product design is already based on sustainably recoverable materials, their long life and later reuse or recycling. The standardisation activities to enable digitalisation and increase the transparency of supply chains are also of particular importance.

COMMON STANDARDS AND NORMS ARE BASIC REQUIREMENTS FOR THE IMPLEMENTATION OF INTERMODAL MOBILITY

There is additional potential in digitalisation to make the mobility system both more sustainable and customised and needs-based. Intermodality in particular, i. e. the combined use of different modes of transport on one travel route, shows great potential for expansion, but also complex hurdles and challenges.[25] Digital services and applications provide the opportunity to offer users an integrated mobility package containing a continuous range of services from information and booking through to payment and billing across the entire mobility chain. Intermodal mobility platforms provide the key to being able to offer the services mentioned seamlessly from a single source.

However, in reality, there are various barriers to data use along the mobility chain as a result of missing or unconnected services. A major deficit is the lack of standards for intermodal information services, booking and billing of mobility services. Among the mobility providers, there is still a lack of common interest in creating intermodal mobility in the form of an integrated package within one application, such as for example with regard to the agreeing on/determining the topics of data exchange, interfaces, standards to be used and guidelines and agreements. The NPM therefore recommends the implementation of a moderation process involving all relevant stakeholders to clarify which agreements and measures are necessary to create an overarching interest in developing standards and norms for intermodal mobility.

New technical standards and interfaces also offer the possibility for contracts to be automatically negotiated. In this way, new mobility providers can be integrated into a platform-based intermodal mobility package. In the same way, a lack of standardisation of organisational parameters (e. g. IDs for trips and routes, tariff provisions) or standardisation that is not applied also makes digitalisation and therefore the provision of intermodal services more difficult. Appropriate norm and standardisation activities to solve these barriers should be initiated as quickly as possible.

STANDARDS AND NORMS SUPPORT THE IMPLEMENTATION OF SUSTAINABLE INNOVATIONS IN THE MARKET

For the rapidly growing area of electromobility, the NPM identifies intelligent load management as a key component in successfully linking the mobility and energy sectors.[26] The increasing number of charging processes as a result of the market ramp-up of electromobility pose major challenges for the power grid. These foreseeable, mainly isolated loads on the power grid must be balanced so that the power grid is stable. This assumes that the charging infrastructure can communicate with the vehicles and the power grid in all directions and be intelligently managed. The further development and implementation of the ISO 15118 series of standards is of particular importance in this context, especially with regard to the nationwide use of Plug & Charge and Vehicle2Grid functions that offers users considerable added value.[27] In this context, Figure 25 shows which market roles and communication routes beyond the vehicle and charging point are necessary to establish the Plug & Charge functionality in the electromobility ecosystem.

25 See NPM WG 3 and WG 6 (2021): Daten und Vernetzung – Standards und Normen für intermodale Mobilität [Data and networking – Standards and norms for intermodal mobility].
26 See NPM WG 6 (2020): Schwerpunkt-Roadmap Intelligentes Lastmanagement [Focus roadmap on intelligent load management].
27 See NPM WG 5 and WG 6 (2020): Roadmap Implementierung der ISO 15118 – Standardisierte Kommunikation zwischen Fahrzeug und Ladepunkt [Roadmap to the implementation of ISO 15118 – Standardised communication between vehicles and charging points].

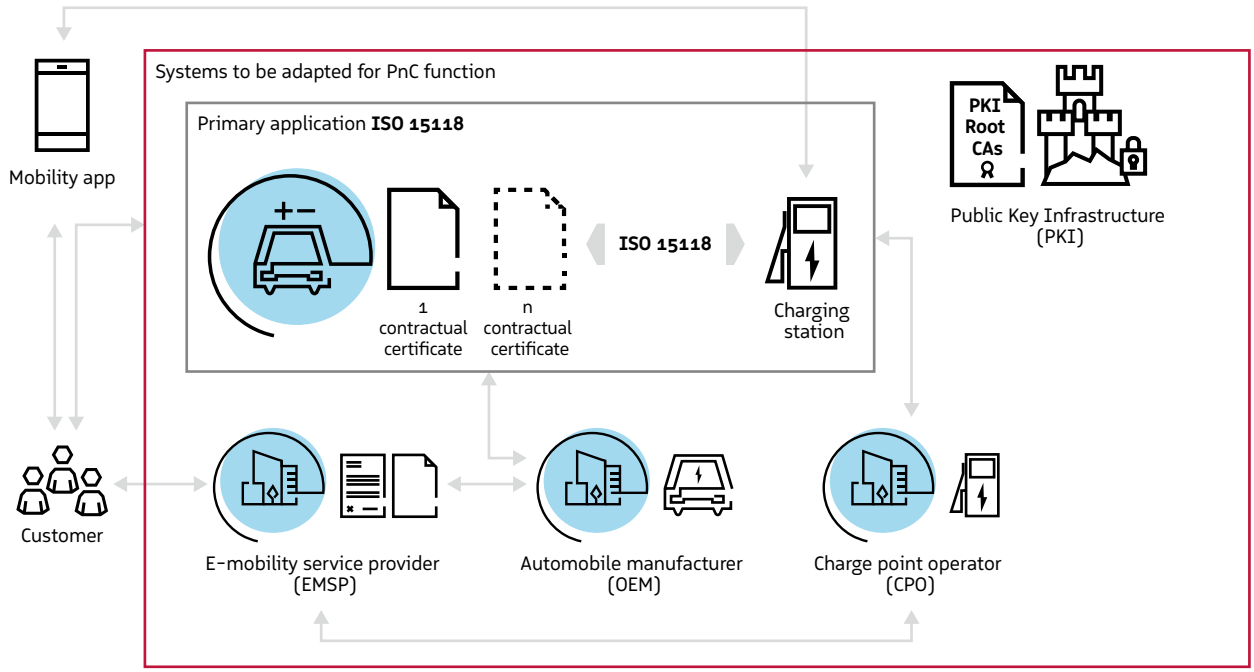

Figure 25: Simplified diagram of the market roles and communication routes required for the Plug & Charge function (Source: NPM)

Another area where action is needed is the further development of automated and connected driving. This increases the complexity of the product, the requirements for interoperability and the infrastructure.[28] The redesign of type approval and certification processes in the automotive sector is also associated with it. Even today, products or their function can be changed today during their useful life through technical further development and digitalisation. The currently valid processes for registration, type approval and periodic monitoring must in future ensure that these changes do not affect safety in road traffic and protection of the environment continues to be guaranteed.[29]

STANDARDS AND NORMS MUST BE ENSHRINED IN INTERNATIONAL LAW AND IMPLEMENTED

Dealing with the individual topics revealed a variety of interactions between different areas and sectors in the mobility system. However, despite all the complexity, the diverse opportunities of developing the mobility sector into a functioning, sustainable overall system in the context of a cross-sector integration and connection of all areas of the economy and society are just as evident. Important groundwork was done with the identification of the necessary standardisation needs and deriving appropriate recommendations for action for the future of mobility. It will be im-

28 See NPM WG 6 (2020): Schwerpunkt-Roadmap Automatisiertes und vernetztes Fahren [Focus roadmap on automated and connected driving].
29 See NPM WG 6 (2020): White Paper Handlungsempfehlungen zur Typgenehmigung und Zertifizierung für eine vernetzte und automatisierte Mobilität [White Paper on recommendations for action on type approval and certification for connected and automated mobility].

portant to introduce these recommendations into the national and international standardisation bodies and push them forward. To this end, the NPM maintains a close cooperation with the German standardisation organisations (DIN/DKE) and the Federal Ministry for Economic Affairs and Energy (BMWi). Many of the recommendations for action have already been implemented or initiated as a result.

The NPM is also actively involved in ensuring that national or European harmonised standards attract global attention. In the area of electromobility, for example, a close collaboration within the German-Chinese Commission for Standardisation (DCKN) is taking place. As part of this technical dialogue, topics such as "charging with higher charging capacities", "wireless charging" and "safety requirements for electric vehicles" are discussed and developed together. Similar formats for strategic collaboration with Japan and South Korea are being developed.

Overall, it is evident that the development and implementation of national and international harmonised standards and norms are a core element for the future of mobility.

Report WG 6

Focus Roadmap Sustainable Mobility – Standards and Norms

Report WG 6

Data and Networking – Standards and Norms for Intermodal Mobility


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4 THINKING AHEAD FOR THE FUTURE OF MOBILITY

In the three years since its inauguration in autumn 2018, the NPM has outlined a holistic path to future-orientated mobility, with mobility needs, sustainable developments and innovations forming the foundation. The mobility system of the future will have to be user-friendly, highly connected across all modes of transport, data-driven and better for the climate, the environment and resources.

If a moderate transformation process was assumed when the NPM started, the mobility system and also the NPM have been challenged in the rapid developments of the last three years. It's still about realigning the mobility system in the long term, but the regulatory decisions on climate change mitigation, the consequences of the COVID pandemic for supply chains and digitalisation and the numerous funding programmes for the market ramp-up of electromobility, the charging infrastructure and economic recovery have greatly accelerated mobility transformation. With this in mind, the NPM had to accomplish short-term tasks to provide context for plug-in hybrid vehicles and the market ramp-up of alternative fuels and update the recommendations for action on climate change mitigation in transport delivered in 2019 after the climate action amendment in spring 2021. It is to be expected that the implementation of climate action targets by 2030 will result in serious changes, not just in the mobility system. In the remaining nine years, many technologies must be scaled, markets developed even more quickly and research and development intensified. The further path to cross-sector climate neutrality by 2045 keeps the pressure to act high and will trigger additional transformation processes. It is important here to maintain prosperity and jobs.

Since its appointment, the NPM has developed recommendations for action for the future of mobility with six working groups focussing on specific topics of mobility, the steering committee as a decision-making body, the advisory commission as a bridge to parliament and the office as a coordination point. This was possible because the platform offered space for a solution-orientated exchange and open dialogue between different stakeholders with very different perspectives and starting points when it comes to mobility. The NPM has compiled, checked and processed important facts relevant for the future of mobility, made and applied connections, demonstrated different positions and formulated specific recommendations to politicians, economists and people in society.

WHAT INSPIRES THE FUTURE OF MOBILITY

The future of mobility is and remains a highly dynamic field. In the last three years, the NPM has dealt with many issues that this field brings up, putting its own stamp on it. The following areas will gain (even more) in importance in the further development of an affordable, sustainable and climate-friendly mobility:

- Strengthening the resilience of the mobility system vis-a-vis the consequences of climate change and the risk of global events
- Developing government support and funding programmes for new mobility forms, avoiding a system of permanent subsidies
- Defining mobility scenarios (through policy-makers with scientific advice) to provide a reliable framework for action to the stakeholders affected
- Focussing on an offer of alternative drive systems, fuels and infrastructures with a reliable legal framework that is economically self-sustaining in the long term
- Consistently implementing sector integration, expanding renewable energies, energy imports, energy pricing (taxes, charges, levies)

- Developing economically and ecologically sustainable, competitive value creation cycles, which guarantee the security of raw material supply and realise employment potential in Germany and Europe
- Ensuring permanently active federal, state and regional political support of the effects on employment of structural changes of the mobility industry, support for companies and employees in qualifying for new areas of activity
- Digitalising the transport sector, especially the infrastructure, and implementing data-driven traffic management for effective traffic control
- Advancing the design of data-driven mobility – secure handling of data, cyber security, use of AI
- Developing standards and norms driving innovation for the use of artificial intelligence and digital twins in the mobility sector and for IT connectivity

Appropriate solutions for the technological and socio-ecological challenges associated with these areas can only be developed together, in an exchange where there is an atmosphere of trust between a large number of different experts from politics, the economy and science. It will be necessary in the future to combine data and facts in the mobility sector, analyse them and prepare them for political decision processes. The NPM has provided a blueprint for this evidence-based and dialogue- and result-orientated working mode for policy-makers to use.

TAKING THE PATH OF CHANGE WITH USERS

In addition to the structured expert dialogue that has been introduced, the social dialogue must be given even greater prominence in the further discussions about the future of mobility. After all, the mobility transformation can only succeed if the local population supports the changes across all modes of transport and integrates the new solutions into their everyday life. The social dialogue helps to expand factual knowledge in the population, integrate lay perspectives early on, show the possibilities and limits of the new mobility system, support political deci sions in the field of mobility and make it understandable to everyone. As part of this dialogue process, which can be designed in different formats, the users and their mobility needs are the focus.

The range of topics for social dialogue for the future of mobility is huge – climate change mitigation and environmental protection, health, infrastructure and justice issues in mobility, such as for example the increasing competition for space in cities. Added to this are new technologies such as automated and connected driving and digital mobility platforms and the associated data rooms.

HOW THE TRANSFORMATION CAN BE PURSUED FURTHER

The vision of a forward-looking mobility system integrating all modes of transport, and one that is sustainable and affordable, will not be easy to achieve – all those involved from the world of politics, the economy, science and civil society will always have to be willing to compromise and make concessions. Politicians must provide support with frameworks and guiding principles so that consumers and employees, industrial locations and regions and companies and research facilities can adapt and align their knowledge, their investments, their developments. This also applies with regard to a new federal government or far beyond the NPM's mission ending in December 2021.

To be able to continue to shape the mobility of tomorrow holistically, a systemic and cross-stakeholder approach remains important. Complex relationships can only be understood, conflicting goals overcome and viable solutions developed in broad and intensive dialogue. The place of mobility, industry and innovation that is Germany is challenged like never before, strong and ambitious enough to master the necessary transformation, and able to write a success story from it.

5 NPM PUBLICATIONS

2021	
12/2021 Final report	**“Abschlussbericht AG 3 (Arbeitstitel)“ (in Bearbeitung)** **[“Final Report WG 3 (Working Title)“ (in process)]** Working group 3 – Digitalisation for the mobility sector
12/2021 Interim report	**“Autonomes Fahren als Baustein einer inter- und multimodalen Mobilität (Arbeitstitel)“** **[“Autonomous driving as a building block of inter- and multimodal mobility (working title)”]** Working group 3 – Digitalisation for the mobility sector
11/2021 Interim report	**“Schwere Nutzfahrzeuge – Standards und Normen für alternative Antriebe“** **[“Heavy-duty commercial vehicles – standards and norms for alternative drive systems“]** Working group 6 – Standardisation, norms, certification and type approval
10/2021 Results report	**Ergebnisbericht der Nationalen Plattform Zukunft der Mobilität “Mobilität von morgen ganzheitlich gestalten” [NPM Results Report “Tomorrow’s mobility – a holistic design”]**
10/2021 Interim report	**“Netzintegration von Elektromobilität – branchenübergreifender Konsens und Aufgaben für die nächste Legislaturperiode“ [“Grid integration of electromobility – cross-industry consensus and tasks for the next legislative period“]** Working group 5 – Connecting mobility and energy networks, sector integration
10/2021 Final report	**“Impulsbericht 2018-2021“ [“Report 2018-2021”]** Working group 4 – Securing Germany as a place for mobility, production, battery cell production, primary materials and recycling, training and qualification
10/2021 Interim report	**“Neue Impulse für Beschäftigung und Qualifizierung im Mobilitätssektor“** **[“Fresh momentum for employment and qualification in the mobility sector”]** Working group 4 – Securing Germany as a place for mobility, production, battery cell production, primary materials and recycling, training and qualification
10/2021 Interim report	**“Quantifizierung von Beschäftigungseffekten durch Leistungselektronik und Brennstoffzellenfahrzeuge“ [“Quantifying employment effects as a result of power electronics and fuel cell vehicles”]** Working group 4 – Securing Germany as a place for mobility, production, battery cell production, primary materials and recycling, training and qualification
10/2021 Interim report	**“Batterierecyclingmarkt Europa: Chance für eine nachhaltige Kreislaufwirtschaft“** **[“Battery recycling market Europe: opportunities for a sustainable circular economy”]** Working group 4 – Securing Germany as a place for mobility, production, battery cell production, primary materials and recycling, training and qualification
10/2021 Interim report	**“Batterieproduktion für Deutschland und Europa“ [“Battery production for Germany and Europe”]** Working group 4 – Securing Germany as a place for mobility, production, battery cell production, primary materials and recycling, training and qualification
10/2021 Interim report	**“Standards und Normen für die Mobilität der Zukunft“** **[“Standards and norms for the mobility of the future“]** Working group 6 – Standardisation, norms, certification and type approval
10/2021 Interim report	**“Kundenakzeptanz als Schlüssel für den Markthochlauf der Elektromobilität“** **[“Customer acceptance as the key to the market ramp-up of electromobility“]** Working group 2 – Alternative drive systems and fuels for sustainable mobility

07/2021 Interim report	**“Daten und Vernetzung – Standards und Normen für Intermodale Mobilität“ [“Data and connectivity – standards and norms for intermodal mobility“]** Working group 3 – Digitalisation for the mobility sector, Working group 6 – Standardisation, norms, certification and type approval
07/2021 Interim report	**“Mobilitätsbudget und digitalisiertes Parkraummanagement als Befähiger für inter- und multimodale Mobilität“ [“Mobility budget and digital parking management as enablers of inter- and multimodal mobility”]** Working group 3 – Digitalisation of the mobility sector
07/2021 Interim report	**“Zentrale Ergebnisse und Empfehlungen – Erreichtes und Offenes“ [“Key results and recommendations – achievements and open questions”]** Working group 5 – Connecting mobility and energy networks, sector integration
07/2021 Interim report	**“Infrastruktur für Wasserstoffmobilität“ [“Infrastructure for hydrogen mobility“]** Working group 5 – Connecting mobility and energy networks, sector integration
07/2021 Interim report	**“Energiewirtschaftliche Auswirkungen der Sektorkopplung – Energiebedarfe“ [“Impact of sector integration on the energy industry – energy needs“]** Working group 5 – Connecting mobility and energy networks, sector integration
07/2021 Interim report	**“Wege für mehr Klimaschutz im Verkehr“ [“Ways to improve climate action in transport”]** Working group 1 – Transport and climate change
03/2021 Interim report	**“Roadmap Markthochläufe Alternativer Antriebe und Kraftstoffe aus technologischer Perspektive“ [“Roadmap – Market ramp-ups of alternative drive systems and fuels from a technological perspective“]** Working group 2 – Alternative drive systems and fuels for sustainable mobility
03/2021 Interim report	**“Ladeinfrastruktur für batterieelektrische Lkw“ [“Charging infrastructure for battery-electric HGVs“]** Working group 5 – Connecting mobility and energy networks, sector integration
03/2021 Interim report	**“Positionspapier Brennstoffzelle“ [“Position paper on fuel cells”]** Working group 4 – Securing Germany as a place for mobility, production, battery cell production, primary materials and recycling, training and qualification
01/2021 Progress report	**Fortschrittsbericht 2020 der Nationalen Plattform Zukunft der Mobilität: “Mit Innovationen Transformation gestalten“ [“NPM Progress Report 2020: “Shaping Transformation with Innovations”]**

2020

12/2020 Interim report	**„Gesellschaftliche Dialog- und Beteiligungsstrategie zur Gestaltung digitalisierter Mobilität“ [“Social dialogue and participation strategy for shaping digitalised mobility”]** Working group 3 – Digitalisation for the mobility sector
12/2020 Interim report	**„Maßnahmen zur Digitalisierung der Verkehrsinfrastruktur“ [“Measures for digitalising the transport infrastructure”]** Working group 3 – Digitalisation for the mobility sector
12/2020 Interim report	**„Werkstattbericht Antriebswechsel Nutzfahrzeuge – Wege zur Dekarbonisierung schwerer Lkw mit Fokus Elektrifizierung“ [“Workshop report on the switch to alternative drives for commercial vehicles – ways to decarbonise heavy vehicles with a focus on electrification”]** Working group 1 – Transport and climate change
12/2020 Interim report	**„Werkstattbericht Alternative Kraftstoffe – Klimawirkungen und Wege zum Einsatz alternativer Kraftstoffe“ [“Workshop report on alternative fuels – climate effects and ways to use alternative fuels”]** Working group 1 – Transport and climate change

12/2020 Interim report	**„Roadmap zur Implementierung einer standardisierten Kommunikation zwischen Fahrzeug und Ladepunkt entsprechend der ISO 15118“ [“Roadmap to the implementation of standardised communication between vehicles and charging points as per ISO 15118”]** Working groups 5 – Connecting mobility and energy networks, sector integration and 6 – Standardisation, norms, certification and type approval
10/2020 Interim report	**„Schwerpunkt-Roadmap Nachhaltige Mobilität – Standards und Normen“ [“Focus roadmap on sustainable mobility – standards and norms”]** Working group 6 – Standardisation, norms, certification and type approval
10/2020 Interim report	**„Factsheet Vehicle to Grid – Kundennutzen und Netzintegration“ [“Factsheet Vehicle to Grid – Customer benefit and grid integration”]** Working group 6 – Standardisation, norms, certification and type approval
10/2020 Interim report	**Flächendeckende öffentliche Infrastruktur“ [“Nationwide public infrastructure”]** Working group 5 – Connecting mobility and energy networks, sector integration
10/2020 Interim report	**„Positionspapier Elektrische Maschine – Status Quo, Ausblick und Handlungsbedarfe für die deutsche Wirtschaft“ [“Position paper on electric machines – status quo, outlook and need for action for the Germany economy”]** Working group 4 – Securing Germany as a place for mobility, production, battery cell production, primary materials and recycling, training and qualification
10/2020 Interim report	**„Positionspapier Qualitative Betrachtung des Wertschöpfungsnetzwerks Batterierecycling“ [“Position paper on qualitative consideration of the value network on battery recycling”]** Working group 4 – Securing Germany as a place for mobility, production, battery cell production, primary materials and recycling, training and qualification
10/2020 Results report	**„Empfehlungen zum optimierten Nutzungsgrad von Plug-in-Hybridfahrzeugen“ [“Recommendations for optimum energy efficiency of plug-in hybrid vehicles”]** PHEV taskforce
07/2020 Interim report	**„Plattformbasierte intermodale Mobilität und Handlungsempfehlungen zu Daten und Sicherheit“ [“Platform-based intermodal mobility and recommendations for action on data and safety”]** Working group 3 – Digitalisation for the mobility sector
07/2020 Short report	**„Netzintegration von Elektromobilität – Basis für eine erfolgreiche Sektorkopplung. Eine Definition“ [“Grid integration of electromobility – basis for successful sector integration. A definition”]** Working group 5 – Connecting mobility and energy networks, sector integration
06/2020 Short report	**„Einsatzmöglichkeiten unter realen Bedingungen“ [“Possible uses under real conditions”]** Working group 2 – Alternative drive technologies and fuels for sustainable mobility
06/2020 Report	**„Schwerpunkt Roadmap Automatisiertes und vernetztes Fahren“ [“Focus roadmap on automated and connected driving”]** Working group 6 – Standardisation, norms, certification and type approval
04/2020 Report	**„Kundenfreundliches Laden – Fokus öffentliche Ladeinfrastruktur“ [“Customer-friendly charging – focus on public charging infrastructure”]** Working group 5 – Connecting mobility and energy networks, sector integration
04/2020 Report	**„Bedarfsgerechte und wirtschaftliche öffentliche Ladeinfrastruktur – Plädoyer für ein dynamisches NPM-Modell“ [“Needs-based and economical public charging infrastructure – plea for a dynamic NPM model”]** Working group 5 – Connecting mobility and energy networks, sector integration
04/2020 Report	**„Schwerpunkt Roadmap Intelligentes Lastmanagement“ [“Focus road map on intelligent load management”]** Working group 6 – Standardisation, norms, certification and type approval

03/2020 White Paper	**„Handlungsempfehlungen zur Typgenehmigung und Zertifizierung für eine vernetze und automatisierte Mobilität“ [“Recommendations for action on type approval and certification for connected and automated mobility”]** Working group 6 – Standardisation, norms, certification and type approval
01/2020 Interim report	**„Zwischenbericht zur strategischen Personalplanung und -Entwicklung im Mobilitätssektor“ [“Interim report on strategic personnel planning and development in the mobility sector”]** Working group 4 – Securing Germany as a place for mobility, production, battery cell production, primary materials and recycling, training and qualification
2019	
12/2019 Interim report	**„Handlungsempfehlungen zum autonomen Fahren“ [“Recommendations for action on autonomous driving”]** Working group 3 – Digitalisation for the mobility sector
12/2019 Progress report	**Fortschrittsbericht der Nationalen Plattform Zukunft der Mobilität [Progress report from the National Platform Future of Mobility]**
11/2019 Short report	**„Elektromobilität. Brennstoffzelle. Alternative Kraftstoffe – Einsatzmöglichkeiten aus technologischer Sicht“ [“Electromobility. Fuel cells. Alternative fuels – possible uses from a technological point of view”]** Working group 2 – Alternative drive technologies and fuels for sustainable mobility
10/2019 Interim report	**„Zwischenbericht zur Wertschöpfung“ [“Interim report on added value”]** Working group 4 – Securing Germany as a place for mobility, production, battery cell production, primary materials and recycling, training and qualification
10/2019 Report	**„Roadmap PtX“ [“PtX roadmap”]** Working group 5 – Connecting mobility and energy networks, sector integration
10/2019 Report	**„LNG- und CNG-Strategie im Schwerlastverkehr“ [“LNG and CNG strategy in heavy goods transport”]** Working group 5 – Connecting mobility and energy networks, sector integration
9/2019 Report	**„White Paper Aktuelle Entwicklungen und Herausforderungen zur Zukunft der Mobilität“ [“White paper on current developments and challenges for the future of mobility”]** Working group 6 – Standardisation, norms, certification and type approval
03/2019 Interim report	**„Wege zur Erreichung der Klimaziele 2030 im Verkehrssektor“ [“Ways to achieve the 2030 climate goals in the transport sector”]** Working group 1 – Transport and climate change
03/2019 Report	**„Sofortpaket Ladeinfrastruktur 2019“ [“Charging infrastructure 2019 emergency package”]** Working group 5 – Connecting mobility and energy networks, sector integration
03/2019 Report	**„Red-Flag-Bericht 10 % EV-Neuzulassungen“ [“Red flag report 10 % electric vehicle registration”]** Working group 5 – Connecting mobility and energy networks, sector integration
02/2019 Interim report	**„Digitalisierung für den Mobilitätssektor“ [“Digitalisation for the mobility sector”]** Working group 3 – Digitalisation for the mobility sector

All reports only reflect the opinions of the experts involved in the NPM.

Reports 2019 to 2021

National Platform Future of Mobility

TABLE OF FIGURES

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