#m 36th International Electric Vehicle Symposium and Exhibition (EVS36)

Sacramento, California, USA, June 11-14, 2023

Possible contributions of state policies and measures to the implementation and scaling of charging and hydrogen refueling infrastructure for long-haul trucks: An example of the state of Baden-Württemberg

Walter Holderried[1], Wolfgang Fischer, Katja Gicklhorn

[1]*Walter Holderried, e-mobil BW GmbH, Leuschnerstr. 45, 70176 Stuttgart, Germany*

walter.holderried@e-mobilbw.de,

Executive Summary

Nowadays, road freight transport causes around one-third of the transport sector's CO2 emissions. In this context, recent manufacturers' announcements show that climate-friendly commercial vehicles for long-haul transport will be available soon. However, an initial infrastructure still needs to be put in place. A chicken-and-egg situation must be prevented in which vehicle sales are impossible due to insufficient infrastructure. So far, research projects have separately addressed publicly accessible high-performance charging and hydrogen infrastructure for trucks. However, due to an extreme shortage of parking areas on and around German highways, the case of a combined refueling and charging infrastructure on the same site is also becoming relevant. By adequately addressing targeted project funding, long-term expansion planning, and exchanging with other European countries, state policies like those of Baden-Württemberg may contribute to creating a European infrastructure network that can keep up with vehicle uptake and regulatory regulations goals.

Keywords: heavy-duty, truck, ultra-fast charging, hydrogen, infrastructure

1 The role of heavy-duty commercial vehicles in the decarbonization of road transport

Trucks are an integral part of today's logistics chain, whose components also include inland waterways, shipping as well as air and rail transport. The mileage of heavy commercial vehicles currently causes about one-third of the total CO2 emissions in the transport sector in Germany [1]. The change in drive systems for long-distance trucks is, therefore, particularly relevant for the reduction of greenhouse gas emissions. In order to meet the 2030 Climate Target Plan [2], significant efforts toward decarbonization must be made in the segment of commercial vehicles, such as heavy-duty vehicles (> 12 tons). With the decision of Regulation (EU) 2019/1242 [3] of June 2019, the EU was also introducing CO2 fleet targets for heavy-duty commercial

vehicles for the first time. These specify that the average specific CO2 emissions per kilometer must be at least 15% lower from 2025 on, based on the values of a comparative fleet in the year 2019/20. From 2030, the benchmark is a reduction of at least 30% compared with the year 2019/20. The legislative review proposed by the European Commission in February 2023 extends and increases these target levels even further [4].

An essential prerequisite for the transition to a largely emission-free vehicle fleet by 2050 is the development of refueling and charging infrastructure in line with demand and timed to match the uptake of zero-emission vehicles. Confidential discussions in compliance with antitrust law between the German Federal Ministry of Digital Affairs and Transport (BMDV), NOW GmbH, and manufacturers show that there are different strategies in the OEM's drivetrain strategies [5]. Of the three possible zero-emission drive options, including overhead contact line technology, electric drives with batteries and fuel cells play the central role in the manufacturers' technology roadmaps.

At this point, however, it should be mentioned that to meet the current EU fleet for 2025, all manufacturers interviewed are focusing on the battery-powered truck. Fuel cell trucks for long-haul applications are expected to reach technological maturity in the second half of the decade. In addition to the need for further technical development, standardization issues regarding hydrogen storage and fueling protocols remain. However, the fact that OEMs already consider both drivetrain strategies show the importance for rolling out infrastructure for both technologies soon as well.

The role of heavy-duty commercial vehicles in decarbonizing road transport is also reflected in the Alternative Fuels Infrastructure Regulation (AFIR), which emphasizes the importance of Europe-wide infrastructure development for refueling and charging. With the law's implementation currently being discussed in trialogue negotiations, minimum binding targets for EU member states for developing charging infrastructure and hydrogen refueling stations are about to be introduced.

1.1 Translation of European decisions into national strategies and measures on a state level

In its strategy paper, "An Overall Approach to Climate-Friendly Commercial Vehicles" [6], the BMDV outlines how the decarbonization of road freight transport can be achieved nationally. This strategy paper has confirmed the intention of the BMDV to create a targeted regulatory environment that ensures the competitiveness of products and investment security. One goal formulated in the paper is that in the first phase, the so-called "scale-up phase", demonstration projects should test the new technologies. For battery technology, the focus will be on the operational demonstration of the technology and, in particular, its interaction with the charging infrastructure. Regarding hydrogen fuel cell technology, the focus will be on demonstrating vehicle and refueling technology, harmonizing refueling standards, and hydrogen transport [6].

For Baden-Württemberg, a German state (Land) in South-west Germany, the task is to implement this framework plan with dedicated measures. The challenge in the market scale-up phase is that alternatively fuelled vehicles will only become attractive for users if an initial charging and filling station network is available [7]. Especially at the beginning of the market introduction of climate-friendly commercial vehicles, it is crucial that the relevant stakeholders, such as infrastructure and grid providers, vehicle manufacturers, and policymakers, act together to make rapid scaling possible. A chicken-and-egg situation in which, for example, vehicles are available but are not purchased due to a lack of sufficient charging infrastructure must be avoided at all costs.

2 Possible contributions of state policies to the infrastructure development

To meet the ambitious regulatory targets and enable a rapid market ramp-up of climate-friendly long-haul trucks, the political measures taken by German states must contribute to both the European climate targets and the national framework plan. In this context, all primary findings must be obtained as quickly as possible to scale corresponding charging and refueling infrastructure as a next step. These basics must be determined in publicly funded research projects to help reduce entry barriers [8]. Following that, state policy needs to pay attention to which aspects are already being considered in other national and possibly also European

research projects and where there is still a need for additional research. This procedure ensures the effective and efficient use of funds, prevents redundant assignments, and thus accelerates the knowledge gain needed for scaling.

Appropriate state policy measures must also include planning an initial refueling and charging network. It is crucial that this planning is carried out at the same time as the research as mentioned earlier and pilot projects and that it is adapted in iterative cycles to the knowledge gained from the projects. Otherwise, there is a risk of losing valuable time for the following area-wide upscaling.

2.1 Current situation and challenges for initial activities

Various challenges must be considered when planning and designing suitable measures to support infrastructure development. One is the diversity of possible drivetrain concepts. As mentioned, three drivetrain technologies exist for climate-friendly electric commercial vehicles. In addition to the overhead contact line, these are the battery and the hydrogen fuel cell. However, in the discussions between the BMDV and various manufacturers, no manufacturer is currently setting its strategic priority on overhead line technology [5]. In the area of standardization of hydrogen fuel cell vehicles, the different hydrogen storage technologies are another challenge. According to announcements by the manufacturers, several technological paths are being considered here. In addition to refueling at 35 MPa and 70 MPa, liquid hydrogen (LH_2) is also used. There are also still open points regarding the charging standards for battery-electric trucks. Fast charging with outputs of up to 350kW is currently possible using the CCS standard. However, a new standard, the so-called Megawatt Charging System (MCS), is expected in the foreseeable future. With charging outputs of up to 1200 kW, it is considered decisive for using battery-electric trucks for long-haul applications [5]. However, the MCS standard has not yet been finally released.

In addition to the technical challenges, the current availability of suitable sites for charging and refueling infrastructure is also a difficulty in Germany. Due to the size of the vehicles, they require considerably more space than passenger cars. However, standard parking spaces for trucks located on highways are already not available in sufficient quantities. In addition to the need for good accessibility from the main transport corridors, new land development also poses the challenge of finding a suitable connection to the power grid. All these aspects offer uncertainties and must be considered for efficient planning of measures at the level of the states.

2.2 Examples of targeted project funding to support the development of an initial charging and refueling infrastructure

So far, research projects and project initiatives have separately addressed publicly accessible high-performance charging for heavy-duty commercial vehicles [9] and hydrogen infrastructure for trucks [10]. One example of such targeted support measures is the project concept "Pilot charging and hydrogen filling station for trucks in Baden-Württemberg (PiLaTes)" [11]. However, due to the above-mentioned extreme shortage of parking space on and around German highways, the case of a combined refueling and charging infrastructure on the same site is also becoming relevant [12]. For this reason, the state of Baden-Württemberg is funding the PiLaTes project.

The aim is to plan, construct, and operate a pilot station for high-performance charging and refueling hydrogen in gaseous and liquid form at a suitable location in Baden-Württemberg. Many of the challenges mentioned in chapter 2.1 were already addressed with these premises. PiLaTes is the first project to consider the combined operation of high-speed charging and hydrogen infrastructure at one location, which poses additional challenges compared to separate infrastructures for both technologies. Due to the project's complexity, it was divided into three independent project stages.

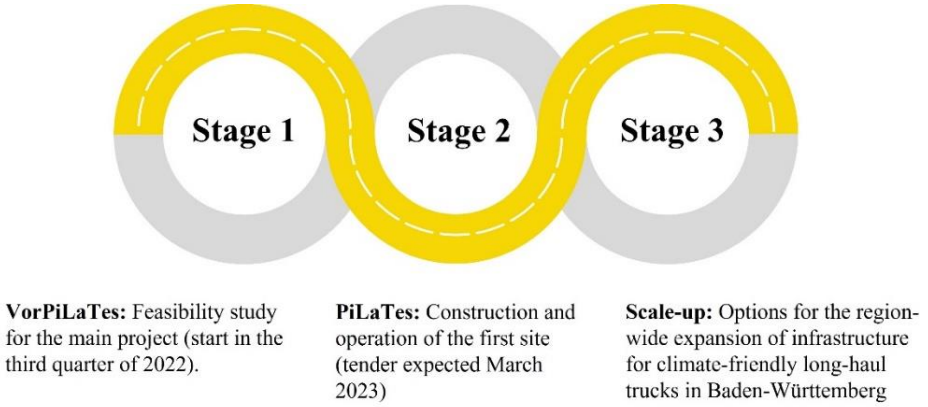

Figure1: Planned stages for the PiLaTes project

The first stage consisted of a feasibility study for the realization of a pilot charging and hydrogen refueling station. Stage 1 officially started in August 2022 and was completed in November of the same year. The project's second phase will then deal with the actual construction of the first site, as well as its operation and the accompanying research. The release of the corresponding tender is planned for March 2023. In the third phase, the results of phase 2 will be used to determine options for the region-wide expansion of infrastructure for climate-friendly long-haul trucks in Baden-Württemberg.

2.2.1 Experiences from the VorPiLaTes feasibility study

The Fraunhofer Institute for Industrial Engineering IAO coordinated the feasibility study jointly funded by the Baden-Württemberg Ministry of Transport and the Baden-Württemberg Ministry for the Environment, Climate, and Energy Management. The project was also accompanied by the state agency for new mobility solutions and automotive - e-mobil BW. The cooperation partners included Daimler Truck AG, EnBW Energie Baden-Württemberg AG, Fraunhofer Institute for Solar Energy Systems ISE, Fraunhofer Institute for Systems and Innovation Research ISI, H2 MOBILITY Deutschland GmbH & Co. KG, Netze BW GmbH and Nikola GmbH.

The aim of the first project stage was a feasibility study for the realization of a pilot charging and hydrogen refueling station in Baden-Württemberg. The focus was identifying a suitable location for the later implementation of the infrastructure and supporting activities for the construction of a planned charging and refueling infrastructure. For this purpose, the current state of the art, the status of standards development, and the current and future market availability of high-performance fast-charging and refueling station infrastructure for long-distance trucking had to be determined. In addition, the space requirements for the planned pilot infrastructure were to be analyzed, criteria for possible locations developed, and a suitable location for the pilot infrastructure identified [13]. Preparing an initial cost estimate was also essential, as this would be used to prepare the tender for the project's second phase. Stage 1 officially started in August 2022 and was completed in November of the same year.

As already mentioned, the guiding principle was that the infrastructures for charging and refueling should be set up at the exact location to investigate and test particular circumstances, e.g., from the point of view of approval procedures or hazard analysis, which arise from this particular case. In order to find a specific location and also to assist in the selection process for other projects, a criteria list was developed. As shown in Fig. 2, this list includes various criteria in the categories "Location", "Energy", "Layout", and "Framework conditions".

During different workshops with the project's associated partners and especially with the infrastructure operators, this list of criteria was specified and concretized. Therefore, an area requiring a total detour of at most ten minutes from the nearest highway was agreed on. H2 refueling stations and megawatt charging stations may address different users with different usage patterns and, sometimes, require different criteria when searching for a location. While battery electric trucks in long-distance traffic usually need a possibility for fast charging directly at the highway, fuel cell trucks, due to higher ranges, can instead rely on refueling

stations in corresponding logistics hubs or business parks, even if they are located further away from the highways. In order to have enough space for the charging and refueling hardware, an area of at least 3,000 to 5,000 m2 was mutually determined. These dimensions also include room for a possible later expansion of the facilities to adapt the project to the growing market ramp-up of zero-emission vehicles. This aspect is particularly crucial regarding the economical operation of the infrastructure. As mentioned in the opening chapter, swift action must be taken to achieve the ambitious goals regarding the transformation of mobility. For this reason, the framework condition that implementation at potential locations must be realistic within a specified time frame (three years) was added to the list of criteria.

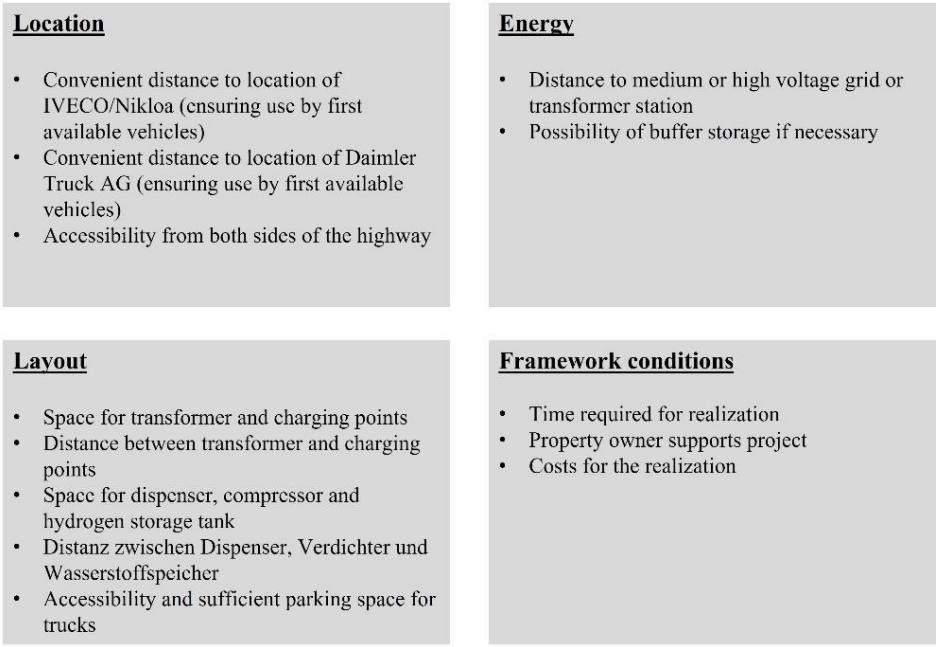

Figure 2: Initial location criteria distinguished by “Location”, “Energy”, ”Layout” and ”Framework conditions”

(Own illustration based on Anna-Lena Klingler et. Al. [13])

In addition to criteria for a possible location, the feasibility study also included a recommendation for specialized hardware based on the findings. A minimum of four MCS chargers was specified for the charging points. However, charging according to the CCS standard for overnight charging applications should also be possible. At least two hydrogen dispensers should be available on the hydrogen infrastructure side. As mentioned above, liquid hydrogen (LH_2) and gaseous hydrogen (70 MPa) should be available with at least one dispenser each. In addition, the infrastructure is to be available around the clock and publicly accessible to all brands and logistics providers, as well as offering non-discriminatory payment options. If it were permissible under-funding law, prioritizing project partners could be discussed without excluding others.

First and foremost, the availability of land, at least in Germany and Baden-Württemberg, plays a crucial role in developing charging and refueling infrastructure. Identifying and developing land is a critical aspect of achieving the goals stated in the opening chapter. Since the current utilization of infrastructure for the conventional operation of trucks with conventional internal combustion engines (ICE) will not be reduced for the time being, or only to a small extent, additional areas to the existing service stations and truck stops will be required. The exact amount of space required and the exact shape of the area cannot be reliably estimated because the PiLaTes showcase will be the first infrastructure of its kind. For the same reason, it is not yet possible to assess the possibilities for optimizing the space available at a combined charging and refueling station. However, this would be an aspect to be investigated in more detail in the second project phase. Therefore, the feasibility study planned for two to three independent loading or refueling points, including the space required for off-tracking large trucks. Discussions with the stakeholders show that more space must be allocated to react to unforeseen difficulties, such as safety requirements or deviating

component sizes, and reserving space for later expansion during the project. Easy accessibility, maintainability, and interchangeability of all components, such as piping and cabling, also increase the space requirement under certain circumstances [13]. This is particularly important because experience has shown that the replacement of components due to technical problems occurs more frequently in prototype equipment. Therefore more considerable distances between individual components must be considered, and placing components or certain connections above ground might be more practical at first. In connection with land development, the time required for this should not be underestimated. In addition to securing an appropriate network connection and an excellent link to transport routes, interested users, and landowners, there may be delays in implementation. This delay may be due to necessary approval procedures for land development. Early identification of the necessary development processes for such areas is therefore essential.

To ensure the best possible knowledge transfer, the first project phase was integrated as a so-called “Mission” within the framework of the "Strategic Dialogue for the Automotive Sector in Baden-Württemberg" (SDA). The “Strategic Dialogue for the Automotive Sector in Baden-Württemberg" initiative started by the state government of Baden-Württemberg in the summer of 2017, bringing together all relevant stakeholders to cooperate and to work together on solutions to issues related to the transformation of mobility in the state. The SDA, therefore, presents a new format of institutionalized collaboration. It follows a holistic approach intending to tap into innovation potential across industrial sectors. During seven years, projects, policies, and concepts will be established in close communication between politics, industry, academy, employer associations, consumer organizations, environmental organizations, and civil society to shape the transformation process in the economy of Baden-Württemberg successfully.

In order to be able to offer good funding conditions for the second project phase and to ensure that non-discrimination and equal opportunities are maintained, a new call for applications for PiLaTes is currently being prepared. All applicants or consortia of applicants must apply with their location. Therefore, the applicant can freely select a suitable site, which means the site differs from the feasibility study. The publication of the corresponding call for proposals is planned for March 2023. In this context, close coordination was made with the BMDV regarding related activities and funding measures at the federal level.

Given the needed infrastructure for the market ramp-up of climate-friendly commercial vehicles in the coming years, more than one location is needed. However, this project was formed with the ulterior motive of using lessons learned as a blueprint to scale infrastructure with similar requirements more quickly in the coming years. In addition, initial showcases such as PiLaTes are needed to stimulate much-needed discussions around framework conditions related to approval processes and the expansion and new development of suitable locations.

2.3 Long-term expansion planning and infrastructure development beyond initial public subsidies

As mentioned several times and underlined by various vehicle manufacturers' statements, infrastructure development is one of the most critical elements for establishing climate-friendly commercial vehicles [5]. Therefore, an ambitious timetable is necessary to keep pace with manufacturers' announcements regarding the market availability of the first models. For this reason, a possible contribution of the state policy to the infrastructure development must ensure that the subsequent scaling is already considered in addition to generating initial findings and basics. These two processes must therefore run in parallel as far as possible. This fact was also taken into account in the PiLaTes project. Although a separate project phase was dedicated to scale-up, aspects of this topic have already been included in the work packages of the first project phase. For example, a heat map was created that analyzed current truck stop locations and used these findings to evaluate potential locations for building charging infrastructure for battery electric and fuel cell trucks. In addition, preparations are underway for creating a demand strategy for Baden-Württemberg by the Baden-Württemberg Ministry of Transport (for charging infrastructure) and the Baden-Württemberg Ministry for the Environment, Climate and Energy Management (for hydrogen infrastructure).

The "Network Development Plan for Electricity (NEP)" is vital for long-term expansion planning of charging infrastructure for battery-electric trucks. The grid operators calculate the expansion requirements for the next ten to 15 years based on various scenarios. This time frame again shows the need for early planning, at least

for an initial charging network. A key factor here is the close cooperation of all relevant stakeholders, such as vehicle manufacturers, energy suppliers, grid and infrastructure operators, and state policymakers. In Baden-Württemberg, this dialog takes place in the "Strategic Dialogue for the Automotive Sector in Baden-Württemberg" (SDA), among others. However, all activities at the state level must also consider the federal government's plans to complement measures and thus avoid redundancies optimally. The German Federal Ministry of Digital Affairs and Transport (BMDV) and the National Center for Charging Infrastructure (NLL) are planning to issue a call for tenders for an initial public charging network for commercial vehicles, if possible, in the third quarter of 2023 [14]. A close exchange is essential here.

Government subsidies in an initial phase can support public charging and refueling infrastructure deployment. The private sector must carry out a rapid and sustainable deployment beyond initial projects. Although the exact design of the AFIR has yet to be finalized, it is already clear that it will require a nationwide network of charging and refueling infrastructure in the long term. This fact means that infrastructure will also have to be built in areas where it is not initially so attractive due to geographical location or lower traffic volumes, especially at the beginning of the market ramp-up of climate-friendly commercial vehicles. Appropriate business models for infrastructure operators are essential for achieving this goal. Here, too, state measures could contribute to infrastructure development. One approach could be to create or support a platform where supply from infrastructure operators and demand from corresponding users such as logistics companies and fleet operators can meet. Through discussions with logistics companies, it was possible to determine that, in some cases, several companies close to one another are pursuing concrete plans to convert their fleets to climate-friendly commercial vehicles but are reluctant to invest in their infrastructure.

On the other hand, infrastructure operators have stated that they would be willing to invest in new infrastructure if they can operate there economically, e.g., through offtake agreements. Directed networking could promote faster infrastructure scaling even in more remote areas. This approach is currently under discussion.

3 The need for a common European strategy to build new and connect existing charging infrastructure

While the issue of charging infrastructure development is finding its way into national strategies and political agendas, long-distance transport is by no means only a regional or national issue but a European one. Here, state activities can also make a significant contribution. Together with six[1] regional cluster initiatives and networks from the mobility sector, the State Agency for New Mobility Solutions and Automotive Baden-Württemberg (e-mobil BW GmbH) has established the “hEVy Charge EU” initiative. It connects stakeholders from different backgrounds, such as scientific institutions, vehicle OEMs, logistic companies, platform providers, energy suppliers, grid operators, municipal consultants, and charging infrastructure companies, and is open to everyone. The initiative aims to support the rapid market ramp-up of battery-electric heavy-duty trucks by contributing to the realization of a coherent pan-European charging corridor. These regional networks have access to politics and authorities in their respective regions and to stakeholders from industry and research. As a result, the hEVy Charge EU initiative raises awareness. It interconnects relevant stakeholders from the individual regions on charging infrastructure deployment for battery-electric heavy-duty trucks through related activities.

The possibilities for action for such an initiative are diverse. One activity is organizing events at the European level with industry, researchers, and policymakers. One example was the "Panel on European heavy-duty charging infrastructure" in November 2022 in Brussels. The topics of vehicle availability and charging infrastructure deployment were discussed during the event with representatives of ACEA, CharIN e.V., the European Commission, and the National Centre for Charging infrastructure, among others. The event also allowed various national bodies responsible for the roll-out of charging infrastructure in their countries to present their strategies and exchange views on possible overlaps between them. The panel, therefore, enabled a first meeting of the relevant stakeholders and provided the platform for a constructive discussion between

[1] ACCIÓ, Business Göteborg, CARA, Cluster Lombardo della Mobilità, FIER Automotive, RAI Automotive

all participants. Further events are planned, e.g., to encourage the exchange of various projects to develop fast charging for heavy commercial vehicles from other EU countries.

Another activity is contributing to EU funding programs and regulations through memberships of the participating regional cluster initiatives and networks in dedicated working groups, organizations like the European Alternative Fuels Observatory, and National Contact Points (people nominated by the national authorities in the Member States and Associated Countries). Furthermore, the initiative can examine suitable funding calls, monitor current national charging infrastructure activities through partners in the respective countries, and support consortium formation.

4 Conclusion and Outlook

The change in drive systems for long-distance trucks is particularly relevant for reducing greenhouse gas emissions because, with a relatively small number of vehicles, a relatively significant impact on CO2 reduction can be achieved. This has also been acknowledged at the level of the European Union and its member states, which is why ambitious targets have been defined and translated into legislation and guidelines. Accordingly, national strategies such as the framework plan "An Overall Approach to Climate-Friendly Commercial Vehicles" of the German Federal Ministry of Digital Affairs and Transport (BMDV) have been developed.

To meet the ambitious regulatory targets and enable a rapid market ramp-up of climate-friendly long-haul trucks, the task for German states like Baden-Württemberg is to support this framework plan with targeted measures and complement national initiatives as best as possible as well as contribute to the European climate targets. However, all activities at the state level must also consider the plans of the federal government to complement measures and thus avoid redundancies optimally. Several guidelines and actions can serve in three areas. Firstly, through targeted project funding to support the development of an initial charging and refueling infrastructure. Here, it is essential to research the basics and gain insights to accelerate the subsequent infrastructure scaling. One example of such targeted support measures is the project concept "Pilot charging and hydrogen filling station for trucks in Baden-Württemberg (PiLaTes)". The project, divided into three phases, is therefore investigating the development of refueling and charging infrastructure close to one location. On the infrastructure side, charging according to CCS standard (350 kW) and MCS standard (up to 1200 kW), as well as the refueling of gaseous hydrogen (700MPa) and liquid hydrogen (LH_2), are considered. Insights are also gained regarding layout, site identification, and approval procedures. Second, a concept for scaling the corresponding infrastructure in Baden-Württemberg must be developed. Care must be taken to ensure that this process is started early and, as far as possible, is carried out in parallel with acquiring basic knowledge from subsidized projects.

Nevertheless, government subsidies can only initially support public charging and refueling infrastructure deployment. This is why appropriate business models for infrastructure operators are essential. Measures such as creating or supporting a platform on which the supply of infrastructure managers and the demand of corresponding users such as freight forwarders meet could contribute to this. Third, measures are needed for a common European strategy for building new infrastructure and connecting existing infrastructure. An initiative such as hEVy Charge EU offers many opportunities to make a contribution.

The measures and guidelines discussed in this paper are not a complete list of all ongoing and planned measures in Baden-Württemberg. Instead, they are intended to illustrate the arguments made by example. State policies and measures like those of Baden-Württemberg may create a European infrastructure network to keep up with vehicle uptake and regulatory goals by adequately addressing targeted project funding, long-term expansion planning, and exchange with other European countries.

References

[1] National Platform Future of Mobility, *Workshop report on the change of drive Systems for commercial vehicles: Ways to decarbonize heavy trucks with a focus on electrification*, Berlin, The Federal Ministry for Digital and Transport (BMDV), December 2020, https://www.plattform-zukunft-mobilitaet.de/wp-content/uploads/2020/12/NPM_AG1_Werkstattbericht_Nfz.pdf, accessed on 2022-10-25

[2] European Commission, *2030 Climate Target Plan, https://climate.ec.europa.eu/eu-action/european-green-deal/2030-climate-target-plan_en*, accessed on 2022-10-25

[3] European Parliament & Comission, *REGULATION (EU) 2019/1242 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 20 June 2019 setting CO2 emission performance standards for new heavy-duty vehicles and amending Regulations (EC) No 595/2009 and (EU) 2018/956 of the European Parliament and of the Council and Council Directive 96/53/EC,* Official Journal of the European Union (2019), https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32019R1242&from=de, accessed on 2023-03-22

[4] Gregor Erbach (Members' Research Service European Parliament), *REVIEW OF THE CO2 EMISSION STANDARDS FOR HEAVY-DUTY VEHICLES Q4 2022*, https://www.europarl.europa.eu/legislative-train/carriage/review-of-the-co2-emission-standards-for-heavy-duty-vehicles/report?sid=6701, accessed on 2023-03-22

[5] National Organization Hydrogen and Fuel Cell Technology (NOW GmbH), *Market development of climate-friendly technologies in heavy road freight transport*, Berlin 2023, https://www.klimafreundliche-nutzfahrzeuge.de/wp-content/uploads/2023/02/Marktentwicklung-klimafreundlicher-Technologien-im-schweren-Strassengueterverkehr.pdf, accessed on 2023-03-22

[6] Federal Ministry of Transport and Digital Infrastructure (BMVI), *An Overall Approach to Climate-Friendly Commercial Vehicles Towards zero emissions road logistics by means of alternative drivetrains*, Berlin, November 2020, https://bmdv.bund.de/SharedDocs/EN/publications/overall-approach-climate-friendly-commercial-vehicles.pdf?__blob=publicationFile, accessed on 2022-10-25

[7] Fraunhofer ISI, *Alternative Antriebe und Kraftstoffe im Straßengüterverkehr. Handlungsempfehlungen für Deutschland*, Karlsruhe, Berlin, Heidelberg, 2018, https://www.oeko.de/fileadmin/oekodoc/Thesen-Zukunft-StrGueterverkehr.pdf, accessed on 2022-10-25

[8] Florian Klausmann et. Al., *Anforderungen an eine elektrische Lade- Anforderungen an eine elektrische Lade- und Wasserstoffinfrastruktur für gewerbliche Wasserstoffinfrastruktur für gewerbliche Nutzfahrzeuge mit dem Zeithorizont 2030*, FAT-Schriftenreihe, ISSN 2192-7863, 342(2021)

[9] Fraunhofer Institute for Systems and Innovation Research ISI, *HoLa - High performance charging for long-haul trucking*, https://www.isi.fraunhofer.de/en/competence-center/energietechnologien-energiesysteme/projekte/HoLa.html, accessed on 2022-11-18

[10] STRINGmegaregion.org, *STRING Hydrogen Corridor, https://stringnetwork.org/wp-content/uploads/2021/04/STRING-Hydrogen-Corridor_project-idea.pdf,* accessed on 2022-11-18

[11] e-mobil BW, *VorPiLaTes*, https://www.emobil-sw.de/en/vorpilates, accessed on 2022-11-18

[12] ADAC, *Massiver Mangel an Lkw-Parkplätzen*, https://www.adac.de/news/mangel-lkw-parkplaetze-autobahn/, accessed on 2022-10-25

[13] Anna-Lena Klingler et. Al., *Durchführbarkeitsuntersuchung zu Pilotlade- und Tankinfrastruktur für Langstrecken Lkw (VorPiLaTes)*, Forschungsbericht BWPLUS (2022), https://pudi.lubw.de/detailseite/-/publication/10488-VorPiLaTes.pdf, accessed on 2023-03-23

[14] Sebastian Lahmann, *Aktivitäten zur Nutzfahrzeug Ladeinfrastruktur*, BMDV Fachkonferenz Klimafreundliche Nutzfahrzeuge, Berlin 2022, https://www.now-gmbh.de/wp-content/uploads/2022/11/NFZ22_Aktivitaeten-zur-Nutzfahrzeug-Ladeinfrastruktur_Lahmann.pdf, accessed on 2023-03-23

Presenter Biography

Walter Holderried studied Industrial Engineering and Innovation Management at the University of Applied Science in Konstanz and Esslingen. He was mainly involved in vehicle technologies and Alternative Drive Concepts in his professional career. Since 2020 he has worked for the State Agency for New Mobility Solutions and Automotive Baden-Württemberg e-mobil BW GmbH. He is responsible for vehicle and mobility technologies at the Cluster Electric Mobility South-West. He manages the working group on electric motor production, vehicle battery disassembly, and commercial vehicles with alternative drives. He also coordinates projects for developing and scaling charging infrastructure for long-haul trucks.