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Electric Long-Haul Trucks and High-Power Charging - Modelling and Analysis of the Required Infrastructure in Germany

Tobias Tietz[1,*], Tu-Anh Fay[1], Tilmann Schlenther[2] and Dietmar Göhlich[1]

[1]*Chair of Methods for Product Development and Mechatronics, Technische Universität Berlin, Straße des 17. Juni 135, 10623 Berlin, Germany; sekretariat@mpm.tu-berlin.de*

[2]*Chair of Transport Systems Planning and Transport Telematics, Technische Universität Berlin, Kaiserin-Augusta-Allee 104, 10553 Berlin, Germany*

[*]*Correspondence: t.tietz@tu-berlin.de; Tel.: +49 (0)30 / 314 - 28434*

Abstract

This study addresses the challenge of transitioning long-haul diesel trucks to Battery Electric Trucks (BETs) within the European Union's framework to achieve climate neutrality by 2055, focusing on the development of German charging infrastructure as a critical component. With heavy-duty vehicles accounting for a significant portion of road transport emissions, BETs emerge as a viable solution, necessitating a substantial shift in both vehicle technology and infrastructure planning. We propose a methodology to evaluate the charging infrastructure needed to support the adoption of electric vehicles in Germany, considering different levels of electrification and integrating European driving and rest time regulations.

Our analysis employs MATSim, an activity-based multi-agent transport simulation, to assess potential bottlenecks in the charging infrastructure and to simulate the demand-based distribution of charging stations. This approach allows for a detailed examination of the required charging infrastructure, considering the impacts of depot charging solutions and the dynamic nature of truck movements and charging needs.

The results indicate a significant need for overnight charging facilities and highlight the importance of strategic infrastructure development to accommodate the growing demand of chargers for BETs. By simulating various scenarios of electrification, we demonstrate the critical role of demand-oriented infrastructure planning in reducing emissions from the road freight sector until 2030. This study contributes to the ongoing discourse on sustainable transportation, offering insights into the infrastructure requirements and planning challenges associated with the transition to battery electric heavy-duty vehicles.

Keywords: battery electric truck, charging infrastructure, heavy-duty, truck traffic simulation, MATSim

1 Introduction

In response to climate change, the European Union has set ambitious targets to achieve climate neutrality by 2055, as outlined in the European Green Deal's "Fit for 55" package [1]. Heavy-duty vehicles represent a significant challenge in this context, accounting for 6% of the EU's total CO2 emissions and over a quarter of emissions from road transport [2]. Therefore, the European Clean Trucking Alliance with over 35 companies and organizations from across Europe is calling for zero-emission road freight [3]. However, replacing today's fleets of diesel trucks entails several challenges. First, electric trucks only recently have become commercially available, and they still need further technical improvements. Second, freight operators face several different options of electric trucks and charging technologies and a vast number of possibilities to combine these options into a system solution. All options have specific assets and drawbacks concerning technological complexity, environmental impact, capital and operational cost [4–8].

Battery Electric Trucks (BETs), which are charged conductively, emerge as a promising alternative to traditional combustion engine trucks [9], offering a viable solution to reduce emissions from the ever-growing road freight sector [10]. However, the transition to BETs not only necessitates advancements in vehicle technology but also poses substantial planning and financial challenges in developing the requisite charging infrastructure [11, 12]. The European Union has already laid down initial guidelines for the standardized expansion of a charging network as part of its "alternative fuels infrastructure" strategy [13]. To ensure effective and demand-aligned infrastructure development, research is being conducted across various projects at both European and national levels, with key initiatives including ZEFES (Europe), HoLa (Germany), and E-Charge (Sweden). In these projects, researchers and industry stakeholders collaborate to examine the efficient energy supply and strategize the deployment of conductive charging technology, utilizing the first Megawatt-charging-system (MCS) sites, by strategically determining optimal charging locations, ensuring adequate charging capabilities for BETs [14–16].

In this context, this paper proposes a methodology to evaluate the required charging infrastructure to support the increased adoption of electric vehicles in Germany, across various levels of electrification, while considering European driving and rest time regulations for drivers according to [17]. Additionally, this paper addresses the importance of depot charging solutions to meet these demands. We use the term "depot charging" throughout and thus summarise all charging processes (at a depot or using conventional public charging facilities) that do not take place at MCS charging points.

Different approaches can be used to support the demand and planning for BET's charging infrastructure in Europe and especially in Germany. A critical distinction emerges between model-based and trip-based approaches, each offering unique insights into infrastructure demands. Model-based simulations [18] employ theoretical frameworks to predict the necessary infrastructure, considering variables such as maximum average waiting times and charging durations. These models often rely on static assumptions about demand and do not always account for the dynamic nature of truck movements and charging needs throughout a day or over longer periods. Conversely, trip-based simulations are particularly adept at capturing the complexities of trucking logistics, including a possible variation in daily routes, the impact of mandatory rest periods on charging patterns, and SoC-based recharging during the journey [11, 19]

Table 1 displays different infrastructure modelling approaches, the basic parameters and simulation aim.

Table 1: Literature overview infrastructure modelling

Reference	Simulation Approach	Region	Charger Power	Share of BETs	Simulation Aim
Speth et al. (2022), [18]	Model & trip based	GER	720 kW	15 %	#charging locations and #chargers every 50 or 100 km; No exact charging location or design
Speth et al. (2023), [20]	Model & trip based	GER	720 kW	100%	#charging locations and #chargers with maximum capacity constraints (based on real data on rest area utilization from Germany)
Shoman et al. (2023), [19]	Trip based	EUR	700 to 1200 kW	15 %	Public charging requirements in 2030 (charging type, charging area capacity and energy supply) No exact charging location or design
Menter et al. (2022), [11]	Trip based	GER	720 kW	1/10/15/ 20 %	# charging locations and # chargers based on traffic flow and on distribution of service areas and existing infrastructure

In a combination of a trip- and model-based simulation focusing on truck traffic in Germany, Speth et al. [18] argue for a charging infrastructure that ensures the average waiting time does not exceed 5 minutes, with a charging duration assumed to be 30 minutes. Their analysis, based on a scenario with 15% BETs and 50% public charging, suggests the need for 267 charging locations equipped with 2-8 chargers (totalling 950 chargers) spaced 50 km apart, or alternatively, 142 charging locations with 2-13 chargers (765 in total) spaced 100 km apart. They incorporate queueing theory into their model and base their data on manual traffic counts, providing insights into the operational aspects of charging infrastructure.

In Speth et al. (2023) [20] the authors model a capacity-constrained public charging infrastructure network for electric trucks in Germany. The approach from [18] has been improved in order to take limited parking capacities into account. By integrating data of available parking lots and trips based on origin-destination flows the authors could indicate the minimum number of charging locations for Germany to be 124 with approx. 12,000 charging points to serve 100% electric trucks with a range of 300 km. Shoman et al. [19] provide a comprehensive analysis at the European level using the trip chain model, which includes necessary breaks for a truck fleet scenario envisaged for 2030. Their findings indicate that to support 15% of trucks as BETs, approximately 40,000 depot and 9,000 megawatt chargers would be required, suggesting a ratio of four to five times more depot charging points than MCS charging points. They estimate an average requirement per charging point of 8 depot and 2 MCS, utilizing charging powers ranging from 0.7 to 1.2 MW. This study lays a significant foundation in understanding the scale of infrastructure needed to accommodate depot charging demands for BETs. In Speth et al. (2022) [18], Speth et al. (2023) [20] and Shoman et al. (2023) [19], the authors apply a queuing model assuming a maximum average queuing time of 5min, fast charging can be done in 30min and 15min of the 45min break is for queuing, preparing for charging and leaving the charging point. Speth et al. (2023) [20] and Shoman et al. (2023) [19] consider trips, however, the real nature of truck movement and SoC-based recharging during the journey is not considered. Menter et al. [11] adopt a trip-based simulation approach using MATSim to propose a demand-oriented charging network based on European and German fleet data for trucks. The simulation, which spans Monday through Thursday to manage computational load, considers real service areas in Germany. The findings suggest that for 1% BETs, 177 chargers at 172 charge points would suffice, whereas for a 20% adoption rate, as many as 1296 chargers at 457 charge points would be required.

All mentioned papers in Table 1 propose a charging network and base their work on BETs that start their journey with 100 % SoC, assuming all BETs can charge in their depot. To the author’s knowledge, there is no assessment of the consequences of not having charging infrastructure in the depot.

The aim of this paper is to propose a methodology to evaluate the required charging infrastructure to support the increased adoption of BETs in Germany, across various levels of electrification including European driving and rest time regulations and evaluate the importance of depot charging solutions to meet these demands. Menter’s work is pivotal in defining the baseline for this paper. However, the queuing algorithm needs improvement since regulation regarding breaks and working hours of drivers are not included and trucks do not always stick to their 45 min break.

The paper is organized as follows. Section 2 describes the used methodology and data. Section 3 presents our findings and in section 4 we discuss these results. Section 5 and 6 conclude our paper and highlight future research plans.

2 Methodology

This paper contributes to understanding the planning and implementation of charging infrastructure for BETs. Our assumptions regarding the proportion of BETs in the German truck fleet through 2030 are grounded in the estimated sales volumes derived from cleanroom talks with various manufacturers [21]. Industry stakeholders expect a distribution of charging between depots and public infrastructure at a 50:50 ratio [21].

2.1 Simulation Framework

We employ MATSim, an activity-based multi-agent transport simulation, where each vehicle is represented by one agent executing predefined plans with specific origins and destinations [22]. By leveraging the detail level, the utilisation of charging infrastructure can be analysed regarding potential bottlenecks. Our simulation model is an improvement of [11] and takes input data from Open Street Map for road mapping, rest areas and industrial zones as well as official German truck traffic statistics as shown in Figure 1. The model has undergone statistical validation based on extensive traffic counts. A detailed description of the model and the pre-processing of input data can be found in [11].

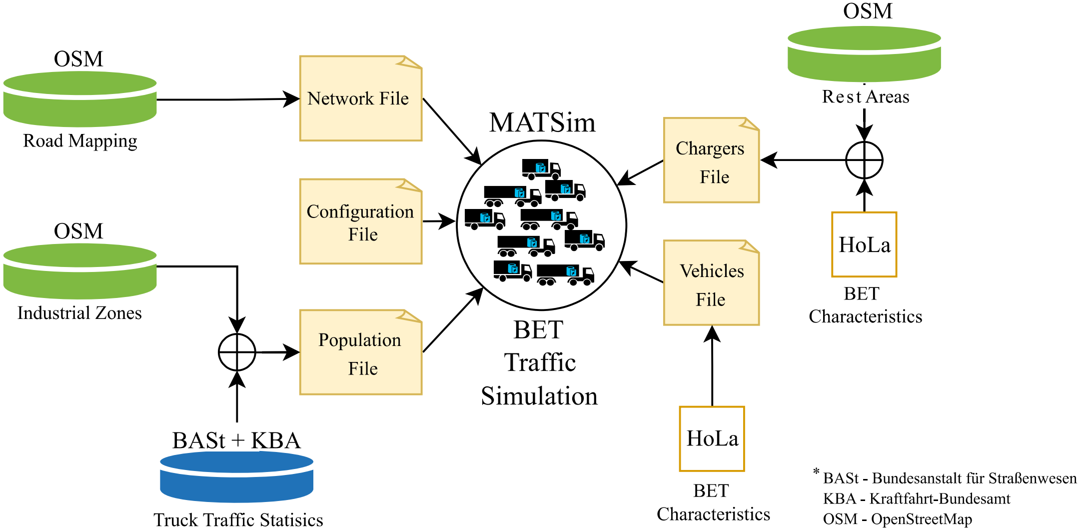


Figure 1: Overview of the simulation environment in MATSim (edited from [11])

The framework conditions of the simulation are summarized in Table 2. Technical specifications for trucks and charging points were determined in consultation with industry partners as part of the HoLa project in Germany [15], setting a realistic framework for our analysis. As a reference we refer to the following semi-trailer BETs: Daimler eActros 600 (600 kWh) [23], Volvo FM Electric (540 kWh) [24], and Scania BEV 6x2 2022 (468 kWh) [25], all with a payload capacity of 22 tons. In the scenario of Menter et al. [11] long-haul operations are categorized as journeys that span more than 300 km.

Our demand-based approach to determine a high-power charging infrastructure design for the entire German area is based on two parameters. First, the locations of the potential charging sites and second the number of chargers per site. We assume all 588 existing rest and service stations with amenities as potential locations (upper bound). Our computer model determines which of these locations should be used and how many chargers are needed at each charging site.

Table 2: Framework conditions of the simulation

Description	Values
Simulation timeframe:	Monday to Thursday (96 h)
Simulated trips with >300 km in Germany (Mo-Thu)	~660,000
Electrification levels:	1%, 5%, 10%, 15% and 20%
BET's battery capacity:	600kWh
BET's consumption:	1.2 kWh km^{-1}
BET's payload	22,000 kg
Charger specification:	720 kW (DC)
Lower SoC threshold:	20%
Max. number of potential charging sites:	588

2.2 Demand-Based Distribution Approach for Charging Stations

In a demand-based distribution of charging stations, it is crucial to evaluate how the number of charging points correlates with potential queues and associated waiting times for effective allocation of charging infrastructure. This assessment utilizes variable percentiles for different scenarios, where a "percentile" in statistics refers to a value below which a certain percentage of values (in this case, the number of charging processes) in a distribution falls. 100th percentile means all BETs can charge when they arrive a charging location. However, this results in an inefficient charging infrastructural design. Figure 2 shows the application of the 90th percentile. Meaning, for this specific charging location the number of chargers is reduced to 9 chargers, enabling 90% of all charging processes while 10% needs to wait.

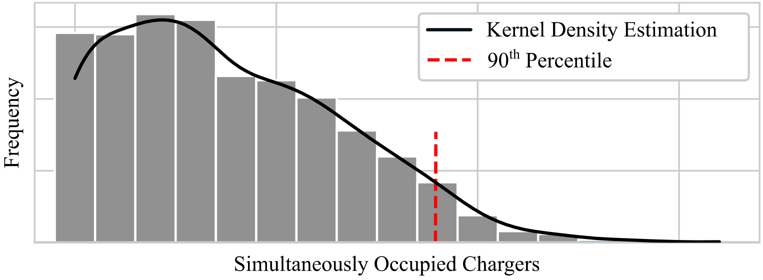


Figure 2: Application of the 90th percentile

2.3 Break Logic

Our model comprises a "break logic" which takes advantage of mandatory break times in accordance with the legal framework of European driving and rest times [17] and the Working Time Directive [26].

Additionally, we force all trucks to take charging breaks upon falling below the predefined minimum SoC of 20%. Typically, a 45-minute break is required after a maximum of 4.5 hours of driving, and according to the Working Time Directive, an employee must take a break after 6 hours of work, interpreted here as a 45-minute break. For truck drivers, the regulation allows a maximum 9 hours driving time followed by an 11-hour rest period. The daily schedules of the BETs emerging from this new logic are illustrated in Figure 3, indicating that the break is always 45 minutes long and includes recharging, regardless of whether there is a charging need or a need to interrupt driving time. The modelling of breaks up to the long 11-hour rest period is sufficient since the vehicle plans in our model do not extend beyond this timeframe.

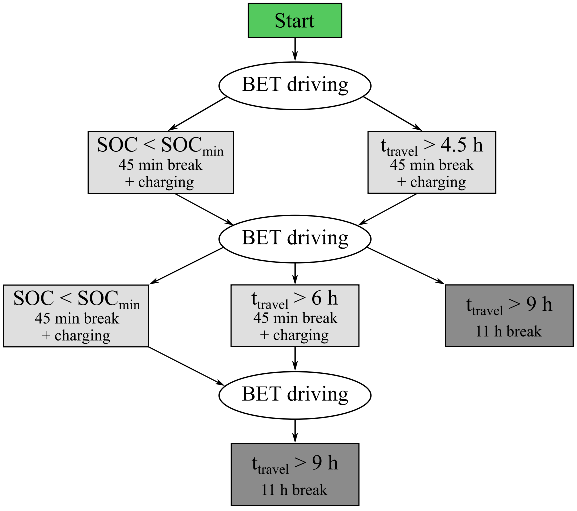


Figure 3: Overview of break scenarios of BETs

2.4 Enforced Charging Duration and Queueing

Applying the standard Electric Vehicles (EV) module in MATSim [27] allows to model charging activities for BET drivers including queuing and potentially waiting for a charger to become free. By standard, the BET drivers integrate the charging activities into their daily schedules as part of MATSim's replanning step in the co-evolutionary algorithm, i.e. a priori [22]. As part of the planning procedure, the charging activity needs to be assigned a duration which covers the waiting time. However, the occupancy of the charger at the time of the BET driver's arrival cannot be precomputed. In consequence, it is impossible to precisely account for waiting time while planning the total time spent at the charging location, a priori.

As pointed out in 2.3, the driver break is assumed to last *exactly* 45 minutes. This shall exclude waiting time, as the driver must not move the vehicle during the break, which is necessary for advancing the BET in the waiting queue.

Therefore, we implemented the option to enforce predefined durations for charging activities, excluding waiting time, by extending the duration one second for each second spent waiting, using MATSim' central infrastructure for within-day replanning [28].

2.5 State of Charge at Start of Operation

In previous simulations, it was assumed that a fleet could replenish its battery capacity before starting the trip either at a depot or using public charging infrastructure. In this paper, however, we also want to analyse what additional charging requirements arise if the fleet operations rely completely on MCS, as a "worst-case scenario". Therefore, we need depot SoC data for a truck fleet reliant solely on MCS-charging during 45-minute breaks. Lacking access to such data, we adopt an approach to generate a synthetic SoC distribution for a truck fleet. Specifically, we simulate a scenario for a Monday, limited by computational capacities, involving a 20% BET fleet starting with 100% SoC and heading to predefined destinations. The charging points are determined by previously mentioned locations, with each site having an unlimited number of charging points. At the end of the simulated day, the vehicles arrive at their destinations with their remaining capacities, which, due to the absence of depot charging infrastructure, can also be used as the fleet's initial SoC distribution for the next day. This statistical distribution is then applied to the different shares of BET fleets we analyse in this paper. The distribution of the fleet SoC over a day is shown in Figure 4.

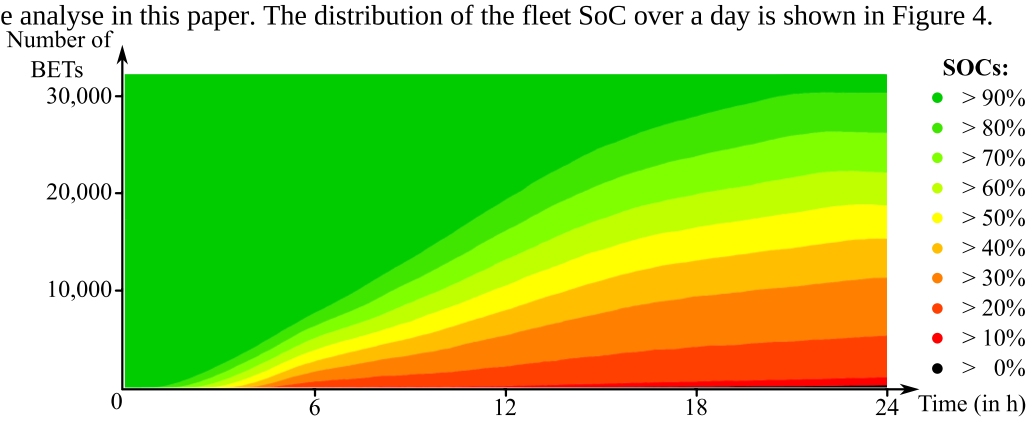


Figure 4: SoC fleet distribution over 24 hours (100% Start Soc)

3 Results

In the following chapter, we present the outcomes of our simulation analysis. In this paper, we focus on a detailed percentile-based overview for 1% and 10% share of BETs based on two scenarios, with and without depot charging.

3.1 Different Scenarios for BET's Market Ramp up

1% BET-Fleet

In this scenario, we assume that 1% of the German heavy-duty long-haul truck fleet is converted to BETs. We present findings that commence at the 92nd percentile (see Table 3), as values below this threshold are considered impracticable due to the appearance of additional waiting times exceeding 6 hours. Additionally, the 100th percentile is excluded from consideration as it merely represents a statistical distribution of a synthetic fleet, and a 100% supply for the real fleet cannot be guaranteed, anyhow.

Table 3: Results of different supply percentiles for a 1% BET fleet

Supply Percentile	Number of Charging Sites	Number of Chargers	Waiting Duration (Queued vehicles)	Share of Waiting BETs
92nd	143	147	00:49:25	38%
93rd	175	181	00:37:34	31%
94th	206	212	00:34:06	26%
95th	231	239	00:30:42	23%
96th	271	285	00:28:30	19%
97th	352	381	00:25:55	12%
98th	392	438	00:24:44	10%
99th	442	532	00:20:41	6%

For the scenario under discussion, the required number of chargers ranges from 147 to 532. Regarding waiting time, it is demonstrated that the queue waiting time for vehicles can be progressively reduced from approximately 49 minutes to about 20 minutes. Furthermore, the proportion of vehicles waiting decreases from 38% to 6% as shown in Figure 5.

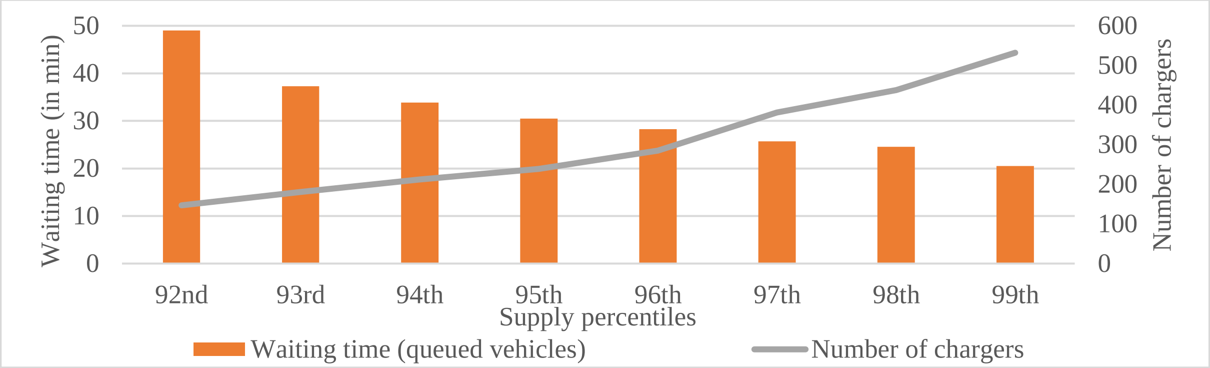


Figure 5: Waiting time over the number of chargers (1% BETs)

10% BET-Fleet

In the second scenario, it is demonstrated that for lower supply reliabilities, waiting times of less than half an hour are observed. This duration can be reduced to under ten minutes by expanding the number of chargers from 945 to 1732 at the 99th percentile. Similarly, the proportion of vehicles waiting decreases from 25% to 3% (see Table 4, Figure 3 and Figure 6).

Table 4: Results of different supply percentiles for a 10% BET fleet

Supply Percentile	Number of Charging Sites	Number of Chargers	Waiting Duration (Queued vehicles)	Share of Waiting BETs
90th	453	945	00:29:23	25%
91st	461	985	00:24:55	25%
92nd	471	1037	00:22:47	25%
93rd	478	1104	00:20:32	21%
94th	481	1148	00:18:56	18%
95th	492	1221	00:17:01	15%
96th	499	1297	00:15:31	12%
97th	508	1396	00:13:49	9%
98th	512	1517	00:12:32	6%
99th	516	1732	00:09:31	3%

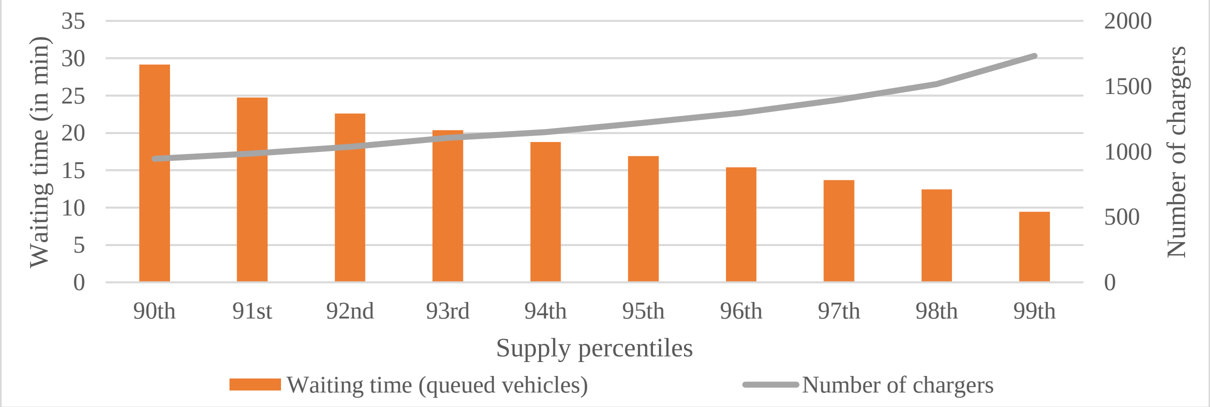
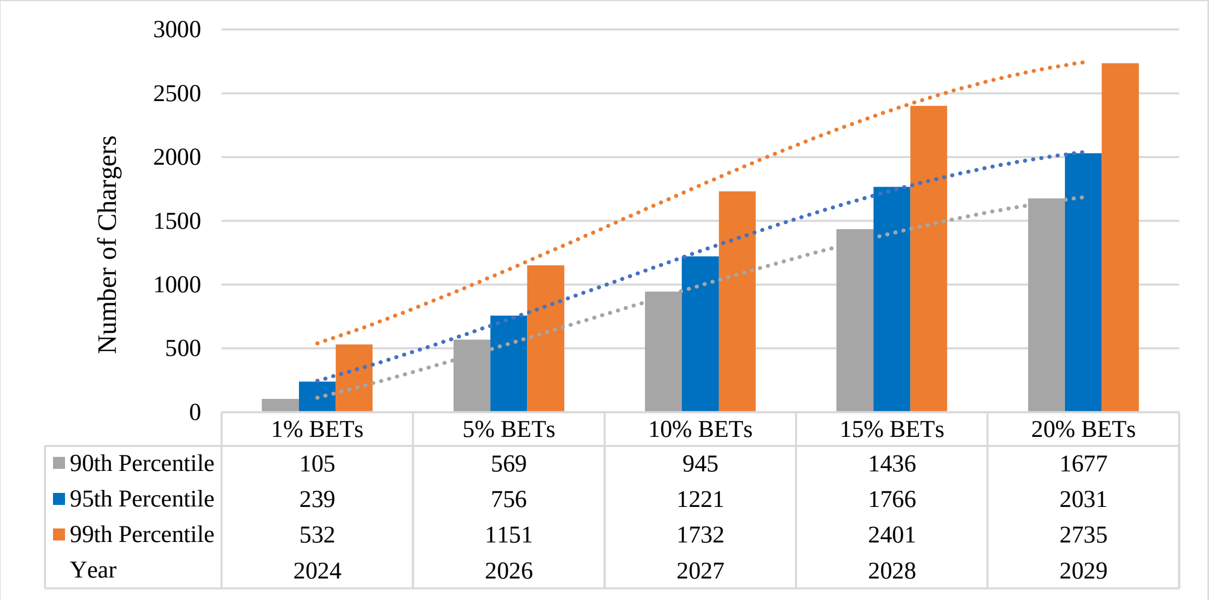


Figure 6: Waiting times over the number of chargers (10% BETs)

Necessary Infrastructure to Support Estimated Market Ramp-Up

The compilation of results for the market ramp-up from 2024 to 2029 is illustrated in Figure 7. It is observed that across all percentiles, as the fleet proportion of BETs increases, a higher number of chargers are required. However, the demand does not develop proportionally to the growing fleet. As a result, the required chargers converge. This is exemplified by the percentiles 95 and 99 over the years from 2024 to 2029, where the ratio of chargers decreases from 239 to 532 units in 2024 to 2031 and 2735 units in 2029. Despite this, it can be realized that improvements in supply from the 90th to the 95th percentile can be achieved with fewer additional chargers per expansion stage, whereas the next demonstrated step to a 99th percentile supply rate would be associated with a significantly larger increase in charger installations. In general, depending on the supply rate, between 1,677 and 2,735 chargers will be needed by 2029.



	1% BETs	5% BETs	10% BETs	15% BETs	20% BETs
■ 90th Percentile	105	569	945	1436	1677
■ 95th Percentile	239	756	1221	1766	2031
■ 99th Percentile	532	1151	1732	2401	2735
Year	2024	2026	2027	2028	2029

Figure 7: Necessary chargers for an assumed German market ramp up from 2024 to 2029

3.2 10% Scenario without Depot Charging

The findings from the 10% BET fleet scenario, without depot charging, are depicted in Table 5. This analysis reveals that to meet the demand at the 90th to 95th supply percentiles, between 1,471 to 1,780 chargers are required. It is noteworthy that the increase in the number of charging stations is minor, moving from 503 to 513. Concurrently, there is a reduction in both the waiting time and the proportion of BETs in queue; the waiting time decreases from approximately 22 minutes for 26% of all BETs to 15 minutes, with only a 13% share of vehicles waiting in line.

Table 5:Different supply percentiles for a 10% BET fleet without depot charging

Supply Percentile	Number of Charging Sites	Number of Chargers	Waiting Time (Queued vehicles)	Share of Waiting BETs
90th	503	1471	00:22:09	26%
91st	504	1534	00:20:17	23%
92nd	509	1583	00:18:50	20%
93rd	511	1642	00:17:48	18%
94th	512	1701	00:16:13	16%
95th	513	1780	00:15:00	13%

In Figure 8, the outcomes of this scenario are contrasted with those from the simulation that includes the option of depot charging. This comparison illustrates that the demand for chargers consistently differs by several hundred charging points. However, it is demonstrated that this difference just slightly diverges as the supply demand increases, resulting in a changing ratio of chargers between the two scenarios.

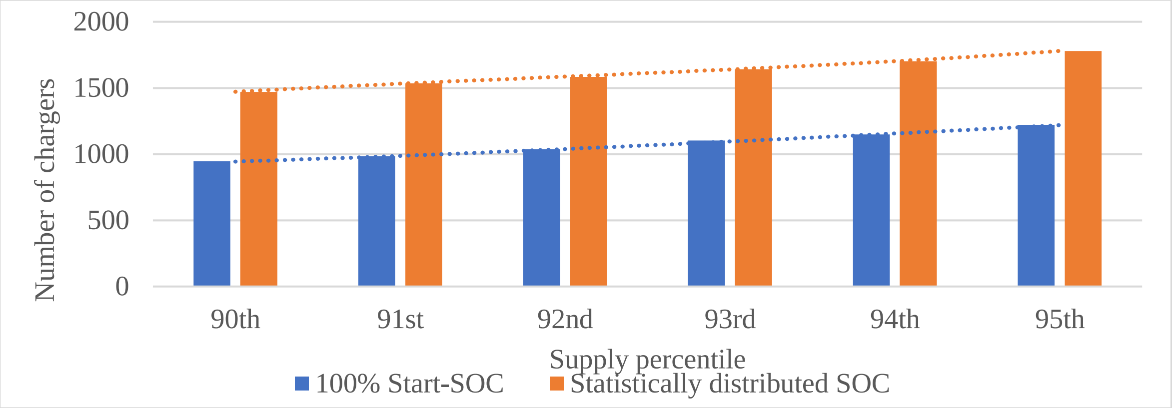


Figure 8: Charger necessity for 10% BETs with different start SoC

Regarding the impact on the truck operations, we compare the two scenarios with a particular focus on their break behaviour (see Table 6). Overall, the number of charging events increases from 46,180 to 80,800 when depot charging is not provided. Additionally, it can be demonstrated that the charging events per truck differ, moving from 0.7 in the scenario with a start SoC of 100%, to 1.2 when SoCs are statistically distributed. As a result, the average break time per truck increases from 31.5 minutes to 54 minutes.

Table 6: Comparison of breaks with and without depot charging

Start-SoC	Charging Events in Total	Charging Events per Truck	Break Time
100%	46,180	0.7	31.5 min
Statistical distribution	80,800	1.2	54 min

4 Discussion

Our analysis reveals a significantly higher ratio of required chargers between the lower and upper supply percentiles for the 1% BET scenario (1:3.6) compared to the 10% BET scenario (1:1.8), despite the calculation for the smaller scenario commencing from the 92nd percentile. This suggests that a proportionately larger initial investment in infrastructure is essential to achieve a substantial enhancement in supply security. For identical supply percentiles, charging infrastructure for a fleet of 10% BETs experiences shorter waiting times and a smaller proportion of waiting vehicles compared to 1% BETs. This is attributed to the more extensively developed charging infrastructure for trucks and the better statistical distribution of a larger fleet across charging points. In the network expansion stages for 1% BETs, even high supply security is critically viewed for logistics companies, because if a truck ends up in a queue, despite a lower probability, waiting times exceeding 20 minutes are deemed too long. It's important to remember that these delays are in addition to traffic jams and other daily disruptions. Although the metrics of vehicle waiting times and the ratio of waiting vehicles to the total fleet see substantial improvements in the 10% scenario with enhanced supply security, the average required waiting time remains a point of critical concern for logistics operations. Regarding the tolerated waiting times for trucks of 15 minutes [29], it's demonstrated that this benchmark cannot be met with an effective and demand orientated infrastructure ramp-up for 1% BETs. Even at 10% BETs, a high supply percentile of more than 96th is necessary. This further emphasizes the need for a rapid and comprehensive rollout of charging infrastructure throughout Germany.

Referring to Speth et al. [18], for an electrification level of 15%, the required number of chargers ranges between 765 and 950, assuming 50% of BETs engage in public charging. When scaled up to our scenario, this translates to an estimated need for 1530 to 1900 chargers, conservatively estimated, since effectively fewer chargers would be needed due to previously described effects. Nonetheless, our results are comparable, as they fall within the 90th to 99th percentile range considered.

Incorporating insights from Shoman et al. [19], our research indicates that Germany would require approximately 8124 to 10155 depot chargers by 2029 to meet the demands of the 95th supply percentile for a 10% BET fleet, correlating to the given 4-5 depot chargers per MCS charger.

Our analysis highlights the critical need for depot charging, demonstrating that increased charging operations, as per current plans, lead to greater downtime for logistics companies' trucks due to the requirement for additional breaks. From an infrastructure perspective, this necessitates an overall increase of 31% in MCS to accommodate the heightened demand.

The described scenario offers an estimate based on the current state of technological development. It is conceivable that the number of charging-required breaks could be reduced in the future. First, future larger batteries will emerge, improving the range of BETs if the volumetric and gravimetric density of battery cells is increased. Second, possibly lower energy reserves (SoC_{min}) could be safely utilized as logistics companies gain experience and the charging network becomes denser. It is essential to note that traffic-related exceptions, including traffic jams and the resulting congestion in parking areas, have not been considered here.

5 Conclusion and Outlook

In this study, we have explored the essential infrastructure requirements for BETs in Germany, focusing on long-haul trucking in the context of the European Union's climate neutrality goals. Our trip-based analysis, relying on MATSim, underscores the critical infrastructure needs to support the market ramp-up of BETs. Through the simulation, we examined various levels of electrification and the pivotal role of depot chargers, orienting our investigation towards demand-driven infrastructure development.

Our study showcases a detailed understanding of supply percentiles, demonstrating that enhanced infrastructure can significantly reduce waiting times and the proportion of waiting BETs., underlining the urgency of infrastructure development. Particularly, the ramp-up must occur swiftly to ensure that logistics companies and early adopters do not experience significant negative impacts, which could harm the reputation of the technology. Another critical insight from our research is the importance of combining high-performance charging with depot charging facilities. The absence of these chargers not only raises the demand for daytime charging but also extends the operational downtime for trucks, underscoring the intricate interplay between charging infrastructure and logistics efficiency.

In conclusion, our research contributes to a critical perspective on the path towards achieving the EU's climate neutrality goals through the electrification of heavy-duty road transport. As we navigate the transition to a more sustainable transport sector, the insights from this study may serve as a cornerstone for policymakers, industry stakeholders, and researchers, highlighting the need for intensive efforts in infrastructure planning.

For future research, we will aim to evaluate required charging power in combination with grid capacities. Additionally, we plan to expand our simulations to a European level, allowing us to grasp the wider implications and potential outcomes of our research across different countries and regions. Another critical aspect is the impact of traffic congestion and the overutilization of parking spaces. Furthermore, the evaluation and application of real data obtained from the HoLa project will offer us a unique opportunity to ground our simulations and predictions in actual user behaviour and system performance. Finally, we aim to simulate the operations over an entire week, providing a comprehensive view that captures the variability in usage patterns and system demands.

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Note according to the guidelines of the German Research Foundation (DFG):
ChatGPT 4 was utilized to support text generation and we can assure that our research remains unaffected by this.

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Presenter Biography

Tobias Tietz joined the Methods of Product Development and Mechatronics department (MPM) at Technische Universität Berlin as a research assistant in June 2023. He completed his five-year mechanical engineering degree at TU Berlin, finishing his master's thesis in April 2023. Currently, he is involved in the High-Performance Charging for Long-Haul Trucking (HoLa) project, which is testing the first MCS chargers for electric trucks on a route between Berlin and the Ruhr area. MPM's team is responsible for defining a data template and assess the real-world data.

Dr.-Ing. **Tu-Anh Fay** is a senior engineer at the chair of Methods in Product Development and Mechatronics at the Technische Universität Berlin, headed by Prof. Dr.-Ing. Dietmar Göhlich. She leads the research group Sustainable Mobility Systems. Tu-Anh Fay started her research career in 2013, supporting the electrification of city buses by implementing a methodical technology comparison of system concepts. Currently, she is involved in the High-Performance Charging for Long-Haul Trucking (HoLa) project, transferring her knowledge from bus to truck electrification.

Tilmann Schlenther is a research associate at Department of Transport Systems Planning and Transport Telematics, led by Prof. Dr. Kai Nagel, at Technische Universität Berlin. He completed his master's studies in Planning and Operation in Transportation at the Technical University of Berlin in 2019. Both thesis works involved simulations using MATSim, including topics related to the integration of freight and passenger transport. His current research focuses on the simulation and impact analysis of innovative mobility concepts for passenger transport.

Prof. Dr.-Ing. **Dietmar Göhlich** is chair of Methods in Product Development and Mechatronics at the Technische Universität Berlin. Prior he held leading positions in passenger car development at Daimler AG, now Mercedes-Benz Group. Dietmar Göhlich is committed to an integrated and climate friendly transition of mobility and energy and is chairman of the Mobility2Grid research campus. His research group is participating in the German research consortium on *High Performance Charging for Long-Haul Trucking* (HoLa) where „megawatt chargers“ for heavy duty electric trucks will be implemented and tested. He is member of German Academy of Science and Engineering (acatech) and author and editor of numerous publications and journals.