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Beijing, 2021

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List of Abbreviations

ARL	Academy for Territorial Development in the Leibniz Association
B2B	Business-to-business
B2C	Business-to-consumer
BAG	Federal Freight Transport Agency
BdKep	Federal Association of Courier-Express-Post-Services e.V.
BEV	Battery Electric Vehicle
BEVH	German E-Commerce and Mail Order Association
BFSTRMG	Federal Truck Road Toll Act
BIEK	Federal Association for Parcel and Express Logistics
BImschV	Federal Immission Control Act
BMAS	Federal Ministry of Labour and Social Affairs
BMBF	Federal Ministry of Education and Research
BMJV	Federal Ministry of Justice and Consumer Protection
BMU	Federal Ministry for the Environment, Nature Conservation and Nuclear Safety
BMVI	Federal Ministry of Transport and Digital Infrastructure
BMWi	Federal Ministry for Economic Affairs and Energy
bn	Billion
BNetzA	Federal Network Agency
BVWP	Federal Transport Infrastructural Plan
CEP	Courier, Express and Parcel service
CNG	Compressed Natural Gas
CO2	Carbon Dioxide
d	Day
DIN	German Institute for Standardization
DST	German Association of Cities
DStGb	German Association of Cities and Municipalities
€	Euro
EC	European Commission
EU	European Union
FCD	Floating Car Data
FMCG	Fast Moving Consumer Goods
GCP	Green City Plan

GDP	Gross Domestic Product
GHG	Greenhouse Gas
GVA	Gross Value Added
GVW	Gross Vehicle Weight
HBEFA	Manual of Emission Factors of Road Transport
HDE	German Trade Association
IW	German Economic Institute
IWVK	Integriertes Wirtschaftsverkehrskonzept
KBA	Federal Motor Transport Agency
kg	Kilogram
km	Kilometer
LNG	Liquefied Natural Gas
M	Million
m²	Square Meter
MFS	Mobility and Fuels Strategy
NOx	Nitrogen Oxides
PHEV	Plug-in Hybrid Electric Vehicle
PM	Particulate Matter
SENUVK	Senate Department for Environment, Transport and Climate Protection
SME	Small and Medium-sized Enterprises
StEP	Stadtentwicklungsplan (Urban Development Plan)
StVO	Road Traffic Act
StVZO	Road Traffic Licensing Act
t	Metric ton
US $	US-Dollar

Definitions

The logistics segment **Courier, Express and Parcel Service (CEP)** includes logistics service providers that focus on the transport of shipments, that weigh between 2 and 31.5 kilograms (kg) or have a maximum combined length and a maximum circumference of 3 m per loading unit. (Schwemmer 2019)

Business-to-Consumer (B2C) refers to shipments from companies to end customers, while **Business-to-Business (B2B)** refers to shipments between companies.

In the context of B2C and CEP, the **last mile** is defined as the delivery tour from the regional hub to the end customer (Brabänder 2020). The last mile accounts for approx. 50 % of the total costs incurred. (Schwemmer 2019)

Shipment is the delivery to a customer, which can consist of several parcels. A parcel is a single box or bin.

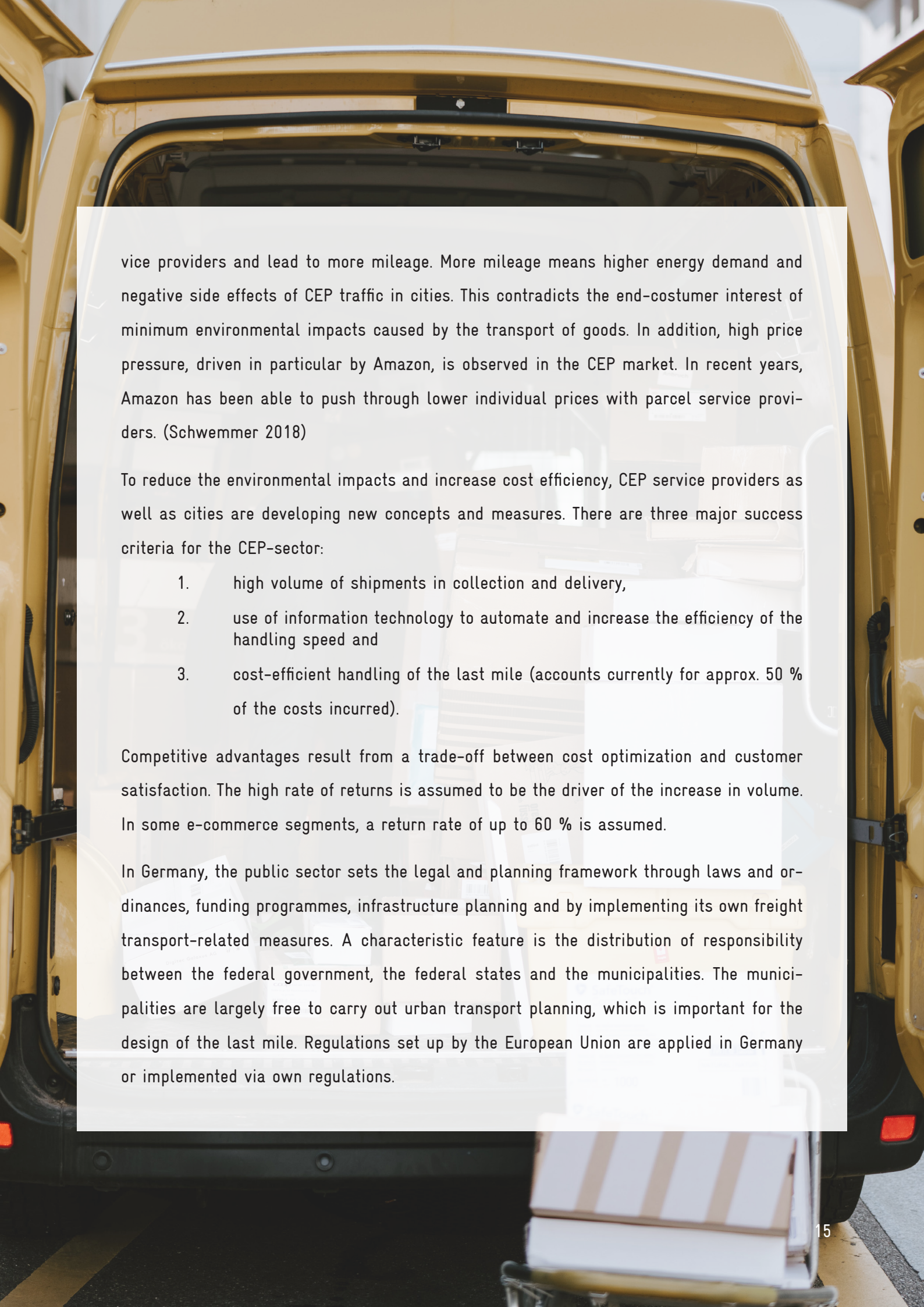
Summary

This study focusses on the last mile organisation, the framework conditions and the structure of the courier, express and parcel (CEP) sector in Germany. As part of a comparative study that compares the processes, the political and conceptual framework conditions as well as the innovative strength of both the Chinese and the German CEP system, this study was prepared in close cooperation with the China Transport Planning and Research Institute (TPRI), which, analogous to the German study, examined the Chinese CEP market and its design and framework conditions.

The handling of the last mile is a result of national and local framework conditions set by society, politics and public sector planning, as well as the market situation and the stakeholders in the market, which include competitors, contracting authorities and contractors.

The parcel market in Germany is essentially made up of five players that operate nationwide. In 2018, the growing parcel market had a sales volume of 11.4 bn €. According to the Federal Network Agency, Deutsche Post AG is dominant with its brand DHL, which has a market share of 45.5 %. (Wambach et al. 2019) In addition, Amazon, which was so far a significant shipper and client of the CEP service providers, has built up its own CEP logistics (with focus on express and parcel services) in recent years, which is already in operation, especially in metropolitan areas.

The growth of e-commerce has changed distribution in cities. E-commerce is heavily dependent on a reliable and short delivery time to fulfil the main interest of the end-consumer: Immediate availability and rapid delivery of goods. Online retailers are therefore demanding CEP services such as Same-Day Delivery, so the requirements that customers in the B2C segment place on CEP service providers are becoming similar in scope to those in the B2B segment. Furthermore, the smaller time windows reduce bundling, which is actually desirable for environmental reasons, and thus increase the costs for the CEP ser-



vice providers and lead to more mileage. More mileage means higher energy demand and negative side effects of CEP traffic in cities. This contradicts the end-costumer interest of minimum environmental impacts caused by the transport of goods. In addition, high price pressure, driven in particular by Amazon, is observed in the CEP market. In recent years, Amazon has been able to push through lower individual prices with parcel service providers. (Schwemmer 2018)

To reduce the environmental impacts and increase cost efficiency, CEP service providers as well as cities are developing new concepts and measures. There are three major success criteria for the CEP-sector:

1. high volume of shipments in collection and delivery,
2. use of information technology to automate and increase the efficiency of the handling speed and
3. cost-efficient handling of the last mile (accounts currently for approx. 50 % of the costs incurred).

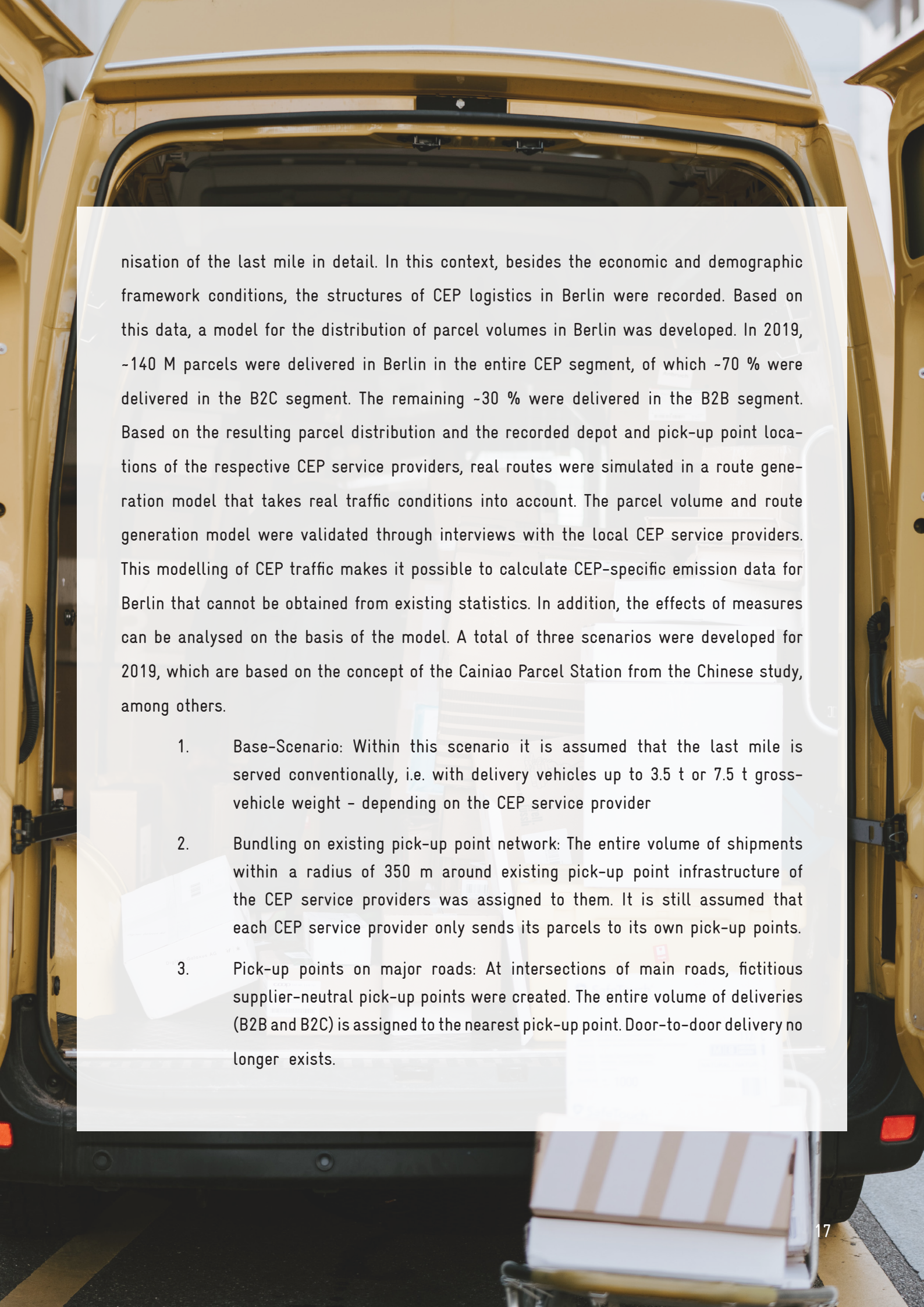
Competitive advantages result from a trade-off between cost optimization and customer satisfaction. The high rate of returns is assumed to be the driver of the increase in volume. In some e-commerce segments, a return rate of up to 60 % is assumed.

In Germany, the public sector sets the legal and planning framework through laws and ordinances, funding programmes, infrastructure planning and by implementing its own freight transport-related measures. A characteristic feature is the distribution of responsibility between the federal government, the federal states and the municipalities. The municipalities are largely free to carry out urban transport planning, which is important for the design of the last mile. Regulations set up by the European Union are applied in Germany or implemented via own regulations.

Regulations from various areas are relevant for the CEP sector. With regard to environmental and climate protection, these include laws and regulations of the EU and the German government, for example, CO_2 fleet limits, emissions standards for vehicles and air pollution limits. Relevant laws and regulations of the EU and the German government also concern traffic rules, vehicle registration, regulation of driving and working times, regulation of subcontractors and market regulation.

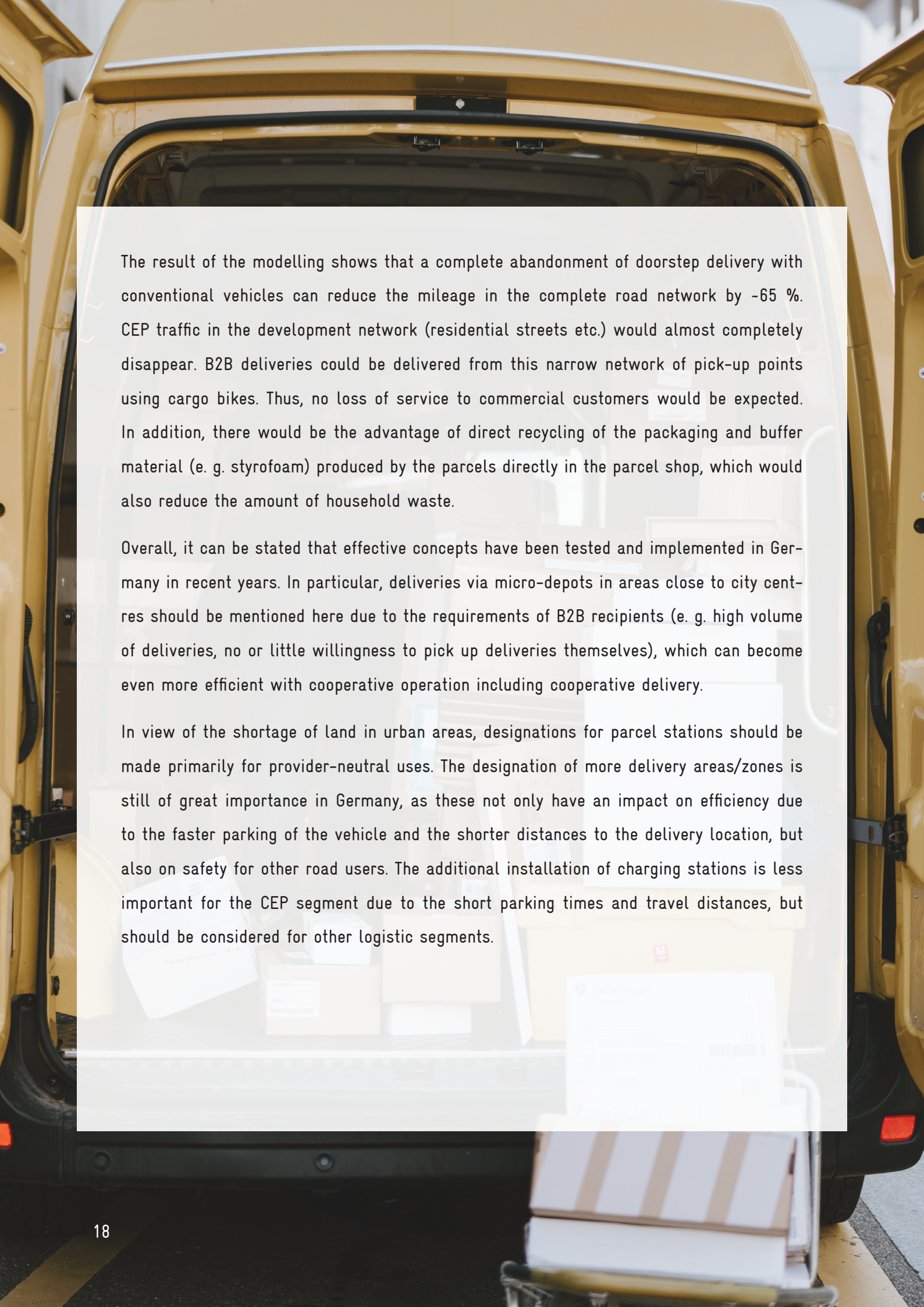
In addition to legal framework conditions, strategic framework conditions are also set. The European Union and the federal government have published several strategies – particularly with the aim of achieving the climate targets set by the National climate protection law through appropriate measures. In order to provide incentives for action, various funding programs exist, for example, programs that provide support for alternative drive systems or the implementation of urban logistics concepts. These funding programmes not only address companies, but also municipalities implementing innovative measures in the area of the last mile. In addition to the public sector, market participants of the CEP sector also have their own sustainability strategies. Another incentive for a stronger focus on sustainability are the end customers, who are paying more attention to it.

Measures that have already been implemented or tested in Germany have been analysed in the context of this study and classified according to the type of measure. This shows that the majority of measures already implemented are very similar and continue to be recommended in expert reports, e. g. in Green City Plans. The majority of the recommended measures are the establishment of micro-depots, the expansion of the parcel station network and the promotion of e-mobility, especially through the designation of delivery areas with charging stations. In addition to surveying the national framework conditions and market situation, this study uses the example of the city of Berlin to show and analyse the orga-



nisation of the last mile in detail. In this context, besides the economic and demographic framework conditions, the structures of CEP logistics in Berlin were recorded. Based on this data, a model for the distribution of parcel volumes in Berlin was developed. In 2019, ~140 M parcels were delivered in Berlin in the entire CEP segment, of which ~70 % were delivered in the B2C segment. The remaining ~30 % were delivered in the B2B segment. Based on the resulting parcel distribution and the recorded depot and pick-up point locations of the respective CEP service providers, real routes were simulated in a route generation model that takes real traffic conditions into account. The parcel volume and route generation model were validated through interviews with the local CEP service providers. This modelling of CEP traffic makes it possible to calculate CEP-specific emission data for Berlin that cannot be obtained from existing statistics. In addition, the effects of measures can be analysed on the basis of the model. A total of three scenarios were developed for 2019, which are based on the concept of the Cainiao Parcel Station from the Chinese study, among others.

1. Base-Scenario: Within this scenario it is assumed that the last mile is served conventionally, i.e. with delivery vehicles up to 3.5 t or 7.5 t gross-vehicle weight - depending on the CEP service provider
2. Bundling on existing pick-up point network: The entire volume of shipments within a radius of 350 m around existing pick-up point infrastructure of the CEP service providers was assigned to them. It is still assumed that each CEP service provider only sends its parcels to its own pick-up points.
3. Pick-up points on major roads: At intersections of main roads, fictitious supplier-neutral pick-up points were created. The entire volume of deliveries (B2B and B2C) is assigned to the nearest pick-up point. Door-to-door delivery no longer exists.



The result of the modelling shows that a complete abandonment of doorstep delivery with conventional vehicles can reduce the mileage in the complete road network by ~65 %. CEP traffic in the development network (residential streets etc.) would almost completely disappear. B2B deliveries could be delivered from this narrow network of pick-up points using cargo bikes. Thus, no loss of service to commercial customers would be expected. In addition, there would be the advantage of direct recycling of the packaging and buffer material (e. g. styrofoam) produced by the parcels directly in the parcel shop, which would also reduce the amount of household waste.

Overall, it can be stated that effective concepts have been tested and implemented in Germany in recent years. In particular, deliveries via micro-depots in areas close to city centres should be mentioned here due to the requirements of B2B recipients (e. g. high volume of deliveries, no or little willingness to pick up deliveries themselves), which can become even more efficient with cooperative operation including cooperative delivery.

In view of the shortage of land in urban areas, designations for parcel stations should be made primarily for provider-neutral uses. The designation of more delivery areas/zones is still of great importance in Germany, as these not only have an impact on efficiency due to the faster parking of the vehicle and the shorter distances to the delivery location, but also on safety for other road users. The additional installation of charging stations is less important for the CEP segment due to the short parking times and travel distances, but should be considered for other logistic segments.

1 Introduction

The study at hand is part of an overall concept in which two parallel studies are being conducted with the aim of comparing the organisation, processes, framework conditions and measures of the last mile delivery in Germany and China.

The aim of this study is to give an overview of the current situation as well as the developments of CEP shipment volume and the CEP delivery processes on the last mile with regard to sustainability and efficiency criteria. For this purpose, the current state of research and already existing or implemented measures for optimising last mile logistics in Germany are presented and discussed in the context of the existing planning and economic framework conditions.

In a first step, the administrative and support policy framework conditions (cp. Chapter 2.2 and 2.5) as well as the relevant laws and regulations and strategy and planning documents are presented at the national level (cp. Chapter 2.3 and 2.4). In addition, an overview of all relevant stakeholders and their interests is provided (cp. Chapter 2.6).

Chapter 3 differentiates the CEP sector from other delivery transport sectors within the city and describes the market situation and development of parcel volumes as well as the volume generators in this market. In addition to the development of parcel volumes, the development of the vehicle fleet will be examined in particular. CEP service providers face great challenges when it comes to the last mile of the supply chain. In addition, the increasing volume of traffic is leading to an increase in conflicts within cities. In response to these challenges CEP providers and cities react with delivery concepts, city-logistic-concepts and single measurements (cp. Chapter 3.5).

Finally, by developing a detailed case study in Berlin, the last mile organisation in the CEP segment in a German city will be examined in more detail (cp. Chapter 4). For this purpose, the volume of shipments in the CEP segment is calculated on the basis of the population and information on commercial locations (cp. Chapter 4.3.1). Emissions and mileage are calculated with the help of a model because no CEP-specific emissions data are available in the statistics.

The model is also used to model a form of delivery presented in the Chinese partner study and the results are to be compared with each other.

2 Brief Analysis of the Regulatory and Political Conditions on National Level

This chapter outlines the general conditions for the national CEP-market in Germany. For this purpose, basic information on economic development is presented (cp. Chapter 1). In order to enable a comparison between China and Germany, the political, governmental and funding framework (cp. Chapter 2, 5) as well as laws and regulations with influence on the CEP market are of particular relevance (cp. Chapter 3). Furthermore, strategic plans and other planning documents are named and explained (cp. Chapter 4). In addition, the respective stakeholders in this field are named and described (cp. Chapter 2 and 6).

2.1 Basic Economic Indicators

As of 30.06.2020, Germany had 83,122,889 inhabitants (Destatis 2020a). According to UN (2019), gross domestic product per capita was 46,232 US $.

In 2019, the nominal gross value added of the German economy as a whole amounted to 3,106.157 billion € (bn €) (Destatis 2020b). Figure 1 shows the nominal gross value added for each economic sector. The sectors „Production industry without construction“, „Manufacturing“, „Public service providers, education and health“ as well as „Trade, transport and hospitality“ are of high importance for the German economy.

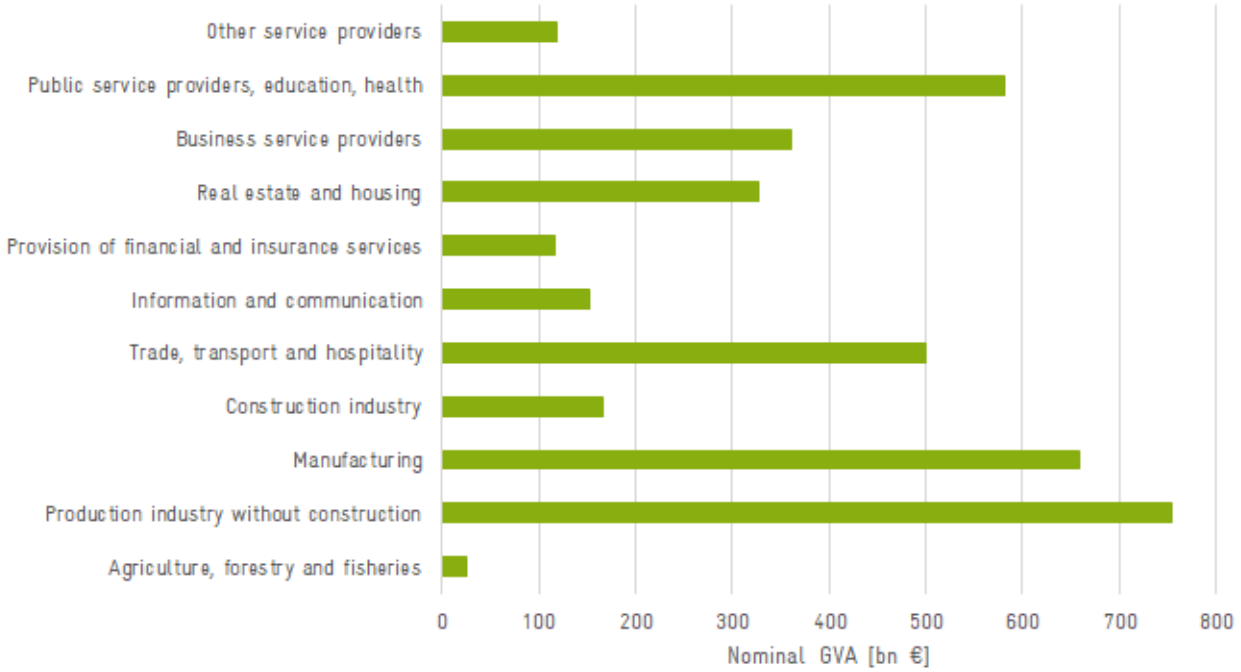


Figure 1: Nominal Gross Value Added by Economic Sector in Germany in 2019

On the basis of the gross domestic product per capita, Figure 2 shows that there are regional differences in economic strength within the country. To date, it is evident that the „new" federal states, the federal states that were part of the German Democratic Republic until 1990, are economically weaker than the rest of the country. Furthermore, the South of Germany (including Hesse) and Hamburg represent the strongest economic regions.

2.2 Overview of Relevant Governmental Authorities

2.2.1 General Description of the German Political System

Germany is a federal state. That means the

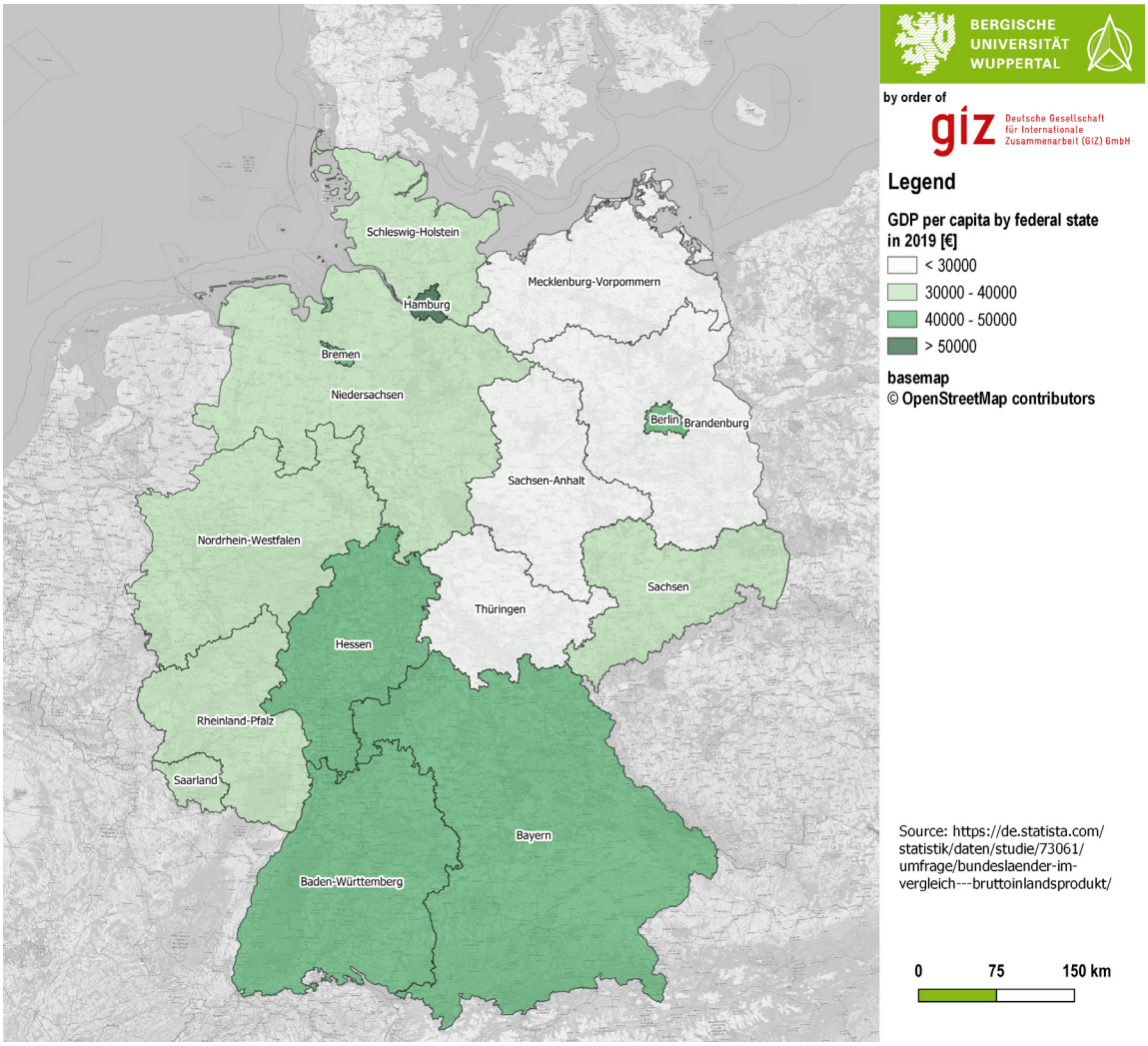


Figure 2: GDP per Capita by Federal State in 2019 (Statista GmbH)

state authority is separated vertically between the 16 federal states (Bundesländer) and the Federation (Bund) (see Figure 3). This distribution of state authority "means that not only the Federation itself but also the […] [federal] states possess statehood." (ARL n. d.a) This so-called principle of federalism gives greater weight to regional specificities and initiatives (ibid). The German political system is further characterized by a functional federalism, in which legislation is predominantly the responsibility of the federal government. Execution is usually the task of the federal states. (Rudzio 2011)

The German Basic Law determines the policy areas in which the state has exclusive legislative power. Concerning postal service and telecommunication, the Basic Law defines the responsibility of the Federal Government. Otherwise, the Federation and the federal states have joint legislative power (concurrent legislation). In the area of concurrent legislation, the federal states have the power to legislate as long as the Federation has not exercised its legislative competence by law. In some policy fields (e. g. road traffic) the Federation only has the right to legislate when the establishment of equivalent living conditions in the federal territory or the preservation of legal or economic unity in the interest of the entire state requires federal legislation.

Furthermore, the Basic Law stipulates that the municipalities/county-free cities have the right to regulate all matters of the local community on their own responsibility (right to self-government).[1] This also includes matters that must be regulated on a mandatory basis (e. g. urban land use planning) (ARL n. d.b; Schmidt-Eichstaedt et al. 2019).

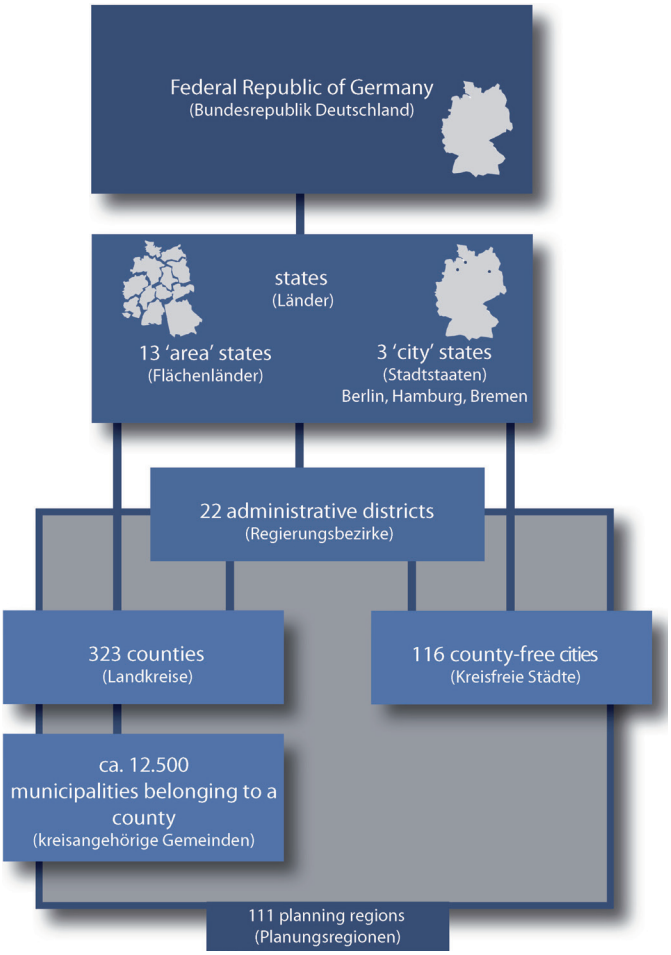


Figure 3: Administrative Structure of the Federal Republic of Germany (ARL n. d.a)

1 German: Kommunale Selbstverwaltung und Planungshoheit

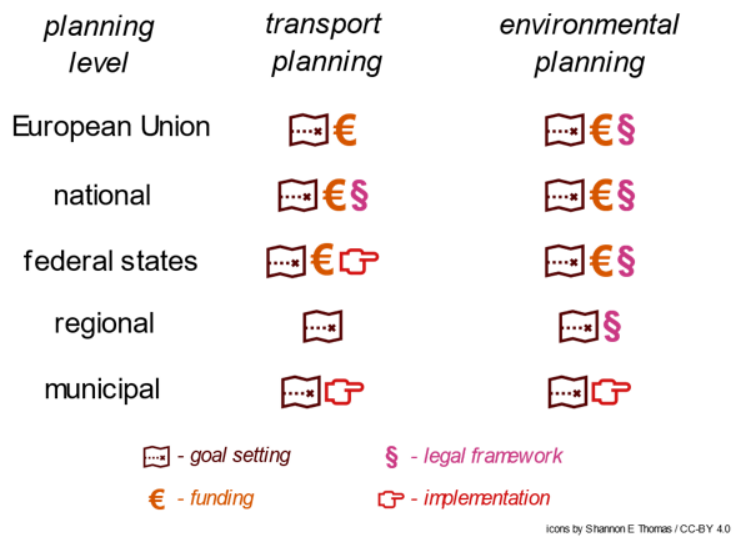


Figure 4: Responsibilities in Freight Transport-related Planning Activities by Planning Level

As Germany is part of the **European Union (EU)**, the regulations of the **European Commission (EC)** apply here as well and therefore their authorities are also relevant.

2.2.2 Responsibilities and Actions in Freight Transport Related Planning Activities

The different hierarchies have different responsibilities within the framework of freight transport planning. Basically, the higher planning levels focus on goal setting, legal framework and funding, whereas the deeper planning levels also implement measures. (see Figure 4)

In Germany, the Federation and the federal states are also involved in the implementation of high-level transport networks. The concretisation of the set goals increases with the depth of the planning level. For a more detailed presentation of the planning instruments see Appendix I.

With regard to the consideration of the last mile in urban transport planning, it must be considered that urban transport planning itself is not regulated by higher-level law, but must comply with technical standards, general road traffic regulations and contribute to the fulfilment of noise and air pollution limits.

2.2.3 Relevant Governmental Authorities on National Level

On national level several federal ministries and authorities are relevant for the CEP segment.

The **Federal Ministry of Transport and Digital Infrastructure (BMVI)** issues regulations (e. g. Road Traffic Act (StVO) and Road Traffic Licensing Act (StVZO)), it provides funding for transport-related research

projects, innovative logistical measures and the purchase of (commercial) vehicles with alternative drive systems. It also issues nationwide transport master plans for all transport modes, especially the Federal Transport Infrastructural Plan (BVWP). The subordinate **Federal Freight Transport Agency (BAG)** supervises EU-wide and national regulations for the freight transport market, the national truck toll, compiles transport statistics and carries out market surveys.

On the other hand, the **Federal Ministry of Labour and Social Affairs (BMAS)** issues regulations on all labour law matters (e. g. working time and subcontracts).

The **Federal Ministry for Economic Affairs and Energy (BMWi)** covers market regulations on postal services. The compliance with market regulations is ensured by the subordinate **Federal Network Agency (BNetzA)**. Unlike mail services, which must have a license, CEP segment providers only have to notify the start of their activities (obligation to notify) (BMWI 1997). Therefore, the Federal Network Agency focusses on market observation in the CEP segment (BNetzA 2017). Furthermore, it mediates disputes between customers and postal service providers (BNetzA 2020).

The **Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU)** issues regulations regarding climate protection and air quality (e. g. Federal Immission Control Act (BImschV)) and therefore implements the rules of the European Union. It also provides funding for climate-friendly measures and concepts that are also related to transport issues (National Climate Initiative).

The **Federal Ministry of Justice and Consumer Protection (BMJV)** regulates issues on consumer protection (e. g. for e-commerce). (BMJV 2021)

Finally the **Federal Ministry of Education and Research (BMBF)** provides funding for transport-related research projects. (BMBF 2019)

2.2.4 Relevant Governmental Authorities

The European Commission and its subordinate directorates are also relevant for the German CEP sector, because EU regulations must be implemented on national level. So, for example, the **Directorate-General for Environment** sets binding rules for air pollution control. (EC 2020a)

The **Directorate-General for Mobility and Transport** regulates the design of national truck tolls (EC 2020b) and the **Directorate-General for Internal Market, Industry, Entrepreneurship and SMEs** sets [among others] out the objectives for postal services and establishes a regulatory framework for European postal services. (EC n. d.)

2.2.5 Other Stakeholders

Additional stakeholders are briefly considered below and come from the private and public sector.

CEP-company Representatives

The **Federal Association for Parcel and Express Logistics (BIEK)** and the **Federal Association of Courier-Express-Post-Services e.V. (BdKep)** represent the interests of the major market participants with the exception of DHL (→BIEK) and the medium-sized market participants respectively (→BdKEP). (BIEK n. d.; BdKEP n. d.)

Employee Representatives

Employee representation is organized by the trade union ver.di, which is part of the German Trade Union Confederation (ver.di n. d.). The low level of unionization is an obstacle for effective employee representation (German Bundestag 2014). The large market players engage a large number of subcontractors (Schlautmann 2019), which is also likely to be an obstacle to worker representation.

Municipal Representatives

The **German Association of Cities and Municipalities (DStGb)** and the **German Association of Cities (DST)** represent the municipal interests. DST represents primarily the independent cities and cities with more than 50,000 inhabitants, while DStGb mainly represents small and medium-sized towns and municipalities, that are part of a district[2]. (DStGB n. d.; DST n. d.)

Consumer Protection

The **Consumer Protection Agency** is an independent, mainly publicly funded, non-profit organization. It informs, advises and supports consumers and serves as a contact point for complaints relating to services provided by the CEP sector. Moreover, it represents the interests of German consumers. (Verbraucherzentrale Bundesverband n. d.)

Shipper Representatives

Shippers in the B2C segment also have their own representatives. For instance, the **German E-Commerce and Mail Order Association (BEVH)** represents the interests of retailers in e-commerce (BEVH 2020). The **German Trade Association (HDE)** represents the entire German retail trade and thus also the stationary retailers (HDE n. d.).

National Standards

The **German Institute for Standardization (DIN)** is an independent institution for standardisation in Germany and worldwide. Standards are also being developed for the CEP sector (e. g. for parcel boxes). (DIN 2015, n. d.)

2 In German: "(Land-)Kreis".

International Standards

The GS1-network develops standardised cross-company processes along the value chain. For that matter, identification, data storage, communication and process standards are developed (GS1 Germany GmbH 2016). For instance with the open GS1 standard it is possible to identify parcel shipments independently of the CEP service provider used, track shipments across service providers along the entire transport chain (ibid). The standard is being tested in a pilot project by BdKEP (representative of medium-sized CEP service providers) and is intended to serve as a perspective supplement to the proprietary systems of the large market participants (Drewes 2017).

2.3 Overview of Relevant Laws and Regulations

The following laws and regulations concerning road traffic, environmental and climate protection, labour law and market regulation must be observed in the economic activity of parcel services.

2.3.1 Road Traffic Regulations

Table 1 gives an overview and describes the actual road traffic regulations in Germany.

Table 1: Road Traffic Regulations in Germany

ROAD TRAFFIC REGULATIONS	DESCRIPTION
ROAD TRAFFIC LAW (STVG)	Defines basic rules for road traffic Contains regulations on driver's licenses and fines (Deutscher Bundestag 2020)
ROAD TRAFFIC ACT (STVO)	Lays down the traffic rules in Germany Amendment adopted in spring 2020 contains regulations that serve to strengthen bicycle traffic: a separate traffic sign for cargo bikes has been introduced (BMVI 2020d)
ROAD TRAFFIC LICENSING ACT (STVZO) / VEHICLE REGISTRATION ORDINANCE	Regulates the registration of vehicles and includes the permissible dimensions of vehicles and vehicle combinations (BMVBS 2011)
FEDERAL TRUNK ROAD TOLL ACT (BFSTRMG)	Regulates the collection of tolls for trucks on German trunk roads Applies to trucks from 7.5 t (metric) gross vehicle weight (BMVI 2020b). In December 2020, the national transport ministers agreed on a common position for a revision (Hütten 2020). The agreement includes, among others, an extension of the toll obligation to vehicles with a permissible total weight of 3.5 t or more

Table 2: Environmental and Climate Protection

ENVIRONMENTAL AND CLIMATE PROTECTION	DESCRIPTION
CLIMATE PROTECTION	National climate protection law was adopted in 2019. Targets on reducing greenhouse gas emissions by 2030 by at least 55 % compared to 1990. (Federal Government 2019)
CO_2 FLEET LIMITS	As of 2020, a limit for vehicle-related CO_2 emissions for light commercial vehicles of 147 g CO_2/km has been in place (EC 2014) Value will be lowered by 31 % by 2030 (e. g. EC 2019a) Concerning heavy commercial vehicles in 2019 a regulation was issued for the first time. According to this, CO_2 emissions must be reduced by 15 % by 2025 and by 30 % by 2030 compared to the fleet emissions in 2019. The fleet limits which have been set in 2019 will initially only apply to trucks with a gross vehicle weight of more than 16 t (EC 2019b)
POLLUTANT EMISSION LIMITS	EC imposes limits on air pollutions. At the moment the Euro 6 emission standard is mandatory for new cars and light commercial vehicles (e. g. EC 2007). With the introduction of the Euro 6d-TEMP emission standard in September 2019, on-road measurements for air pollutants like particulate matter (PM) and nitrogen oxides (NO_x) have become part of the vehicle approval test procedure for the first time. (e. g. EC 2017)
AIR QUALITY	The Federal Immission Control Act (BImschV) implements the regulations of the EC (e. g. EC 2008) on air quality If the air pollution limit values are exceeded, low emission zones are designated by the municipalities. Currently there are 57 low emission zones and in 56 of them diesel vehicles are only allowed to enter, if they are equipped with Euro 4/IV emission standards or better. (UBA 2020) In 2017 already 76 % of the vehicle fleet of the major CEP service providers showed an emission standard of Euro 5/V or better. (BIEK 2018a)

2.3.2 Environmental and Climate Protection

Table 2 gives an overview and describes the current laws and regulations in Germany for environmental and climate protection.

2.3.3 Labour Law

Regulations on Driving and Working Hours

The maximum permitted driving time in the European Union is nine hours per day. Individual extensions are possible as an exception, but must be combined with longer rest periods. The EC has adopted this regulation for vehicles with a maximum permissible weight of 3.5 t. In Germany, the regulations already applies to vehicles with a permissible gross weight of 2.8 t and therefore to all vehicles used in the CEP area. (EC 2006; BMVBS 2005).

In addition, national rules on working time

apply. As a general rule, the working time of employees should not exceed eight hours per working day. In exceptional cases, it may only be extended to up to ten hours. In sum working time is not supposed to exceed 48 hours per week. In exceptional cases, it may be extended to up to 60 hours. (German Bundestag 1994)

Regulation on Subcontractors

In the German CEP segment subcontractors are used to a large extent (Schlautmann 2019). According to the trade union ver.di, some of the major providers had a subcontractor share of almost 100 % in 2013 (ver.di 2013). In this sector, labour law violations often occur (Schlautmann 2018). To avoid labour law infringements such as undeclared work or social insurance fraud, in 2019 the "parcel courier protection law" was adopted. Anyone who accepts a contract and subcontracts it to a subcontractor is liable for the social insurance contributions which are to be paid by the subcontractor. (German Bundestag 2019)

2.3.4 Market Regulation

In order to strengthen e-commerce in the European internal market and to reduce the previously very high prices for cross-border parcel shipments, an obligation was introduced for parcel services to publish the prices for cross-border parcel shipments. (EC 2018)

A revision of the German Postal Act is currently underway to strengthen consumer rights. In addition, the possibility of governmental support for cooperations between parcel service providers for inner-city deliveries is also examined. (BMWi 2019)

2.4 Overview of Strategy and Planning Documents

The **EU White Paper "Roadmap to a Single European Transport Area"** published by the EC in 2011 defines strategic goals for the development of the European transport system, e. g. related to climate protection. Initiatives are proposed for the implementation of the objectives. One goal is to "achieve essentially CO_2-free city logistics in major urban centres by 2030" (EC 2011).

Furthermore, the German **Mobility and Fuels Strategy (MFS)** was published in 2013 and serves as a central instrument for shaping energy system transformation in transport. The MKS focusses on the design of climate-friendly transport. It is designed as a "learning strategy". Therefore, the scientific consortium is conducting studies on measures and technologies that can contribute to reduce energy consumption and Greenhouse gas (GHG) emissions. Practical perspectives of the central actors from industry, science and society are included in interviews to answer the research questions, so that relevant developments can

be considered at an early stage, e. g. in the design of funding guidelines. (BMVI 2018a)

The **Concept for Climate-Friendly Commercial Vehicles**, which was published in November 2020 by the Federal Ministry of Transport and Digital Infrastructure, serves to implement the climate targets in freight transport. It includes a subsidy strategy for the purchase of climate-friendly commercial vehicles. Additional procurement costs compared to diesel trucks are to be subsidised by up to 80 %. It also contains a strategy for the necessary tank and charging infrastructure for commercial vehicles with alternative drive systems. Regulatory conditions for the promotion of alternative drive systems will be created by introducing a truck toll which is based on the vehicles CO_2 emissions. Initially, no selected technology will be funded; instead, all technologies (e. g. battery electric vehicles, fuel cell electric vehicles) will initially be given equal status. (BMVI 2020a)

The **Innovation Programme Logistics 2030** addresses amongst others the last mile in the CEP segment. As an implementation for a sustainable design of the last mile, the concept proposes the promotion of electric commercial or delivery vehicles that include the respective charging infrastructure, the promotion of micro-depot initiatives and a simplification of the approval of night logistics. (BMVI 2019b) In addition, CEP service providers have their own strategies for achieving a more sustainable design of their transports. The big five market players (DHL, Hermes, UPS, GLS, DPD according to Schwemmer (2018)) all have own **sustainability strategies**. GLS, DPD and DHL already offer climate-neutral parcel shipping for B2C-shipments throughout Germany (GLS Germany n. d.; dpdgroup n. d.; Deutsche Post DHL Group n. d.).

DHL aims to reduce all logistics-related emissions to net zero by 2050. By 2025, DHL also aims to reduce emissions of local air pollutants by using zero-emission solutions for 70 % of deliveries and collections (share in 2019: 33 %). This refers to the company's own services and not those of subcontractors. (Deutsche Post DHL Group 2019) The DPD Group plans to reduce its CO_2 equivalent emissions by 30 % by 2025 compared to 2013 (dpdgroup 2020a). For this, the DPD Group aims at making parcel delivery in 225 European cities, including 23 in Germany, CO_2 free by 2025 (dpdgroup 2020b). By 2040 the entire last mile is to be CO_2 free (ibid).

2.5 Government Support Programs

Funding for City Logistics Projects

Existing funding directives provide subsidies for the implementation of urban logistics concepts, feasibility studies on projects in urban

logistics (e. g. white-label micro-depots[3]) and the implementation of sustainable projects in urban logistics (BMVI 2019a; BMU 2021b, 2021a, 2020; BMVI 2019b). The eligibility to apply is regulated differently. For some funding directives, only municipalities are eligible to apply (ibid). Most of the support programs are set up by the federal government; some federal states also provide subsidies (VM NRW 2019).

Funding and Support for Alternative Drive Systems

Funding is also provided, for example, for the purchase of trucks and tractors powered by compressed natural gas (CNG), liquefied natural gas (LNG) or electric drive systems whose permissible gross weight is at least 7.5 t as well as for the purchase of battery electric vehicles (BEV), plug-in hybrid electric vehicles (PHEV) with a minimum range of 40 km and fuel cell cars with a maximum permissible weight of up to 3.5 t (BMVI 2018b; BMWI 2020). Further funding for BEV and PHEV is provided in connection with municipal electromobility concepts, among other things (BMVI 2017). In addition to the federal government, some federal states (e. g. North Rhine-Westphalia) also fund the purchase of electric vehicles between 3.5 and 7.5 t gross vehicle weight. (MWIDE NRW 2020)

Electric-power heavy duty vehicles are exempted from the national truck toll (German Bundestag 2011). CNG-powered heavy duty vehicles are planned to be exempted from the national truck toll until 2024 (BAG 2020)[4].

Funding for Turn-off Assistants

In order to promote turn-off assistants for vehicles with a maximum gross vehicle weight of over 3.5 t, the respective equipment and retrofitting of turn-off assistants is funded by the **Funding Directive for the Equipment of Vehicles with Turn-Off Assistance Systems** (BMVI 2020c), before their mandatory introduction comes into force (from 2024 for all newly registered vehicles according to EC (2019))

2.6 Stakeholder Interests

According to Russo and Comi (2011) the relevant actors/ stakeholders in urban B2C freight transport are:

- End-consumers,
- Logistics and transport operators and
- Public administration.

The **end-consumers** comprise among others of residents and businessmen. Their main interests are primarily the delivery of the ordered products with a short lead time and se-

3 Refers to a stationary or mobile interim storage facility through which transhipment takes place on the last mile (e. g. from the truck to the cargo bike) Stodick and Deckert 2019

4 This regulation is currently questioned, because it contradicts European law (Hütten and Landwehr 2020).

condarily minimal environmental impact due to the transport of goods. (based on Russo and Comi (2011)) Additionally, half of the recipients of CEP-shipments consider it important to be able to specify the day or a delivery time window for the delivery of the shipment. (MRU GmbH 2016)

The **logistics and transport operators** comprise of the shippers and the transport companies (Russo and Comi 2011). The shippers' main interest is the "delivery and pickup of goods at the lowest cost while meeting customer needs" (ibid). The transport operator, in this case the CEP service provider, tries to satisfy the requirements of the end customer and shipper by working cheaply and with high quality service (ibid). The production of parcel services, which has so far been based on a high degree of standardisation, is reaching its limits due to the increasing demand for flexibility from parcel recipients (Manner-Romberg et al. 2016). The last mile accounts for approx. 50 % of the costs incurred (Schwemmer 2019). Thus, new services such as pick-up points are used to facilitate delivery and to reduce costs (Bogdanski 2017). One option to make the last mile more efficient is the cooperation of the CEP service providers, e. g. by sharing pick-up points or micro-depots (Wambach et al. 2019). So far, however, there is no willingness to cooperate on the part of market participants (Junk and Wielgosch 2019).

Furthermore, city logistics projects aiming at establishing a more sustainable freight transport system concentrate currently on (subsidised) pilot projects in large cities and have not yet been implemented across the board (Junk and Wielgosch 2019). This may be due to the very low innovation intensity (share of innovation expenditure in turnover) in the whole CEP sector compared to other sectors of the economy (ZEW 2019). Only 5 % of companies in the CEP sector carry out Research & Development (R&D) projects continuously or occasionally (ibid).

The **public administration** comprises the municipality which aims to make the city more liveable while at the same time it has to implement legal regulations (e. g. on air pollution control). However, it also comprises the national government, as it aims to fulfil minimizing external effects and maximizing noneconomic benefits.(Russo and Comi 2011; Bogdanski 2017) Although it is considered to be one of the main tasks of the city's administration to organise urban transport, it has only indirect control over urban freight transport, since unlike passenger transport it is completely privately organised. (Leerkamp et al. 2020) One measure to be implemented by the municipality is the introduction of regulations and moderation between the local actors of urban freight transport. (ibid) The formal principle of the **urban logistics funding directive**, that cities should implement urban logistics projects in-

dependently, must therefore be questioned.

Delivery Process

Shippers, transport operators and end-consumers are directly involved in the process of CEP service provision. The shipper hands over the parcel to the CEP service provider and the end customer receives the parcel in the end of the delivery process (e. g. at home or at a pick-up point). Although the **end customer** comes into contact with the CEP service provider, they are usually not their contractual partners, as that is usually the shipper. So, their interests are only indirectly considered. Even though individualized offers are increasingly made to end customers (Manner-Romberg et al. 2016), the satisfaction of the end customers with the service providers tends to decrease in Germany (Schneider 2018). That is also recognisable by the fact that the number of complaints received by the Federal Network Agency tripled between 2017 and 2019. (BNetzA 2019)

Stakeholder Coherence on Inner City Last Mile Challenges

Representatives of the CEP service providers, individual retailers and local authorities have agreed in a memorandum of understanding in 2018 that urban transport problems must be tackled collectively. Among other things, the signatories call explicitly for loading zones, that are especially designated for urban freight transport and the CEP service providers also promise to increasingly use vehicles with alternative drive systems in the city centres. (DST et al. 2018) There is even the intention of co-operation to reduce the volume of traffic (and thereby also noise, GHG and pollutant emissions) by CEP service providers (ibid), which would be in the interests of all stakeholders. However, this has not yet become apparent.

Example: Stakeholder Collaboration in the Development of a Micro-depot

Micro-depots are used to transfer goods to cargo bikes that deliver goods to the nearby neighbourhood or city centre (delivery radius approx. one kilometre) (agiplan GmbH 2019; Assmann et al. 2019). When a municipality specifies in its urban freight transport concept to implement a micro-depot for a more sustainable last mile delivery, there are three challenges (ibid):

1. Find a plot/property where the project is legally permissible.
2. Find an operator.
3. Find CEP service providers that are willing to use the micro-depot and, if the concept of the city provides for it, who are willing to cooperate.

In this case, the municipality has to fulfil multiple tasks (ibid):

- Acquiring funding (e. g. from the f

deration).

- Searching for suitable plots/properties (e. g. on municipal properties).
- Searching for the operator by invitation to tender.
- Communicate with possible users (CEP service providers) and obtain binding commitments from them.
- Issuing permits for the realization, considering e. g. the legal requirements of the federation for noise emissions

3 Brief Overview of the Current and Future Developments of the CEP Segment

3.1 Delimitation of the CEP Segment

CEP transports are a fundamental and a growing component of urban logistics. In particular, last mile deliveries in an urban context are a major challenge for both CEP service providers and cities. Studies in London suggest that around 20 % of freight vehicles on a central London shopping street are attributable to the CEP segment. (Allen et al. 2018) To create a better understanding of the challenges of urban freight transport, a deeper examination of the CEP segment is needed. The following section therefore takes a closer look at the structural characteristics of the CEP market in Germany and the drivers of growth.

In scientific literature a description of the CEP segment is predominantly based on a differentiation of the logistics segments of urban freight transport like in Thaller (2018). Kienzler et al. (2019) distinguish the segments of urban freight transport from the other logistics submarkets by considering only those that are active in the final stage of the logistical process. According to this definition, only the submarkets of general and specialized general cargo, consumer goods distribution and the CEP market are relevant for urban freight transport. Moreover, an accessible demarcation can in principle be made via the shipments. Shipments in the CEP segment generally have a low weight (2 kg to approx. 31 kg) and volume. The primary customer groups, which are composed of e-commerce or direct sales,

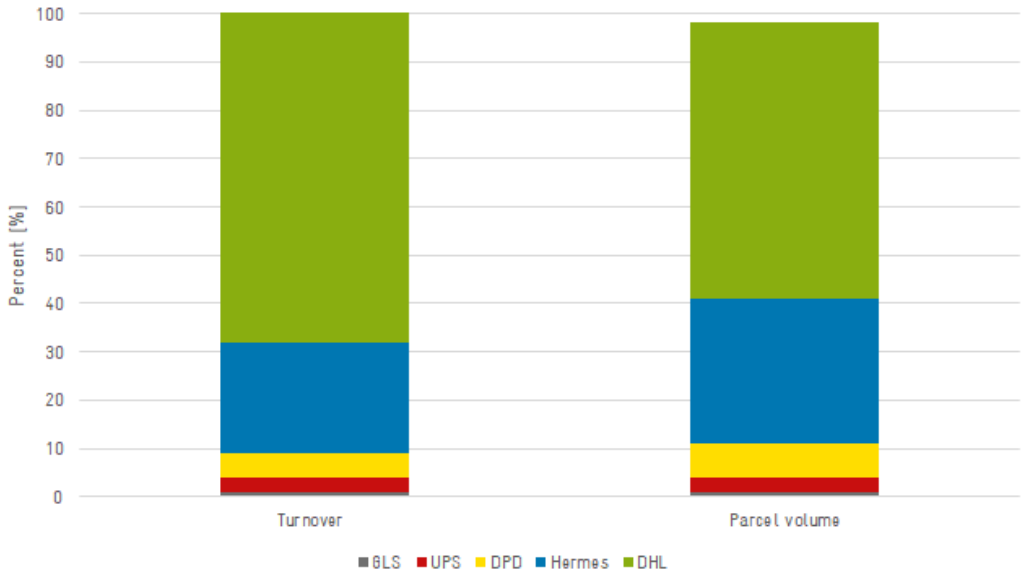


Figure 5: Market Shares and Share of Shipment Volume of CEP Service Providers for the Parcel-subsegment in Germany in 2016 (Schlautmann 2018)

are served under the terms B2C or B2B[5]. The CEP segment is also often characterized by individual customer service in terms of speed, punctuality and reliability. (Kille 2012; Kersten 2021) Albeit, it is not only necessary to differentiate the CEP segment from the other logistics submarkets but also to distinguish the CEP market itself. CEP service providers offer services in the courier, express and parcel markets. A clear segmentation of the CEP market is fundamentally hampered by the lack of a legal definition. This problem of classifying services is made more difficult by increasing business models (e. g. multichannel). However, this is particularly valid for the differentiation of express and courier services, so that the usual segmentation is possible at this point, as the focus of the study at hand is on the parcel market. (Manner-Romberg et al. 2017b) The largest sub-segment of the CEP market in Germany in terms of volume is the **parcel** segment. (Schwemmer et al. 2020) This segment is characterized in particular by high standardized and lightweight parcels. CEP service providers in the segment are characterized by a high degree of systemisation in order to process the large volumes of shipments. (Kultu et al. 2013; Schwemmer 2019) The parcel market in Germany is essentially made up of five players that operate nationwide. In 2018, the growing parcel market had a sales volume of 11.4 bn €. According to the Federal Network Agency, Deutsche Post AG is dominant with its brand DHL, which has a market share of 45.5 %. (Wambach et al. 2019)

Figure 5 shows the market shares of CEP service providers by turnover and parcel volume for 2016. It is evident that DHL and Hermes in particular have the highest shares in the end-customer business in Germany.

Courier services are characterized by very high-quality products, delivered personally by a courier and with the option to make new arrangements at any time. On average, shipments of the courier segment weigh about 1.5 kg. In the national context, shipments are delivered the same day. Service providers in the **express** segment predominantly transport individual shipments that are transported in groupage via hubs and depots. Unlike courier shipments, express shipments are not exclusively monitored. Express services, however, are organized via the CEP service providers' own Express services and courier services are mainly ordered by business clients. A key criterion is a fast and time-definite delivery in door-to-door service. There is no specific size limit for the shipments, but the maximum weight limit of 31 kg is sufficient. (Kille 2012; Kultu et al. 2013)

The degree of concentration of the CEP sector is particularly high compared to other sub-markets in the logistics sector: 76 % of the shares awarded are allocated to the ten largest

5 Business-to-consumer (B2C) refers to shipments from companies to end customers, while Business-to-business (B2B) refers to shipments between companies.

companies in the market. 70 % of the companies in the CEP sector operate only in this segment of the logistical submarkets. The expected sales growth is assumed to be very dynamic. (Schwemmer 2018) For 2016, the CEP market had a revenue volume of around 20 bn €, almost half of which have been generated in the whole parcel segment. About one third of the turnover has been achieved in the express market as well as 19 % by courier services. The development of the parcel segment has been increasingly formed by higher demand from end customers. The express segment, which is traditionally characterised by B2B, has benefited from the increase in cross-border e-commerce. (Manner-Romberg et al. 2017a)

CEP service providers face major challenges. For example: High price pressure is observed in the CEP market, driven in particular by Amazon. In recent years, Amazon has been able to push through lower individual prices with parcel service providers. (Schwemmer 2018) The classic demarcation between B2B and B2C is also becoming more complex. The requirements that customers in the B2C segment place on CEP service providers are becoming similar in scope to those in the B2B segment (e g. Same-Day-Delivery). This is evident in the fact that demand for express deliveries is increasing in the B2C segment, which was once reserved for customers in the B2B segment. The demand behaviour of customers in the B2C segment has adjusted so that end customers expect fast and reliable deliveries in this segment. As a result, the differences between regular and express deliveries are decreasing. DPD therefore offers deliveries within 90 minutes or at specific delivery times in selected cities in Germany in response to the shifts in the B2C segment. (Ducret 2014) Following on from this, Allen et al. (2018) observe increasingly complex customer requirements in the B2C segment, manifested in customer-specific time windows, tracing of parcels and alternative delivery locations. The increase in the B2C segment results in more complex delivery processes, as the first delivery rates can be assumed to be lower compared to the classic B2B segment, as well as the B2C customers are spatially more dispersed and the shipment density per stop is lower. Another challenge is the increasing number of returns. Lengauer et al. (2015) suggests that around 20 % of shipments are returned in Austria. This increases the pressure on CEP service providers, as an adjustment of the return process is first assumed to be the responsibility of the shippers and end-customers. It is estimated for Austria that the introduction of a return fee would have a significant influence on the purchasing behaviour of end-customers and therefore indirectly also on the logistical processes of CEP service providers on the last mile. (Lengauer et al. 2015) In Germany, approximately 280 million parcels and 487 million articles have been returned in 2018, which corresponds to

16.3 % of all parcels and 12.1 % of all articles. The environmental impact is estimated at 238,000 tonnes of CO_2-aquivalents. Technological and standardised measures are identified as the greatest potential for reducing the probability of returns. In addition, as in Austria, the introduction of a return fee is also considered an effective instrument. (Forschungsgruppe Retourenmanagement, Universität Bamberg 2019a, 2019b) Besides increasing challenges, CEP service providers also have opportunities to solve them. Schwemmer (2018) identifies three success criteria for the CEP sector:

1. high volume of shipments in collection and delivery,
2. use of information technology to automate and increase the efficiency of the handling speed and
3. cost-efficient handling of the last mile.

Competitive advantages result from a trade-off between cost optimization and customer satisfaction. The high rate of returns is assumed to be the driver of the increase in volume. In some e-commerce segments, a return rate of up to 60 % is assumed. (Schwemmer 2018) In addition, new potentials arise from multi-channel strategies of retailers. The interaction with the customer will be more important, making individual delivery locations and times easier to implement. New distribution structures must also be implemented in order to get as close to the customer as possible with new distribution centres. This serves the goal of saving mileage, especially on the last mile, but is also driven by new customer needs. It is assumed that to-door delivery, which is identified as a cost driver on the last mile, will increasingly turn into a premium service in the future. (Schwemmer 2018; Witten and Schmidt 2019)

3.2 E-Commerce

The growth of e-commerce has changed distribution in cities. E-commerce not only causes changes in the perception of shopping behaviour, but also shapes the challenges cities and transport planners are facing.

There are many reasons why e-commerce has become more attractive to consumers: for instance the greater variety of products, home delivery, time savings and independence from opening hours all play a role. (Engels 2019)

E-commerce is a growing business. The trend of its market growth is influenced by many figures. For instance, a huge increase in growing online shoppers can be observed. According to EU data, 88 % of individuals aged 16 to 74 have used the internet, 71 % of whom had bought or ordered goods or services online. Around 80 % of the internet users in Germany have ordered online in 2019. Gender, age and the level of education all have an impact on e-commerce behaviour. The EU survey il-

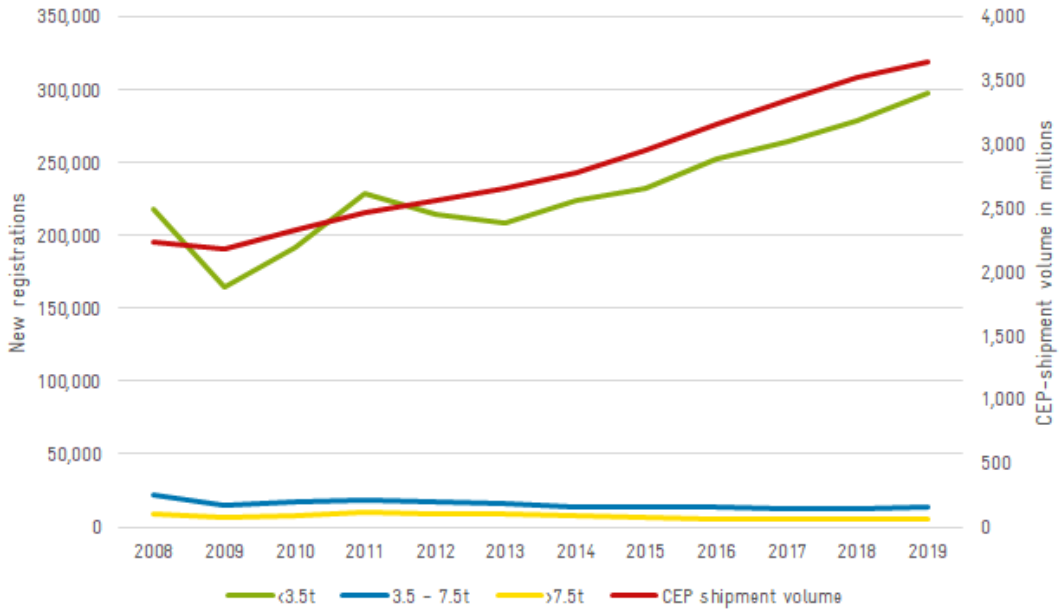


Figure 6: Development of Registration Figures for Commercial Vehicles and Shipment Volumes in the CEP Sector in Germany (2008-2019) (Leerkamp et al. 2020)

lustrates that younger generations and particularly people with a higher level of education are shopping more frequently online. (Eurostat n. d.; Seidel and Blanquart 2020)

Moreover the European Commission estimates that the B2C e-commerce markets of goods and services more than doubled its revenue from 200 bn € in 2013 to 490 bn € in 2017. (EEA Report 2019) In Germany e-commerce has recorded steady growth for years. The commercial associations HDE and BEVH monitor market developments annually, although their figures differ due to different survey methods. The HDE reports a turnover of 53.6 bn € for the year 2019. The BEVH forecasts gross sales of goods for the year 2019 at around 72 bn €, which promises double-digit growth. (Deges 2020)

3.3 Annual/Daily Parcel Shipment Volume in Germany

As a decisive parameter for describing the CEP segment from a transport planning perspective, the development of the volume of shipments per capita is important. It not only provides indications for assessing possible consequences for urban freight transport, but also makes it possible to spatially model the traffic of the CEP market in the city. (cp. Chapter 4.3)

The parcel segment is the main driver of the increasing number of shipments per capita in

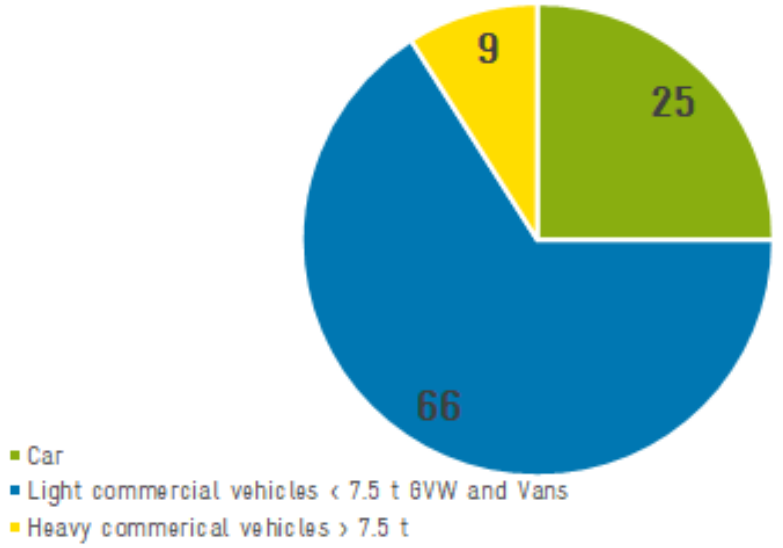


Figure 7: Shares of the Vehicle Classes in the Vehicle Stock in Percent (BIEK 2018b)

the CEP market. It can be assumed that more than half of all parcels sent can be assigned to the B2C segment. (Manner-Romberg et al. 2017a) For 2024 a growth to 4.3 bn shipments is expected. (BIEK 2020) The growth in shipment volumes differs between the two relevant segments of the demand side. The B2C-segment in particular is showing stronger growth than the B2B-segment. In the B2C-segment a growth of 8.6 % is recorded and a decrease in shipments of 2.8 % in B2B. There are several reasons why market shares are shifting towards B2C-segments. The dynamic growth of e-commerce is contributing to the rising share of B2C-shipments. Moreover a significant increase is predicted for the goods of daily use which will have a significant impact on the growth dynamics of the market in the future. (BIEK 2020)

The parcel volume varies within Germany. In principle, the distribution of B2C parcel volumes reflects the population distribution. An analysis of the regional postcode-districts for the year 2016 concludes that the parcel volume is highest in Berlin, Hamburg and in parts of the Ruhr area. For example, a regional postcode-districts in Berlin is estimated to have a volume of around 65.7 million parcels per year. In comparison, the volume in the weakest regions, which are predominantly located in rural areas, is only around 4.9 million parcels per year. If, on the other hand, the parcel volume per capita in Germany is considered, a different spatial distribution emerges. The average parcel volume is highest in the Bergisches Land region (22.1 parcels per capita). On average, a parcel volume of 18 parcels per capita is assumed for Germany. (Manner-Romberg und

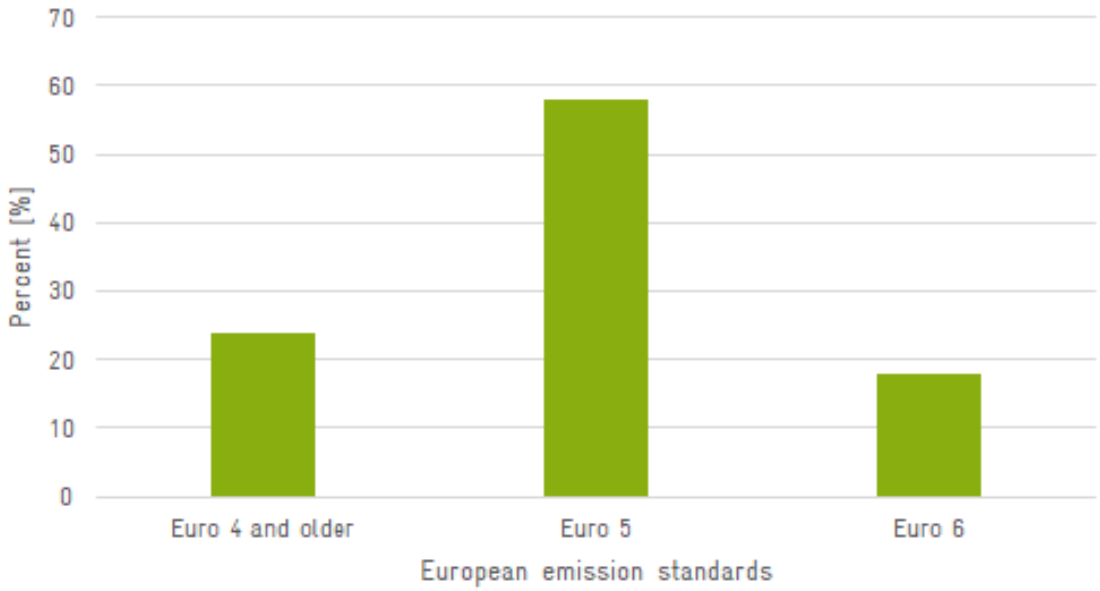


Figure 8: CEP Vehicle Fleet Differentiated by Emission Classes in 2017 (BIEK 2018a)

Müller-Steinfahrt 2017)

3.4 Vehicle Fleet in the CEP Segment

In the course of digitalization, urban freight transport is undergoing rapid change and is facing further growth due to an increase in the volume of shipments. Consequently rapid growth in shipment volumes will increase the trips of small-sized vehicles. (Dabidian et al. 2016; Leerkamp et al. 2020) As shown in Figure 6, it can be assumed that the demand for light commercial vehicles in particular will continue to increase in the upcoming years.

According to a study by the World Economic Forum, the number of delivery vehicles in the world's 100 largest cities will increase by 36 % in 2030 (World Economic Forum 2020). In contrast to heavy commercial vehicles, which are predominantly used for freight transport, light commercial vehicles are not only used for the transport of freight but also through services such as craftmanship. An analysis in England concludes that around 34 % of the mileage performed by light commercial vehicles that are used commercially is in the goods transport segment. (Allen et al. 2018) The authors of the study do not have similar figures for Germany. However, there is relatively reliable data on the vehicle fleet of CEP service providers in Germany. A rough estimate is sufficient at this point to draw conclusions

for the subsequent modelling of CEP transports. The last mile is predominantly managed by using light commercial vehicles (7.5 t gross vehicle weight (GVW)). (Kienzler et al. 2019) A total of 140,000 vehicles were used in the German CEP sector in 2016. From the data available for Germany, there is a breakdown of vehicle classes, albeit not based on the official statistics of the Federal Motor Transport Authority (KBA). The present differentiation is however sufficiently precise to gain an understanding of the use of vehicles in the CEP sector. The vehicles were divided into the following vehicle categories (BIEK 2018a):

- Car
- Light commercial vehicles < 7.5 t gross vehicle weight (GVW) and vans
- Heavy commercial vehicles > 7.5 t

In relation to the German truck fleet in 2016, CEP-vehicles represent a share of approximately 4.5 %. Within the commercial vehicle segment, the share is approximately 3.5 % compared with the nationwide stock. 92 % of the vehicles used in CEP sector are delivery vehicles. (BIEK 2018b)

To map the emissions of the CEP segment, a breakdown of the emission classes is important. Around 95 % of the vehicles used in the CEP segment are powered by fossil fuels. It is estimated that about 5,000 electric vehicles are used in the last mile. (Kienzler et al. 2019)

A consideration of emission classes is relevant for the last mile, as there are access restrictions for low emission zones in Germany. For example, only vehicles that have at least Euro 4 are allowed to drive into low emission zones. Currently, Euro 6 d meets the strictest limit value regulations that apply throughout Europe. (UBA 2021)

For the year 2017, Figure 8 shows the emission classes for the vehicle population of CEP service providers. (BIEK 2018a) It follows from Figure 8 that the vast majority of vehicles used in the CEP segment meet the requirements for German environmental zones.

3.4.1 Alternative Vehicles in Last Mile Delivery

Currently the use of vehicles with diesel engines can be considered as standard on the last mile. The reasons are manifold. In particular, the high availability of fuel, an area-wide refuelling infrastructure and low acquisition costs of the vehicles are seen as the main reasons for their use today. In contrast to combustion vehicles, electric vehicles offer the possibility of local emission-free operation, which provides opportunities to handle the last mile more sustainably in view of air pollution control in cities. The limited range of an electric vehicle is not a barrier to last mile use, as trip distances are usually short. If the trend of falling battery prices continues, their use may also be economically worthwhile for CEP service providers.

(Hardi 2019) The DPD group aims at making parcel delivery in 23 cities in Germany CO_2 free by 2025 by using cargo bikes and electric vehicles (dpdgroup 2020b). UPS has been testing the use of cargo bikes throughout Germany since 2012. GLS uses both cargo bikes and e-scooters in selected model cities. In addition to the use of cargo bikes, Hermes is also testing delivery by mini electric vehicles. (Junk and Wielgosch 2019)

The use of cargo bikes is particularly worthwhile for very short distances. The maximum load is estimated at 80-200 kg, in some cases up to 400 kg. The advantages of the cargo bike result from the lack of fuel costs, better accessibility and the independence from restrictions such as the time limitation of the delivery of the inner cities for conventional vehicles. (Slabinac 2015)

3.5 Last Mile Delivery Concepts

CEP service providers face great challenges when it comes to the last mile of the supply chain. These include the intensity of competition, which is caused by free delivery offers of the shipper, or the expectations of customers to have short delivery times. Especially the last mile in the urban context is an obstacle caused by strict regulatory measures of the local authorities, or by the lack of logistic infrastructure, such as missing loading zones. (Janjevic and Winkenbach 2020) Second-row parking is increasing, which leads to insecure situations for all road users, especially in large cities with a high delivery density. In addition, a study in London showed that CEP delivery vehicles are parked on delivery areas for about 2/3 of the day and the parcel couriers have to cover up to 10 km by foot (each tour). (McLeod et al. 2020)

In the following, delivery concepts are presented that are widely discussed in the scientific literature. Boysen et al. (2020) have named a number of drivers that increase the need for new concepts. Thus the authors particularly point out the following effects as drivers: (Boysen et al. 2020)

- Sustainability: The increasing demand for parcel services is causing growth in CEP traffic in the cities. As a conse quence, an overload of infrastructure capacities and an increase in environmental pollution (like GHG emissions and noise) can be observed.
- Costs: Gevaers et al. (2014) have been able to show in their basic scenario for modeling the costs for a conventional delivery of the last mile, that for Belgium 3.87 € of delivery costs would occur on the last mile. A systematic sample calculation for Germany shows that the costs of the last mile, with 11.51 €, account for 77 % of the total

Table 3: Comparison of Attended and Unattended Delivery Systems (Allen, J., Thorne, G., Browne, M. 2007)

	ATTENDED DELIVERY	RECEPTION BOX/ DELIVERY BOX	CONTROLLED ACCESS SYSTEM	LOCKER-BANK	COLLECTION POINT
WHO COVERS THE LAST MILE?	Delivery company	Delivery company	Delivery company	Customer	Customer
CUSTOMER PRESENT	Yes	No	No	No	No
TYPES OF PRODUCTS	Any	Packages, groceries	Packages, groceries	Packages, groceries	Packages
FAILED DELIVERIES	High	Virtually none	Virtually none	Virtually none	Virtually none
DELIVERY WINDOW	Fixed delivery hours	Delivery company operating hours	Delivery company operating hours	Delivery company operating hours	CP opening times
TIMES AT WHICH GOODS CAN BE COLLECTED	Not appropriate	24 hours	24 hours	24 hours	CP opening times
RETRIEVAL TIME FOR CUSTOMER	None	Very short	Very short	Short-long	Short-long
DROP-OFF TIME	Long	Short	Short	Very short	Very short
INITIAL INVESTMENT	Low	High/medium	Medium	Medium	Low-Medium
DELIVERY COSTS	High	Low	Low	Lowest	Lowest
POSSIBLE OPERATIONAL PROBLEMS	High failed deliveries. Poor use of vehicle capacity	Large number of boxes needed/Need to collect boxes	Customer concerns about safety. Need for suitable delivery location	Customer has to travel to collect	Customer has to travel to collect
POTENTIAL REDUCTION IN GOODS VEHICLE ACTIVITY COMPARED TO ATTENDED DELIVERY		Some reduction	Some reduction	Greatest reduction	Greatest reduction

costs. (Brabänder 2020)

- Time pressure: The growth of e-commerce and the associated offers such as same-day-delivery have increased the pressure on the last mile. In addition, the weekly schedule of CEP traffic is differing. In particular, a peak in demand can be observed on Mondays which requires an adjustment of the workforce to the drivers. (Boysen et al. 2020) Questions of delivery speed, choice of delivery day and the possibility of being served in a delivery window increase the complexity of the last mile and are cited as reasons why the need for newer concepts is growing. (Janjevic and Winkenbach 2020)

A consideration of alternative delivery concepts is also becoming more important in Germany. The industry representative BIEK assumes that deliveries to parcel boxes will increase to which the corona pandemic also contributed. (Incoterms 2020) DHL has been testing a more sustainable way to handle deliveries via packing stations since the beginning

of 2000. Currently, around 3,500 packing stations are operated throughout Germany. (Junk and Wielgosch 2019) In their study of good practices in urban freight transport Allen, J., Thorne, G., Browne, M. (2007) compared different delivery systems. In general, deliveries can be made to the following locations (ibid):

- the customer‘s home,
- the customer‘s workplace,
- delivery boxes,
- collection points and
- locker banks.

Table 3 represents a comparison of attended and unattended delivery systems and contrasts the delivery systems with characteristics describing coverage of the last mile and level of delivery costs. (Allen, J., Thorne, G., Browne, M. 2007)

4 Last Mile Organisation in Berlin

4.1 Short Overview and Description of Berlin

4.1.1 Political and Social Overview

The capital Berlin is the largest city in Germany and one of three cities which is also a city-state. With 3,662,501 million inhabitants Berlin is also the most-populous one in Germany. (Statistical Office for Berlin-Brandenburg 2020a) As a federal state, Berlin is also directly involved in Germany's federal system. Figure 9 shows the administrative organisation of Berlin in relation to the responsibilities of the federal government. The Senate as the executive branch is responsible for making state policy and represents the top of the administration in Berlin. The Senate headed by the governing mayor is responsible for different departments which are led by the Senators. (Center for Political Education Berlin n. d.) However, the Senate is not only the governing body of Berlin, but also simultaneously assu-

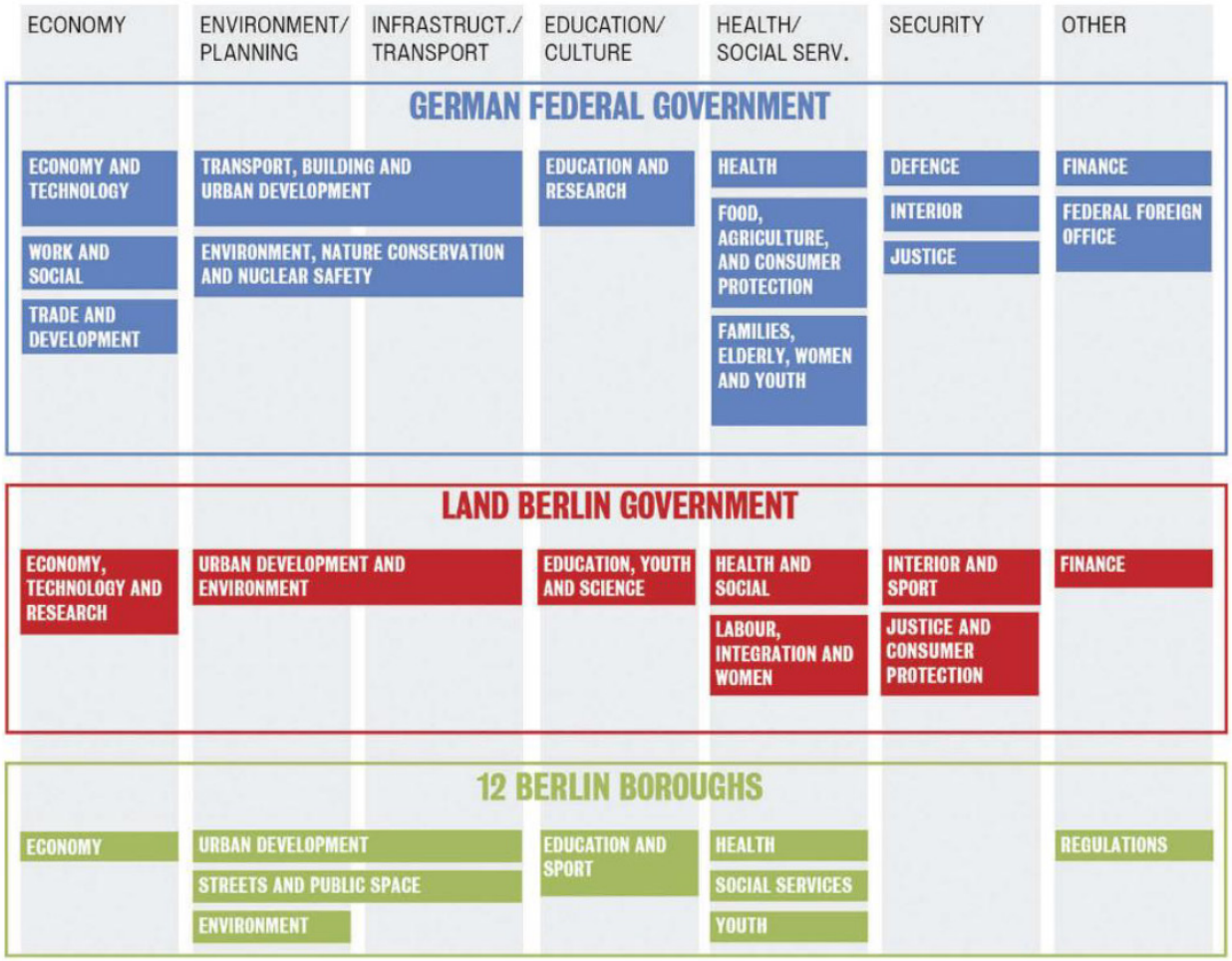


Figure 9: Structure of Berlin's Government (Rode 2019)

mes municipal tasks, which it shares with the districts. As a consequence, Berlin's state administration is organised in two tiers. On one level is the Senate and on the other the districts, which are self-governing units but not independent territorial authorities. This results in a complex interplay of responsibilities. (Hoffmann and Schwenkner 2010) For this study, the key stakeholder is the Senate Department for Environment, Transport and Climate Protection (SENUVK), whose structure can be seen in Figure 10. SENUVK represents two policy areas where the Department of Transport clarifies urban freight transport issues.

4.1.2 Development of Berlin's Population

The number of Berlin residents has been growing with an upward trend since 2004. The prospering economy in particular is cited as the reason for the population growth. Since 2011, the population development has experienced an even more dynamic growth. The population forecast for Berlin is based on three possible variants. In the conservative estimation, a population of approximately 3.81 million is assumed for the forecast year 2030. In the optimistic variant, an increase up to 4.05 million inhabitants is estimated. Population growth is expected for all districts. Nevertheless, the dynamics diverge within the districts. The strongest growth of 11 % is assumed for district

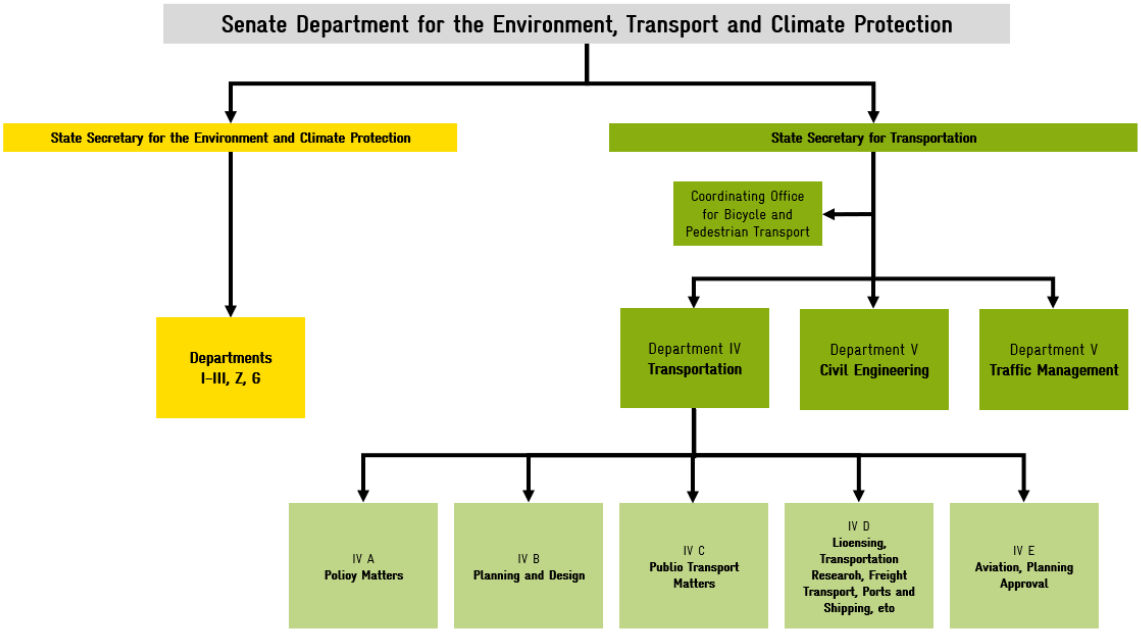


Figure 10: Organisational Chart of the Department for the Environment, Transport and Climate Protection Following (Senate Department for the Environment, Transport and Climate Protection 2020a)

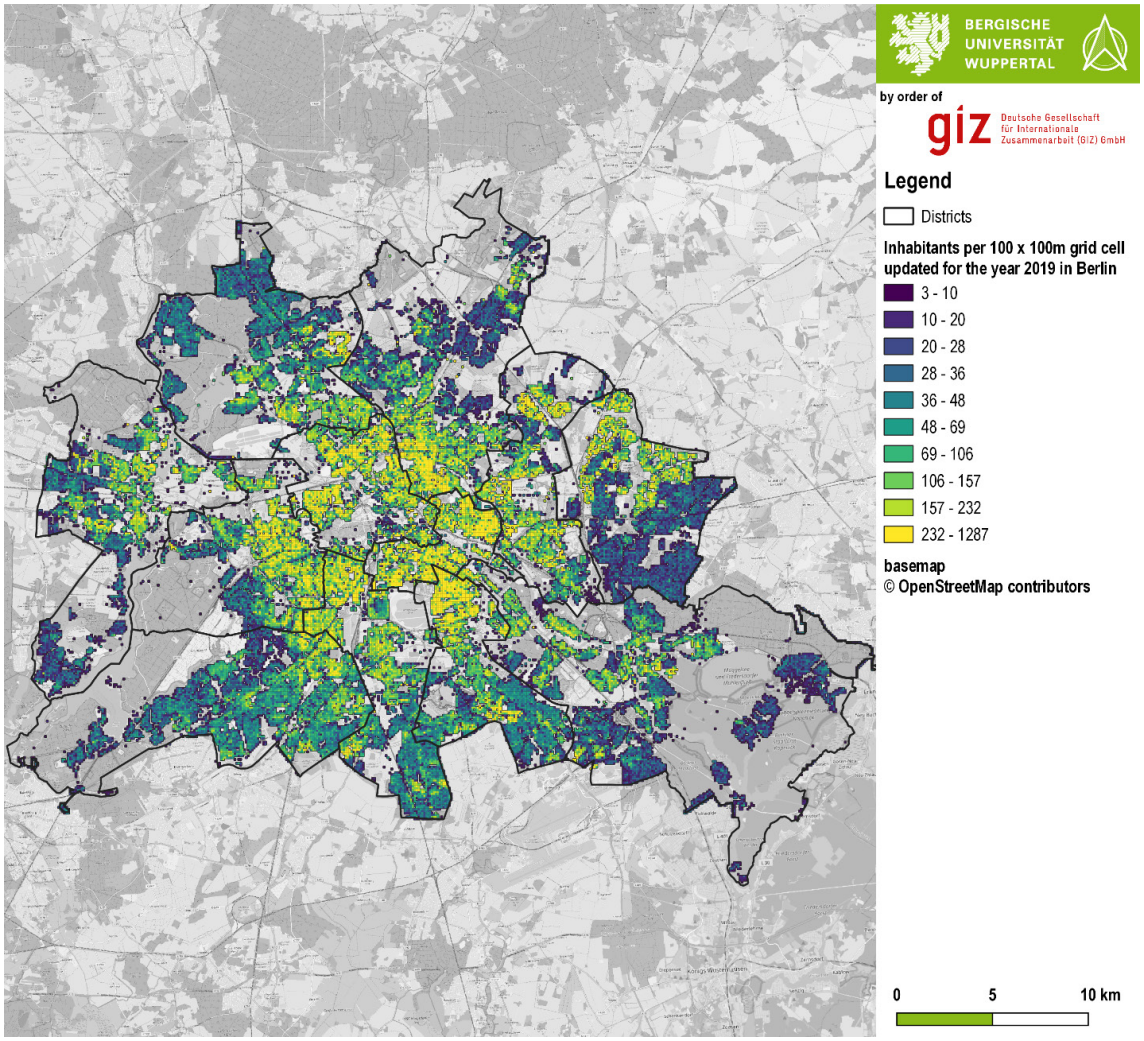


Figure 11: Inhabitants per 100x100 m² Grid Cell Updated for the Year 2019 in Berlin, Own Calculation

Pankow. In contrast, Charlottenburg-Wilmersdorf, which is at the rear of the rankings, is expected to grow by only 0.3 %. (Senate Administration for Urban Development of Berlin 2019)

Figure 11 shows the population distribution at grid cell level for the year 2019. It can be seen that the population density is particularly high in the inner city districts.

4.1.3 Economic Development of Berlin

Since 2005 expansive forces can be observed in Berlin, which have contributed to the growth of Berlin‘s economy. Between 2004 and 2010, Berlin’s real macroeconomic performance developed almost twice as fast as Germany‘s, contributing to Berlin’s narrowing of its economic gap compared with major European cities. (Geppert and

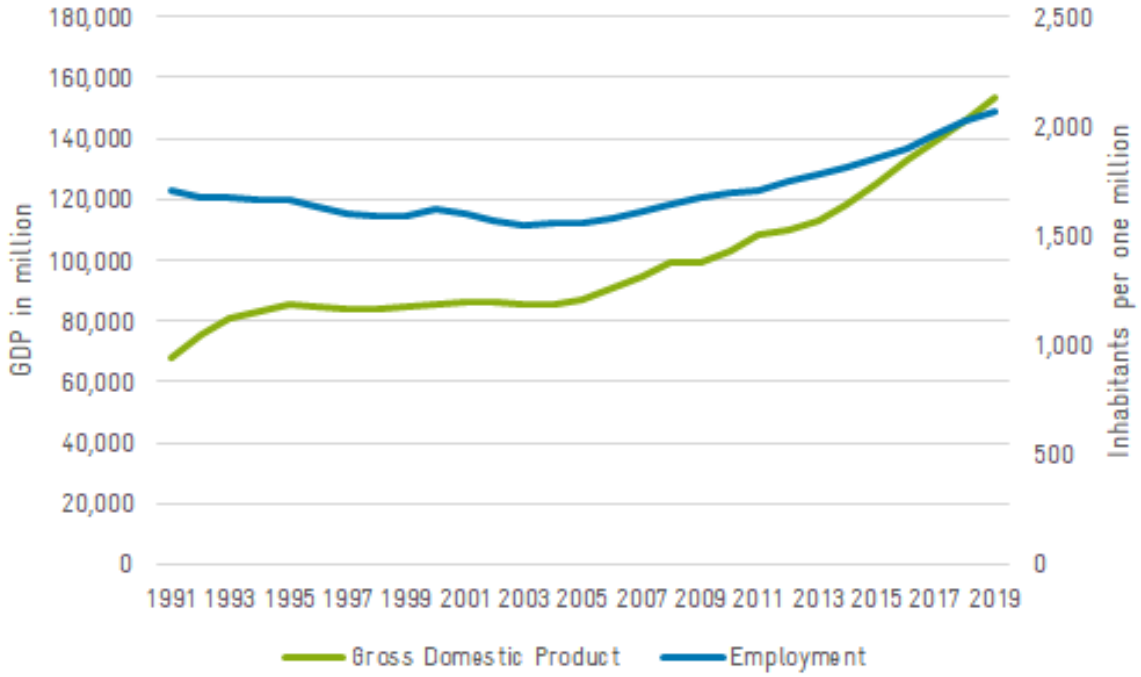


Figure 12: GDP and Employment Figures in Berlin (Statistical Office for Berlin-Brandenburg 2020b)

Gornig 2012) Berlin had an average growth rate of 4.42 % between 2008 and 2018. The GDP per capita reached 36,900 € in 2018 which is almost the same level as the German average. (EC NaN) Figure 12 compares the development of Berlin's GDP and employment figures for a period of 28 years. We can see that growth is evident for both variables over a similar period of time with GDP growth being stronger.

Since reunification, Berlin's economy has undergone considerable structural changes. The growth of the tertiary sector has gone hand in hand with the decline of industry. An abundance of smaller companies has helped to make Berlin's economic system very dynamic and innovative. For example, companies are particularly active in the following fields: creative industries, IT, health care, biotechnology and environmental technology, optical industry and medical technology. (EC NaN)

4.1.4 Overview of Traffic Relevant Parameters in Berlin

In the following, traffic indicators and the spatial distribution of pick-up points and depots in Berlin are considered.

In general, the data basis for passenger traffic in cities is better positioned than the data basis for freight transport. In addition, there is a lack of in-depth knowledge about the logistics processes for supply in cities. (Leerkamp et al. 2020) Specific data-based statements on the situation of CEP traffic in Berlin are only

possible to a limited extent. For example, there is no city- or state-specific information on the vehicle fleet composition of CEP service providers.[6]

A decisive parameter for the description of traffic in a city is the modal split, which describes the shares of the modes of transport in a defined area. Berlin's modal split is characterized by a high share of environmental transport. Thus, 26 % of the trips are made by public transport. Pedestrian traffic (walking) has the highest share of all means of transport with 27 %. The share of the trip purpose shopping/ services accounts for 28 % of all trips in Berlin. This is carried out by 39 % on foot. (Agora Verkehrswende 2020; Gerike et al. 2019)

6 In the context of this project, representatives of the CEP service providers in Berlin were asked for expert interviews. Only one CEP service provider gave more detailed information on the vehicle fleet.

A relevant parameter for describing CEP-transport in cities is the average parcel volume per capita. For 2016, the absolute B2C parcel volume for Berlin was approximately 65.7 million.(Quantity is discussed in depth in chapter 4.3.1) (Manner-Romberg et al. 2017a)

As already explained in Chapter 3.5, a large number of alternative delivery concepts exist. In order to evaluate the feasibility of alternative delivery locations, an analysis of the spatial distribution of pick-up points is required. In Berlin there are approximately 2,793 pick-up points spread across all CEP service providers.[7] The number of pick-up points varies between the districts. It is noticeable that the districts with a high population density in particular have many stations (cp. Figure 11 and Figure 13). In addition to the absolute consi-

7 Own investigation.

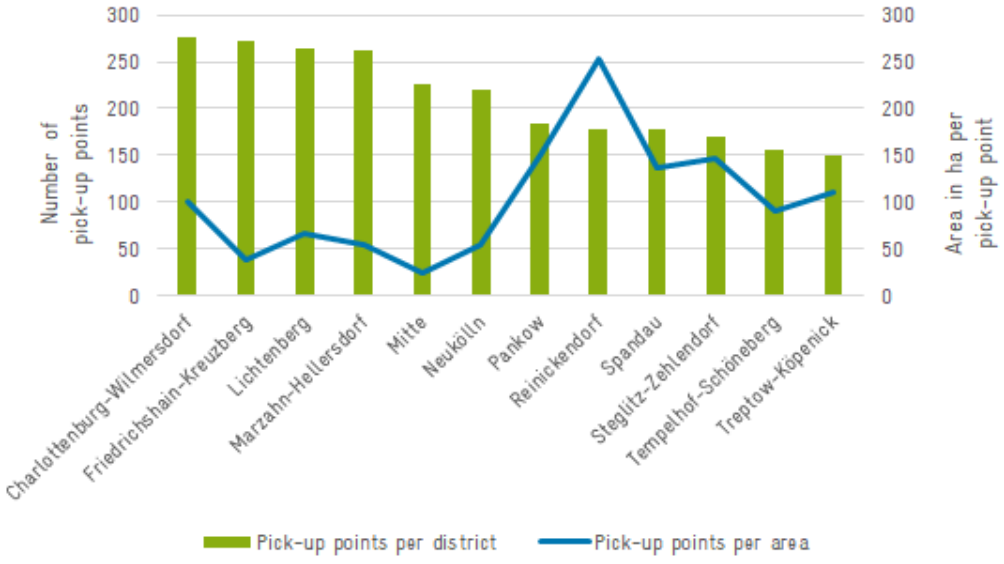


Figure 13: Pick-up Points per District and Area

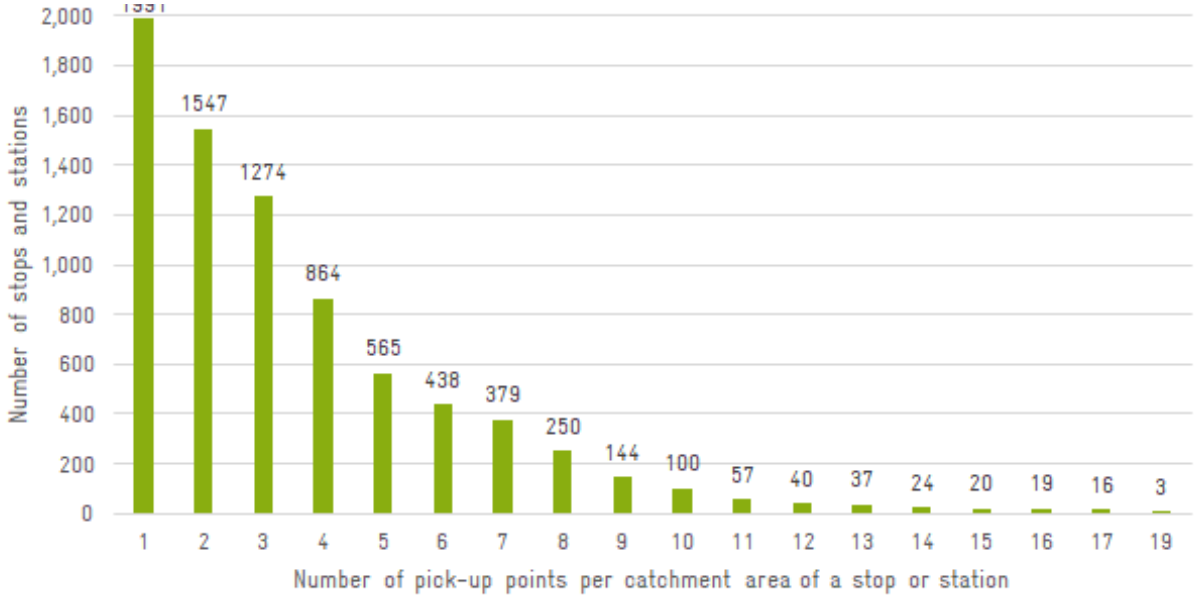


Figure 14: Number of Stops and Stations with at Least 1 Pick-up Point in Catchment Area of 350 m in Berlin, Own Calculation. Stops from (Verkehrsverbund Berlin-Brandenburg n. d.)

deration of the pick-up points per district, the average catchment areas per hectare (ha) of a pick-up point per district are also taken into account. Here, too, it becomes clear that the districts close to the city centre perform significantly better, as shown in the Figure 13.

Another criterion to determine the spatial accessibility of Berlin through pick-up points is to check how many public transports stops within a catchment area have pick-up points. The lower bounds from Pütz and Schönfelder (2018) are selected as the size of the catchment area which is 350 m. Among the 10,979 stops included in (Verkehrsverbund Berlin-Brandenburg n. d.), 7,768 stops have at least one pick-up point within the 350 m catchment area. The distribution of pick-up points per stop is shown in Figure 14.

Figure 15 shows the pedestrian accessibility of the pick-up points. The pedestrian network from OpenStreetMap (OSM) is used as a model to calculate the accessibility of the pick-up points. Since a travel time is calculated for each 100x100 m grid cell, it is also possible to calculate the number of residents who are reachable within a given interval. This means that around 2.85 million inhabitants can reach a pick-up point within 10 minutes as shown in Figure 16. Furthermore, it can be seen that less than 30,000 inhabitants need 30 minutes or more to reach the next pick-up point. The analysis shows that Berlin has high potentials to deliver shipments at alternative delivery locations.

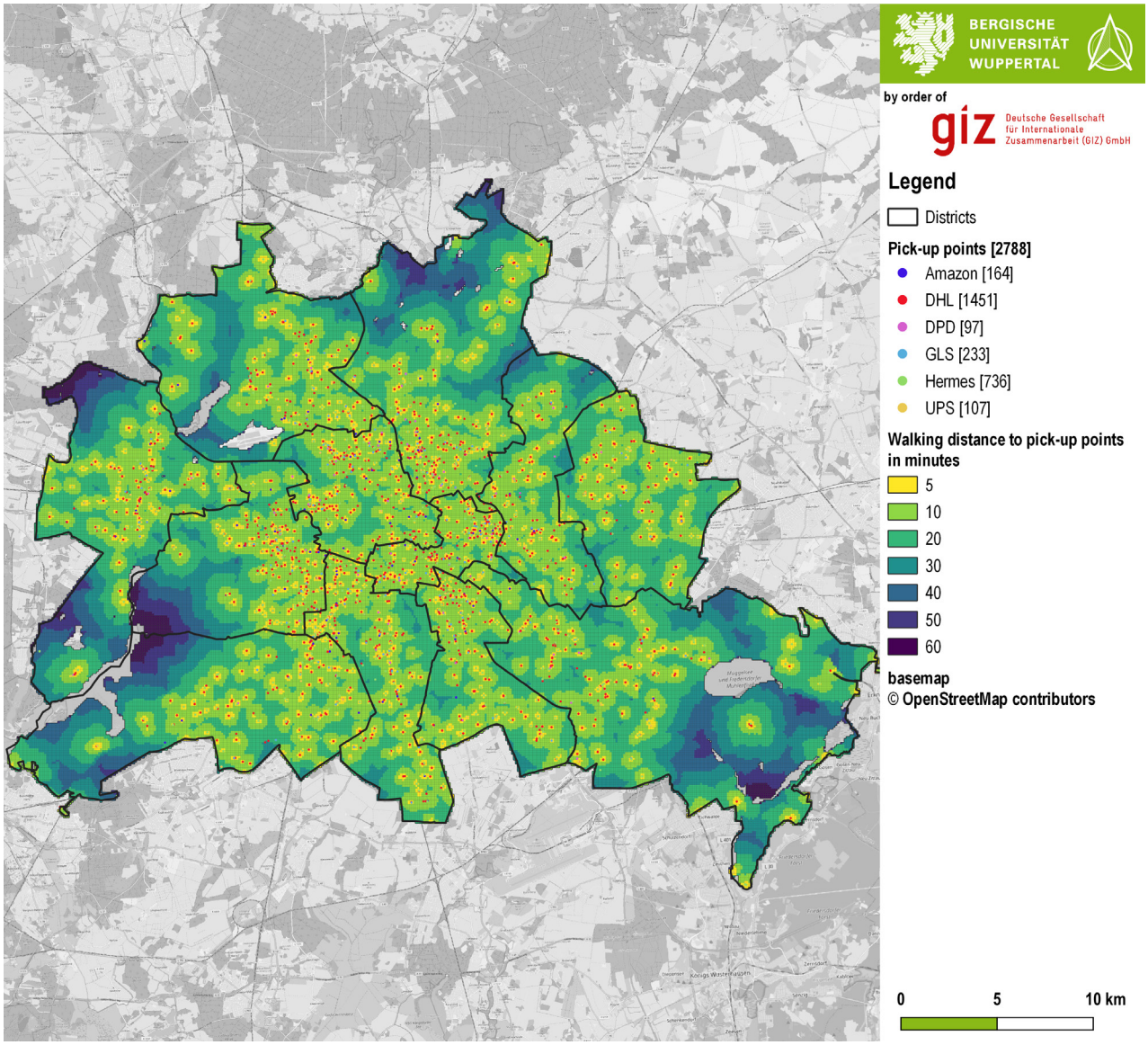


Figure 15: Walking Distance to Pick-up Points in Berlin, Own Calculation

Another way of evaluating the spatial coverage of Berlin is to analyse the number of depots in comparison to the area or the number of inhabitants. Table 4 compares key figures regarding the number of inhabitants and the areas of the seven largest cities in Germany in relation to the number of depots which are located geometrically in these cities. The area per depot, for which it is simplistically assumed that it is the operational area of a depot, is lowest in Berlin. If we compare the number of inhabitants with the number of depots, Berlin ranks

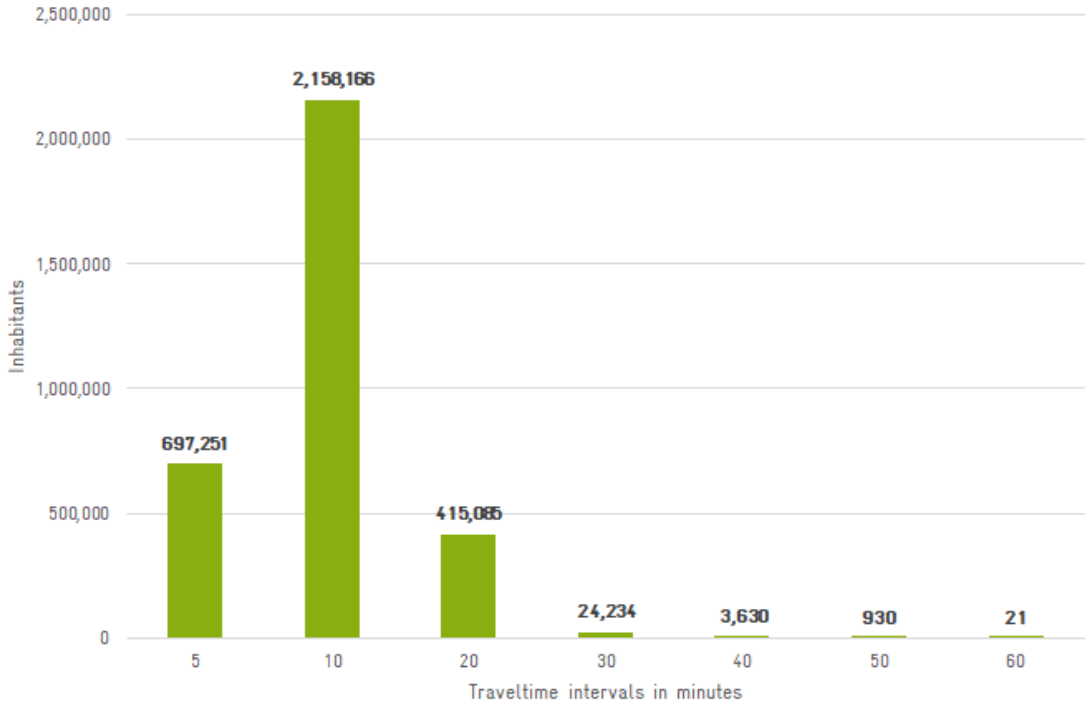


Figure 16: Distribution of Inhabitants within Travel Time Intervals of Pick-up points in Berlin, Own Calculation

third to last.

4.2 Overview of Current City-wide Logistics Strategies and Plans

Numerous cities in Germany have a variety of formal and informal concepts in which urban freight transport plays only a subordinate role, even though its supply function makes a significant contribution to life and economic activity in cities. At the same time, urban freight transport contributes to negative impacts that run counter to the goals of a sustainable urban and transport development. These include for example the emission of air pollutants and the irregular loading and unloading in the second line. (Leerkamp et al. 2020)

Against this background, urban freight transport concepts can make a significant contribution to the sustainable handling of incompatible traffic. In recent years, different designs of conceptual solutions have been discussed, which according to Straube et al. (2018) focus on the following instruments:

- Introduction of a city toll to avoid driving in the city centre.
- Creation of loading zones for commercial traffic.

Table 4: Comparison of the 7 Largest Cities in Terms of the Number of Depots in the City

CITY	AREA (HECTA)	DEPOTS	DEPOT PER AREA (HECTA)	RESIDENTS	INHABITANTS PER DEPOT
BERLIN	89,186.20	19	4,694.01	3,669,49	193,131.11
HAMBURG	73,638.02	11	6,694.37	1,847,25	167,932.10
MUNICH	31,142.10	4	7,785.52	1,484,23	371,056.50
COLOGNE	40,667.84	7	5,809.69	1,087,86	155,409.00
FRANKFURT A. M.	24,822.41	5	4,964.48	763,38	152,676.00
STUTTGART	20,991.59	1	20,991.59	635,91	635,911.00
DÜSSELDORF	21,756.97	4	5,439.24	621,88	155,469.25

- Establishment of urban micro-hubs and use of cargo bikes.

In general, the urban freight transport concept is an opportunity for the municipality to intervene in urban freight transport in a steering manner. It considers the actors and processes that are fundamentally different from passenger transport and makes it possible to build up common knowledge, networks and trust together with the actors in the logistics industry. Since many measures have to be implemented by the logistics industry, extensive participation and coordination with them is necessary. Therefore, the concept should contain a coordinated mission statement, ambitious goals and suitable measures. (Leerkamp et al. 2020)

For Berlin in particular, a concrete concept is available in the form of Integriertes Wirtschaftsverkehrskonzept[8] (IWVK), which in essence concretises the Stadtentwicklungsplan Verkehr[9] (StEP Verkehr). The IWVK further specifies the content and derives detailed approaches and measures from StEP Verkehr. (Menge n. d.)

The objectives of the IWVK can be integrated into the overarching range of objectives of the StEP Verkehr which are shown in Table 5. (Senate Administration for Urban Development of Berlin)

Currently, the new edition of the IWVK is in progress. The goal for the short and medium-term planning horizon is to review the existing measures and identify new approaches for the compatible handling of urban freight transport. The following core topics form the focus of the concept which are developed on a cross-stakeholder basis. (Senate Department for the Environment, Transport and Climate Protection n. d.):

- Heavy transports
- Waste management companies and – infrastructure

8 engl.: Integrated Commerical Transport Concept
9 engl.: Urban Development Plan Transport

Table 5: Quality Objects and Goals for Action in IWVK (Senate Administration for Urban Development of Berlin)

QUALITY OBJECTS	GOALS FOR ACTION
ENSURE THE FUNCTIONALITY OF THE ECONOMIC SYSTEM	Ensuring the functionality of the networks and providing the necessary infrastructure. Securing sufficient shares of freight transport of network capacities Ensuring the accessibility of sources and destinations of freight transport and the provision of necessary areas for planning purposes
INTEGRATING FREIGHT TRANSPORT IN AN URBAN-FRIENDLY MANNER	Increasing traffic safety Improvement of the traffic-influenced residential quality in the urban area by reducing traffic-related air pollutants and noise pollution Increasing the cooperation of stake holders
REDUCING ECOLOGICAL CONSEQUENCES OF FREIGHT TRANSPORT	Reduction of transport-related environmental use in terms of consumption of natural resources and reduction of climate gas emissions of transport

- CEP
- road freight transport
- Inland waterway transport, rail freight transport and logistics locations
- Traffic data and information
- Air cargo

In addition, there are a number of other concepts and plans from which targets for freight transport in Berlin are derived.

For example, the **StEP Industrie und Gewerbe**[10] which fleshes out and identifies key sources and destinations of urban freight transport. The accessibility of these areas is also a core topic of the IWVK. (Menge n. d.) (cp. Table 5)

10 engl.: Urban Development Plan Industry and Commercial

The **Berlin Energy and Climate Protection Program (BEK)** for instance sets out a timetable for achieving a climate-neutral Berlin in 2050. For freight transport, the concept envisions a shift from fossil-fuelled trucks to more sustainable modes and vehicles. (Menge n. d.; Senate Administration for Urban Development of Berlin 2016)

The **Clean Air Plan** contains a wide range of measures that also affect urban freight transport. Thus, a key measure has been the gradual introduction of an environmental zone. In addition, the **noise action plan** describes strategies to help reducing traffic-related noise, especially on major roads. (Menge n. d.)

Currently SENUVK is working on two new sections for Berlin‘s mobility law. (Senatsverwaltung für Umwelt, Verkehr und Klima-

schutz, 2020c) The following points of the draft bill are relevant for CEP transport (Senate Department for the Environment, Transport and Climate Protection 2020b):

- Securing areas for the establishment of local transshipment centers.
- Promoting the sensible use of alternatives to diesel-powered commercial vehicles.
- Delivery processes should be efficient, compatible with the city and as low-emission and bundled as possible.
- Consideration of the concerns of urban freight transport by creating a platform for exchanges between stakeholders in the field of freight transport and the administration and updating of the integrated freight traffic concept.

4.2.1 City-logistics Measures in Berlin

Logistics concepts offer a wide range of measures, which are examined in more detail as follows. According to Leerkamp et al. (2020) and Russo and Comi (2011) urban freight transport measures can be differentiated into the following categories as shown in Figure 17.

Here, the measures differ depending on the category. For example, a possible **material infrastructure** measure is aimed at securing available areas that can be used as micro-depots. In this measure, the task of the municipality is the preparation of the micro-depot according to planning law. Private actors, on the other hand, operate the micro-depot site. (Leerkamp et al. 2020) One example of a measure implemented in the area of material infrastructure is the KOMODO project, which tests a sustainable design of the last mile using cargo bikes and micro-depots open to CEP service providers in Berlin. Starting from the depot on a shared area, the final distribution of parcels is carried out without consolidation of the shipments. (Junk and Wielgosch 2019)

Immaterial infrastructure on the other hand describes a set of measures that uses information technology to increase both the service qualities of private actors and the efficiency of logistics processes in terms of costs and negative externalities. In this context, the use of telematics tools can contribute to both making transports more sustainable and also improving operational processes. One example is the increase in vehicle load rates. (Russo and Comi 2011)

Equipment measures for instance are implemented by private actors. In particular, this involves alternative vehicle concepts. For example, the deployment of cargo bikes on the last mile can reduce negative effects. (Compare with Descriptive profile 21) (Leerkamp et al. 2020)

Measures from the **governance** area subsu-

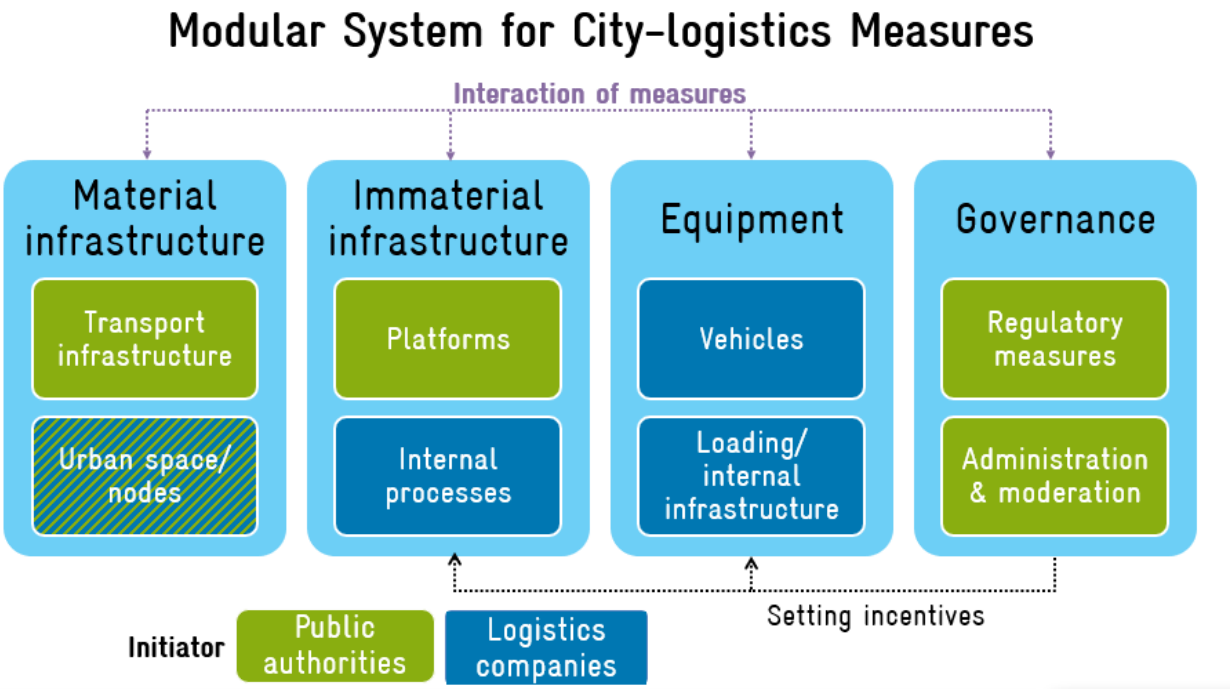


Figure 17: Measures in Urban Freight Transport, Own Description Based on (Francesco Russo and Antonio Comi 2011; Leerkamp et al. 2020)

me both regulations such as access restrictions, nighttime driving bans or delivery time windows as well as the moderation of coordination processes. Regulatory actions and the bringing together of various stakeholders fall within the scope of the municipality's responsibilities. (Leerkamp et al. 2020) In the area of governance, the following measures can be mentioned as examples, some of which are already being implemented in Berlin or have been identified as potential measures. In terms of planning and zoning law, the Berlin administration has a range of instruments at its disposal to take the interests of freight transport more fully into account. Freight transport zones, for instance, can be formally designated in the building plan (*Bebauungsplan*). In addition, as part of the building permit process (*Baugenehmigungsverfahren*), the building permit authority has the opportunity to consider the interests of freight transport on an equal footing with the interests of passenger transport. Participatory planning procedures in the form of a consultation group such as the *Plattform Wirtschaftsverkehr* have been tested and are being implemented. (Senate Administration for Urban Development of Berlin)

In addition to the pure description of possible measures in the previously defined dimensions (cp. Figure 17), an analysis with regard to their feasibility and impact must also be

considered. In the wake of the annual exceedance of NO_x limits, the federal government initiated an emergency programme to reduce pollution in the affected German cities, which resulted in so-called Green City Plans (GCP), among other initiatives, that provide measures for NO_x reduction. (Breiden 2020) Breiden (2020) has analyzed the measures described in German GCP in terms of their effectiveness and feasibility in time. The results are briefly presented below. [11]

Within the bundle of measures for material infrastructure, micro-depots and parcel stations in particular are identified as the most effective measures, as they can achieve a short-term effect in addition to being cost-effective to implement. Besides, the establishment of delivery and loading zones is of considerable importance, as they are easy to implement and are considered to be cost-effective. In the area of equipment measures, the use of cargo bikes and electric vehicles is prioritized the most. Even though the acquisition costs are higher compared to fossil-fuelled vehicles, the use of alternative vehicles is rated as effective. In addition, the high potential also results from the short-term feasibility as vehicles are already offered on the market. In the realm of governance, the introduction of access restrictions and delivery at off-peak times are prioritized the most. This results from the high effectiveness of the measures, which can also be implemented promptly.

In addition to assessing measures that can be implemented in the short term and that are effective, it follows from the analysis of the GCP that the measures applied are in many cases identical to those in the cities analysed as seen in Figure 18. Figure 18 shows how often the measures described occur in German GCP. According to the analysis, the use of alternative vehicles and the use of micro-depots are most frequently proposed as measures in GCP. For example, in the B2C segment, parcel stations are often proposed; in the B2B segment, the establishment of micro-depots are named as a measure. (Breiden 2020)

Further details on urban freight transport measures can be found in the which contains an overview of measures in urban freight transport as well as differentiated descriptions of individual measures.

4.3 Modeling Last Mile Logistics in Berlin

4.3.1 Calculation of Parcel Volume and Spatial Distribution

The parcel volume is calculated separately for B2C and B2B. The total B2C volume is determined on the basis of the annual per capita volume in B2C. The per capita volume of the parcel market is taken from a market survey

11 The prioritised measures in the dimension of immaterial infrastructure are not considered here.

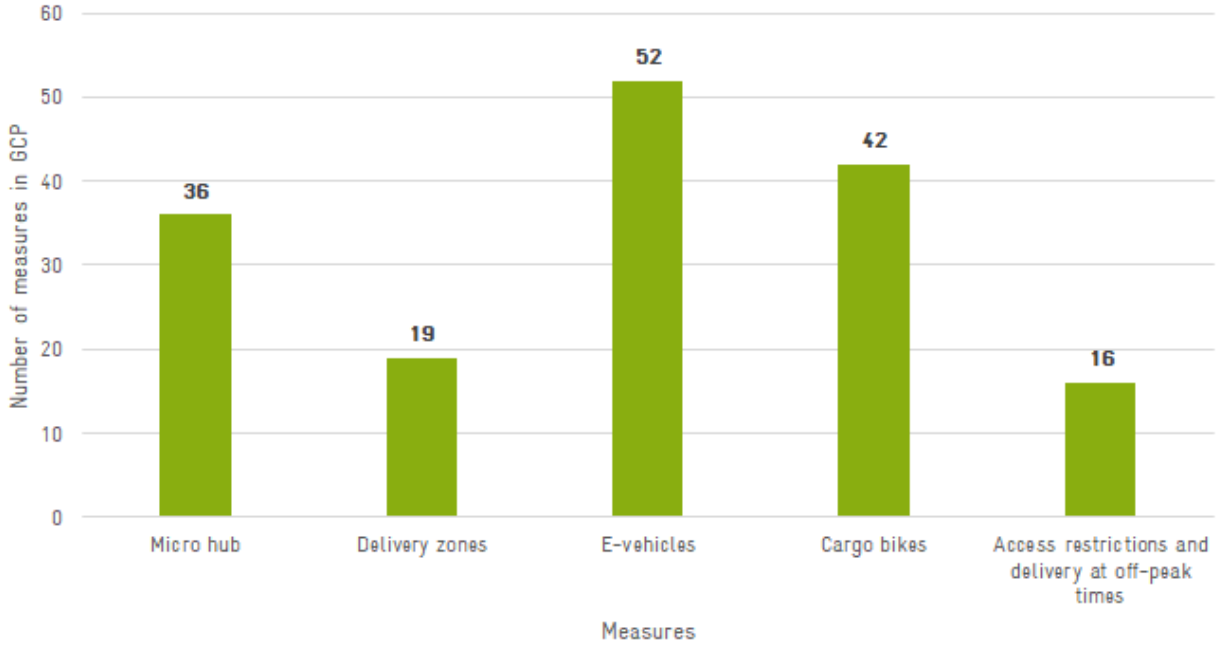


Figure 18: Number of Selected Measures in GCP in Germany (Breiden 2020)

by the German Federal Network Agency from 2017 (BNetzA 2017). The study displays the per capita parcel volume on the basis of the 2-digit zip code areas for the year 2016. The development is extrapolated into 2019 based on the increase in national B2C parcel volumes, resulting in a 24.4 % increase in parcel volume in the period from 2016 to 2019.

Since the study only displays the parcel market, the volume of courier and express shipments are determined proportionately. In 2019, courier and express shipments account for 15.8 % of CEP volume, which is added to the per capita volume in the parcel market. The resulting annual per-capita-CEP-volume is shown in Figure 19 for the city of Berlin.

Berlin‘s B2C per capita volume is then calculated using the population distribution based on the 100x100 m census cells. The census cells are based on the population of Berlin in the year 2011, which is why the population data is also extrapolated to the year 2019 based on the population development in Berlin‘s districts.

Hence the total annual B2C volume in Berlin amounts to 98.308 million parcels. The spatial distribution is shown in Figure 20.

The volume of parcels is concentrated in the inner-city areas, in line with the population distribution. The highest volume is 29.0222 parcels.

As there are no reliable key figures on the

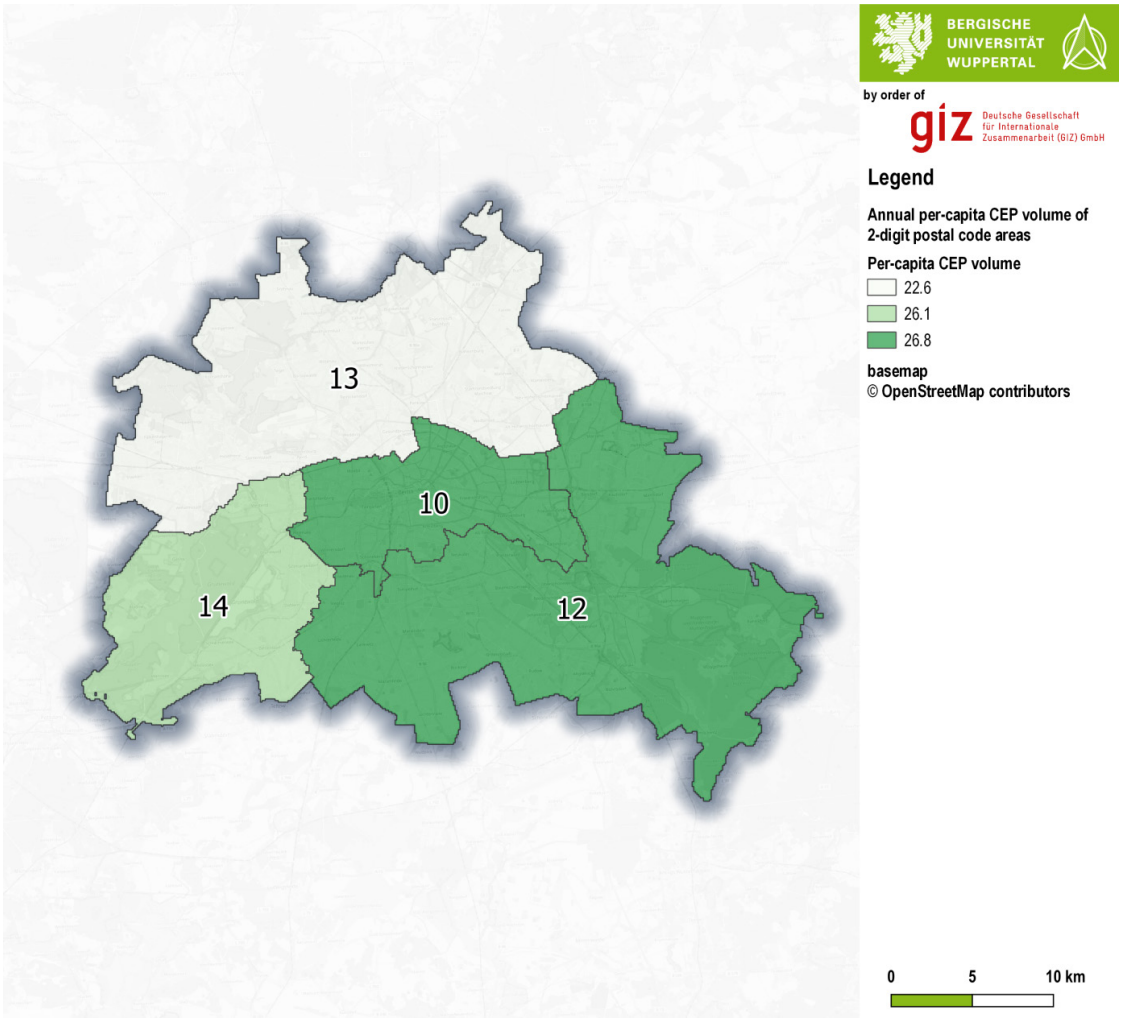


Figure 19: Annual Per-Head-Parcel-Volume Grouped by 2-digit Postal Code Area

volume of B2B Volume, the B2B volume is estimated proportionally to the B2C parcel volume. The share of the B2C parcel volume is around 70 %, consequently 30 % is accounted by B2B. With an annual B2C parcel volume of 98.308 million parcels, this corresponds to 42.132 million parcels in B2B per year.

The spatial distribution of the B2B volume is based on company locations. Retail companies are treated separately. For companies that cannot be assigned to the retail sector, it is assumed that the parcel volume corresponds to that of a private individual. A total of 27,435 companies that cannot be assigned to the retail trade can be identified via the commercial register. For these, an average parcel volume of 20.4 parcels is assumed. Thus, an annual volume of 663,304 parcels can be specified for the companies. The remaining B2B CEP-vo-

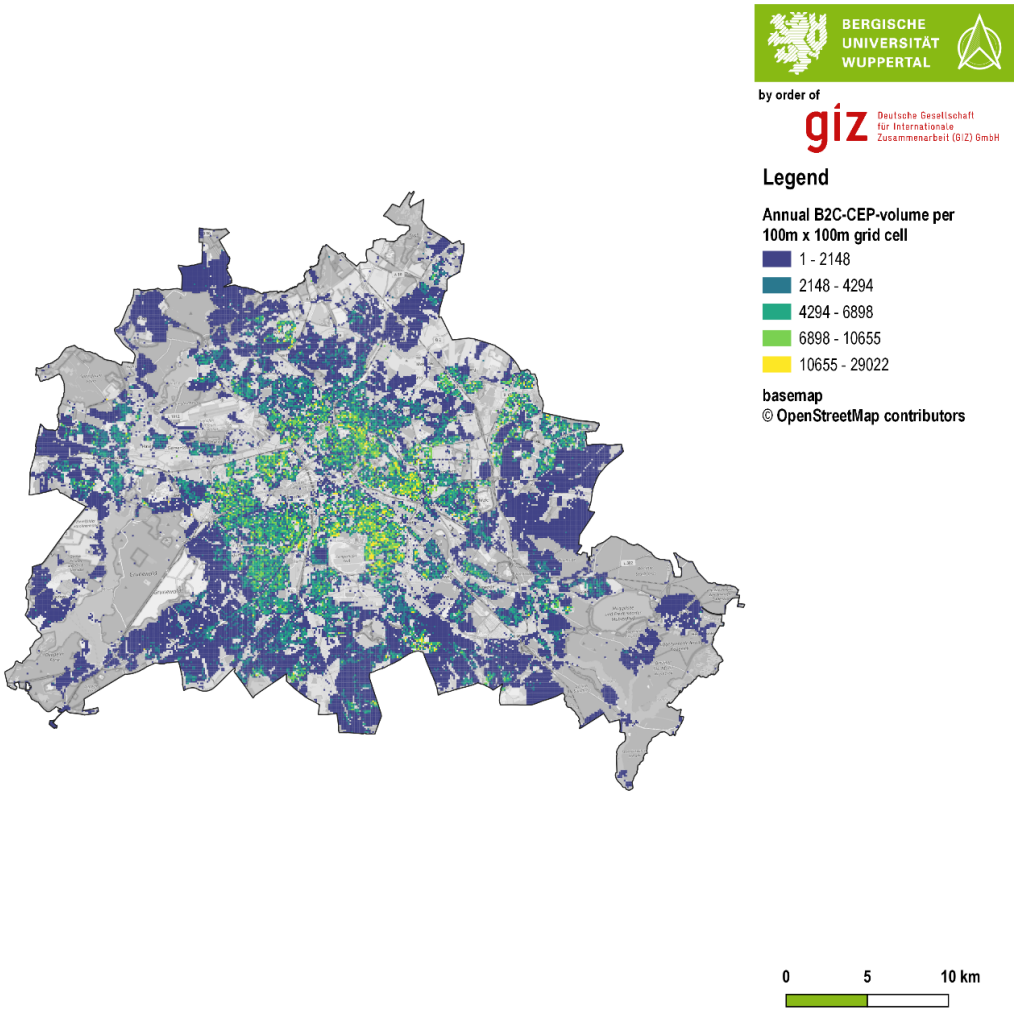


Figure 20: Annual B2C-CEP-Volume per 100x100 m^2 Grids Cells

lume is allocated to the retail sector. A total of 13,443 retail stores can be identified that receive 39.0 million parcels per year. Each retail store thus receives around 2,901 parcels per year.

The total CEP volume amounts to 140.440 million parcels per year. Express and courier services account for 15.6 % of this, which corresponds to 24.809 million parcels. The spatial distribution of the entire CEP-volume is represented in Figure 21.

According to BIEK (2018c) figures, around 10 % of B2C parcel volumes are attributable to parcel stores and around 3 % to pick-up points.

Therefore, in the next step, the parcel volume is distributed among the relevant CEP service providers in proportion to their market shares. DHL, DPD, UPS, GLS, Hermes and Amazon

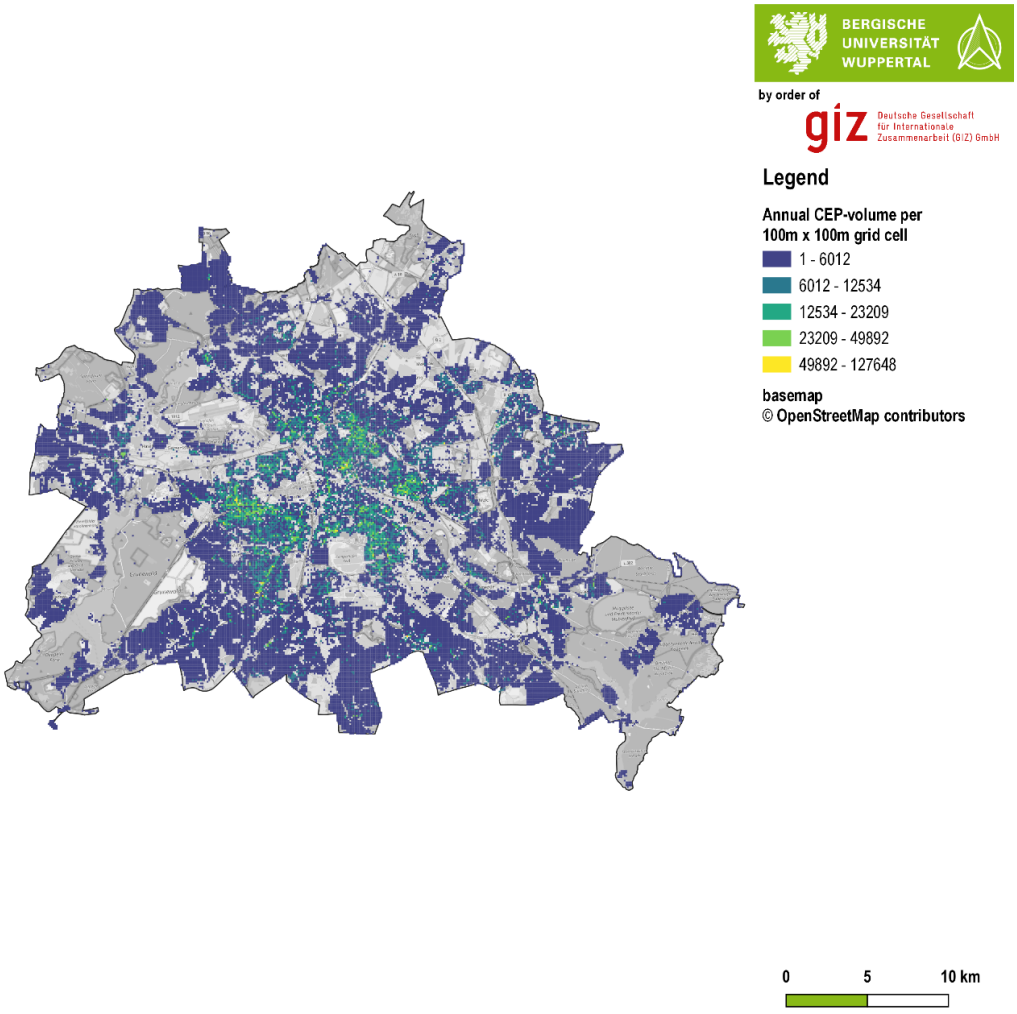


Figure 21: Annual CEP-volume per 100x100 m² Grid Cells

are considered. 13 % of the mail volume of each service provider is thus allocated to the pick-up points and parcel stores of the respective service providers. The calculated volume of the pick-up points and parcel stores is subtracted in equal parts from the volume of the grid cells without any pick-up points or parcel stores.

The result for each of the 100x100 m grid cells is information on the CEP-volume and the proportional distribution among the service providers. Based on this information the delivery tours are created.

4.3.2 Network Model

In order to be able to measure the contribution of measures in terms of mileage and CO_2

reduction, information on the current CEP organisation, number of vehicles used, type of vehicles (combustion engine, electric, etc.) and mileage as well as impact estimates of individual measures are necessary. Information on the fleet used, the respective mileage and the degree of utilisation (parcels/tour) per CEP service provider can only be obtained through a survey and serve to calibrate a model that is used to estimate the effects of measures and the status quo of mileage. There are no detailed statistics on the CO_2 emissions of CEP service providers in Berlin.

Figure 22 shows the underlying network model that is an extract from the OpenStreetMap road network. If a CEP tour is considered in more detail, it is made up of the entry into the delivery area, the servicing of the delivery area and the exit from the delivery area to the CEP depot. (Holthaus et al. 2019) Depending on the location of the depot in relation to the delivery area, the CEP traffic overlaps the morning peak hour. The latter has an impact on the driveable speed, especially in densely populated cities. In addition, logistics areas are usually located on the periphery. The afternoon peak hour usually does not overlap with the CEP tours. Based on a working time of 8.5 hours/d, most CEP tours are finished between 3 and 4 pm. In addition, the afternoon peak hour is usually less pronounced because commuter traffic is spread over a longer period of time due to trip chains (e. g. shopping after work) and part-time work. The influence on the possible travel speed is therefore less in the afternoon than in the morning. Therefore, the network model was parameterised with driveable speeds in the morning hours.

The influence of traffic on the drivable speed can be seen in Figure 23. The thinner a network edge is, the lower the driveable speed. At motorway exits, lower speeds towards the city centre can be seen in the morning hours, which is not least due to the congestion at the traffic lights.

Based on the depot locations of the CEP service providers (cp. Figure 26), the location of the pick-up points (cp. Figure 15) as well as the distribution of the B2C and B2B parcel volumes on the basis of the 100x100 m grid cells (cp. Figure 21), the mileage and the routes of the CEP tours are determined by modelling (cp. 4.3.3). The tour generation algorithm is calibrated using the information from the interviews with the CEP service providers.

4.3.3 Model Results - Emission and Mileage

Due to the lack of CEP-specific emission data in the statistics, the following scenarios are modelled. The first scenario, called „Base-Scenario“, describes a conventional delivery with diesel vehicles without taking district-based measures into account. The achievable emission reductions are classified using the example

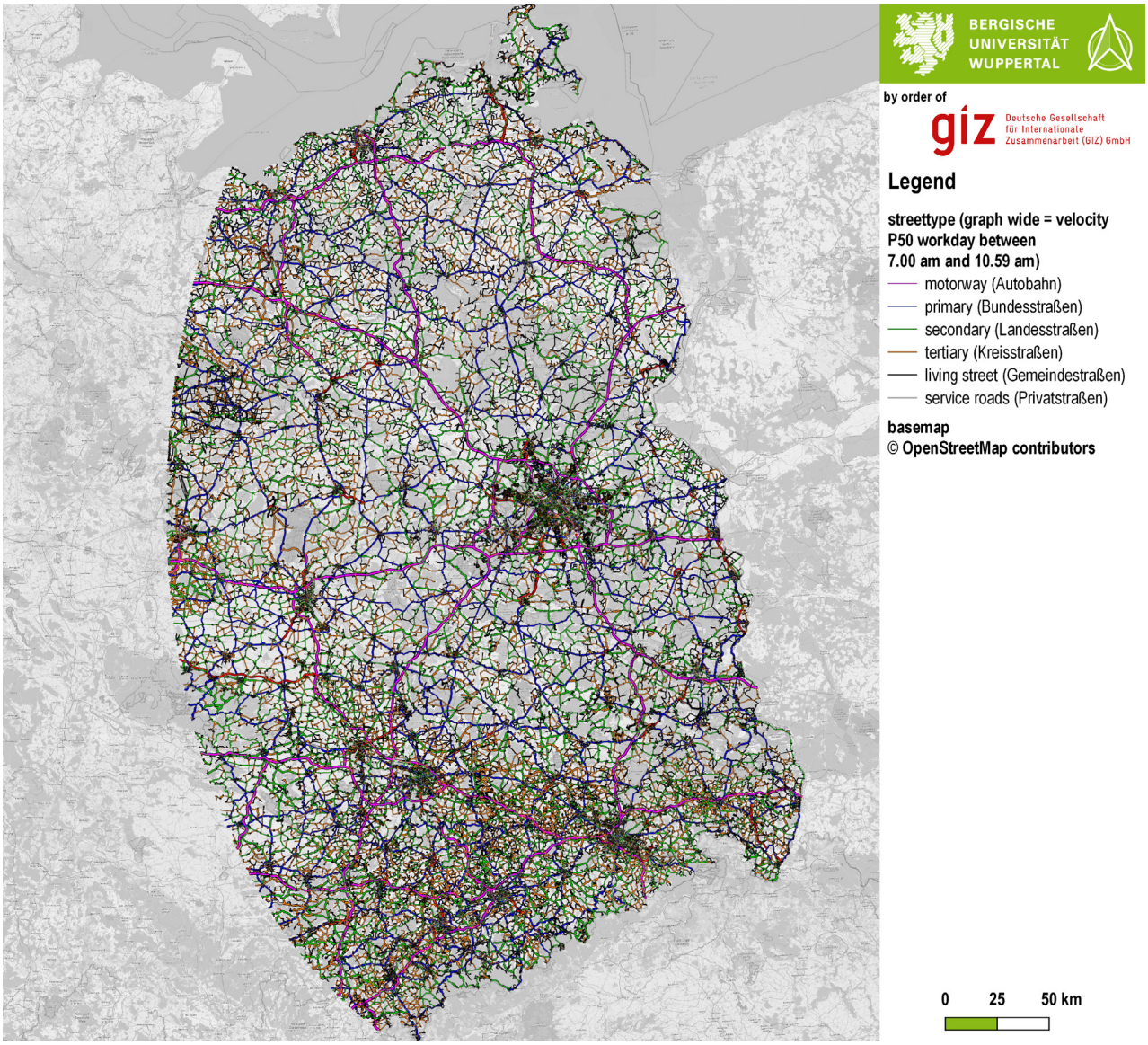


Figure 22: Parameterised Network Model

of KoMoDo (compare to Descriptive profile 11 in Apendix II). Subsequently, two scenarios are looked at. In order to map the theoretical optimum of the existing delivery infrastructure, the entire CEP volume within a given area around the pick-up points gets allocated to the pick-up points of each CEP service provider, then a scenario inspired by existing structures in China is presented.

Model output is the mileage of each CEP service provider. On this basis, the resulting emissions are calculated with the Manual of Emission Factors of Road Transport (HBEFA) 4.1.

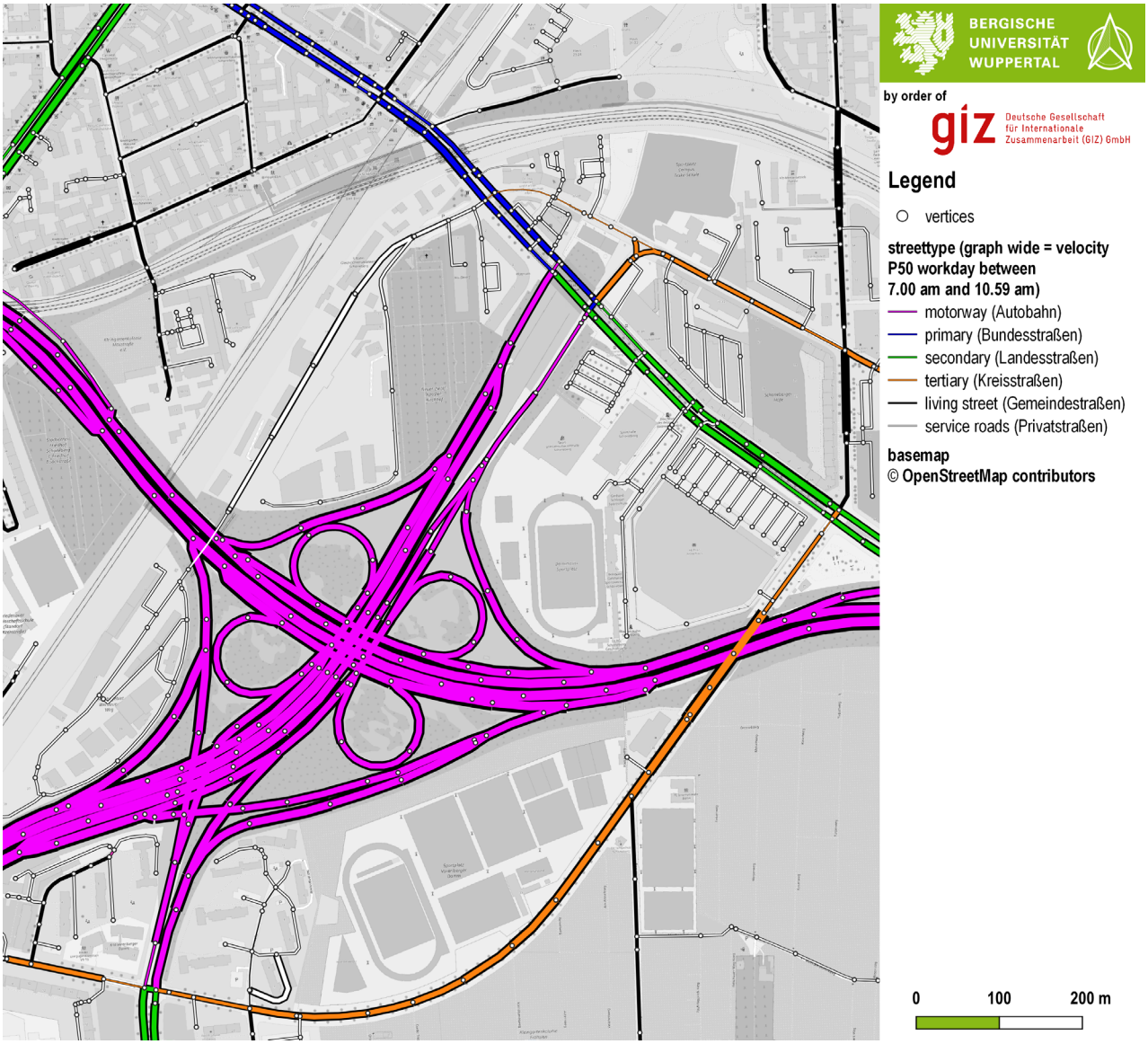


Figure 23: Parameterised Network Model – Sample Cut-out

HBEFA is a database that presents emission factors for road traffic. Emission factors are differentiated according to different spatial references, traffic situations, road types and longitudinal gradients. The aggregation levels of the HBEFA are shown in Figure 24. (INFRAS Bern/Schweiz with MKC Consulting GmbH und IVT/TU Graz 2019)

Furthermore, different vehicle classes (including passenger cars, light commercial vehicles and heavy commercial vehicles) are differentiated. The vehicle fleets of the specific vehicle classes are weighted with the mileage shares

of the EU emission standards and can be differentiated according to different weight classes for commercial vehicles. Emission modelling is done for CO_2, NO_x and PM. Emission factors are differentiated by space reference, street type and traffic situation.

The traffic situations necessary for this calculation can be derived from the parameterisation of the network model with real driven speeds out of Floating Car Data (FCD) (cp. Figure 25). Both, the results of the model, as well as the vehicles used (vehicle type, total gross vehicle weight and payload volume) were calibrated on the basis of interviews with the CEP service providers in Berlin.[12]

Despite the use of a model, the results of this study are only orders of magnitude and do not represent exactly measured emissions. In addition, a detailed analysis of the traffic situations in the delivery area is missing. Here, the HBEFA emission values depend strongly on the distance travelled between two deliveries and not on the general traffic situation. However, the model is suitable for illustrating the effects of the measures and for comparing the characteristic values.

4.3.3.1 Base Scenario

The base scenario reflects conventional delivery with delivery vehicles up to 3.5 t GVW (gross vehicle weight) or 7.5 t GVW - depending on the CEP provider. Based on the parcel volumes calculated in chapter 4.3.1 (each 100x100 m grid) and the recorded depot locations (cp. Figure 26), tours can be calculated starting from each depot on the basis of the network model.

12 All CEP service providers in Berlin were contacted in this regard, of which only one service provider provided feedback. Due to the large volume of consignments to be handled by this service provider, it was possible to validate the model.

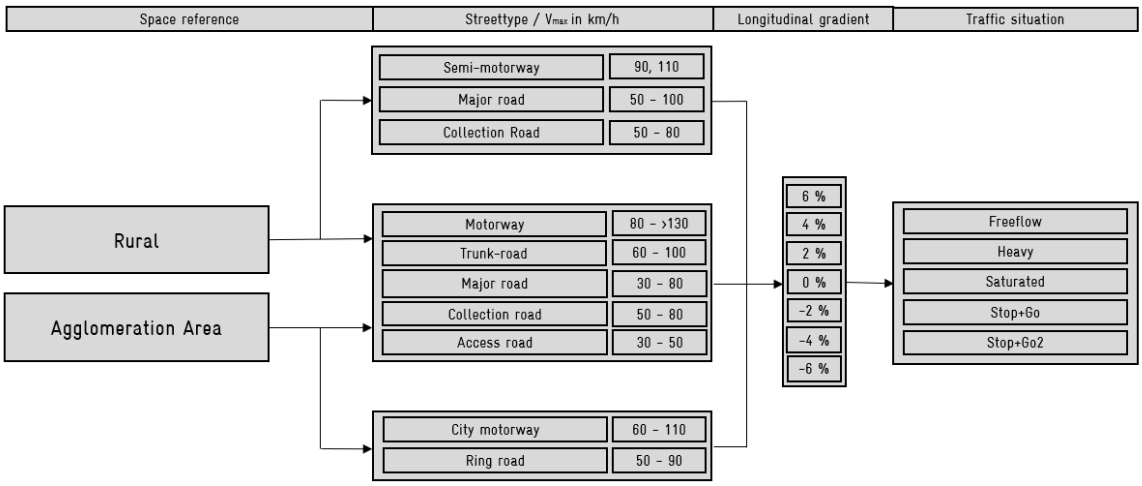


Figure 24: Aggregation Levels of HBEFA 4.1 (INFRAS Bern/Schweiz with MKC Consulting GmbH und IVT/TU Graz 2019)

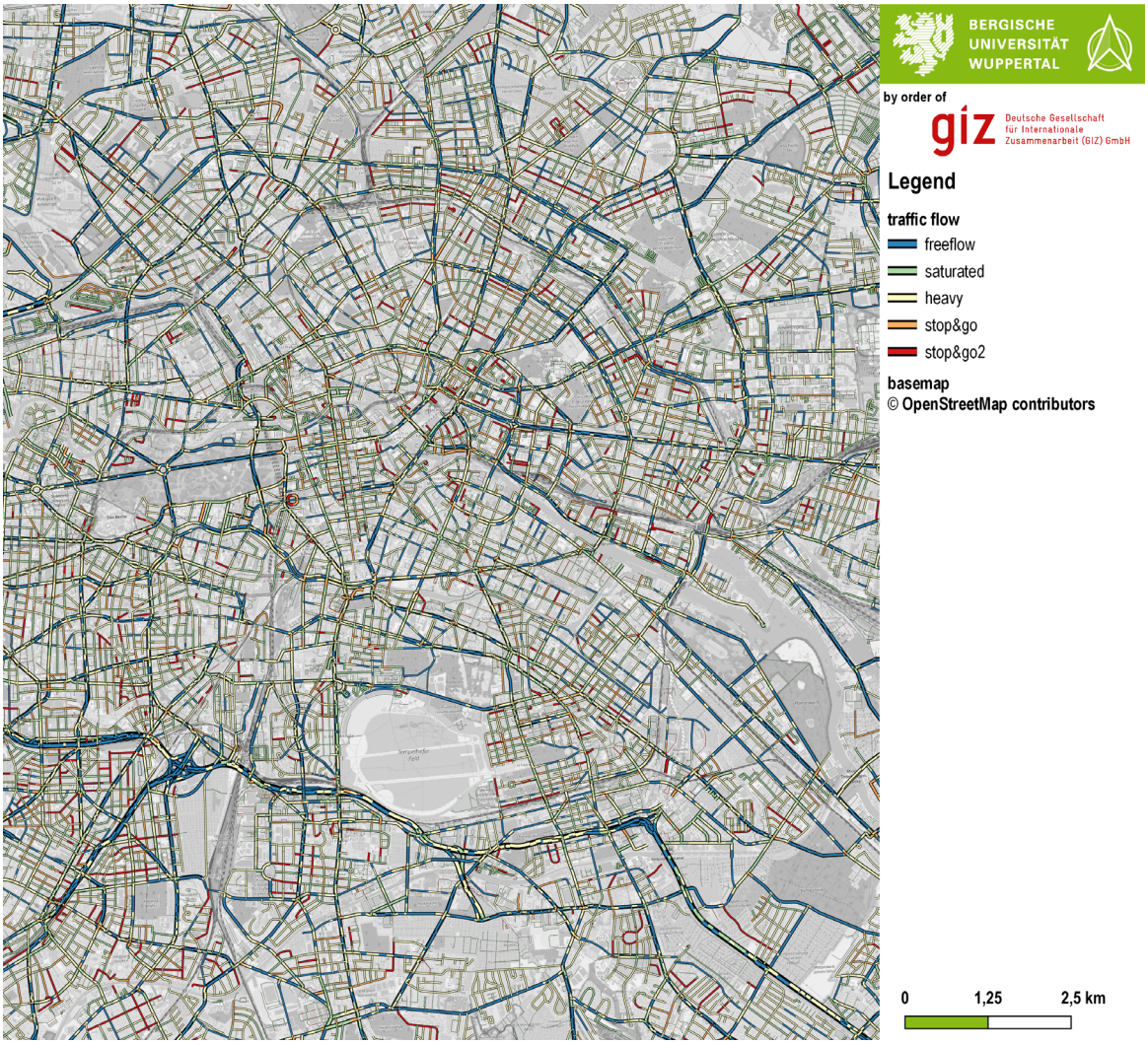


Figure 25: FCD Based Traffic Situations within the Network Model

In addition to the depot locations, Figure 26 shows the CEP-vehicle volume resulting from the model on the network model. The thickness of the network edges reflects the number of crossings of CEP vehicles. It can be seen that CEP traffic is concentrated on the main road network, but that the vast majority of secondary roads are also used at least once.

This scenario results in a total daily mileage of 77,322 km per day. Of this, 59,152 km are in the area of Berlin (76.5 %). Within the city limits, the main road network is more heavily used than the access roads. Here, 67.3 % of the mileage is accounted to the major road network. In total (Berlin and surrounding area) 18.2 tons of CO_2, 386 kg NO_x and 1.4 kg PM[13] are emitted.

13 Particulate Matter.

4.3.3.2 Cooperative Use of Micro-depots

In addition to the base scenario, two alternative delivery scenarios are considered. At first, the KoMoDo project is pictured. (Further details in Descriptive profile 11) The CEP providers share an area in the city district Prenzlauer Berg. Each CEP provider has its own Micro-Depot on the area. The parcels are delivered via cargo bikes. The catchment area of KoMoDo is within a radius of 3 km[14] around the Micro-Depot which has, according to prior calculations, an annual parcel volume of 17,5 million parcels. The project report states that 160,000 parcels are delivered within a period of 12 months via cargo bikes outgoing the micro-depots. (LNC LogisticNetwork Consultants GmbH 2021)

In order to map the impact of KoMoDo the

14 As stated in chapter 2.6 the catchment area of a micro-depot is approx. 1 km. However, KoMoDo states a catchment area of 3 km. It is assumed, that most parcels are delivered within a radius on km around the KoMoDo Depot, which can't be proven, therefore the designated catchment area of 3 km is taken.

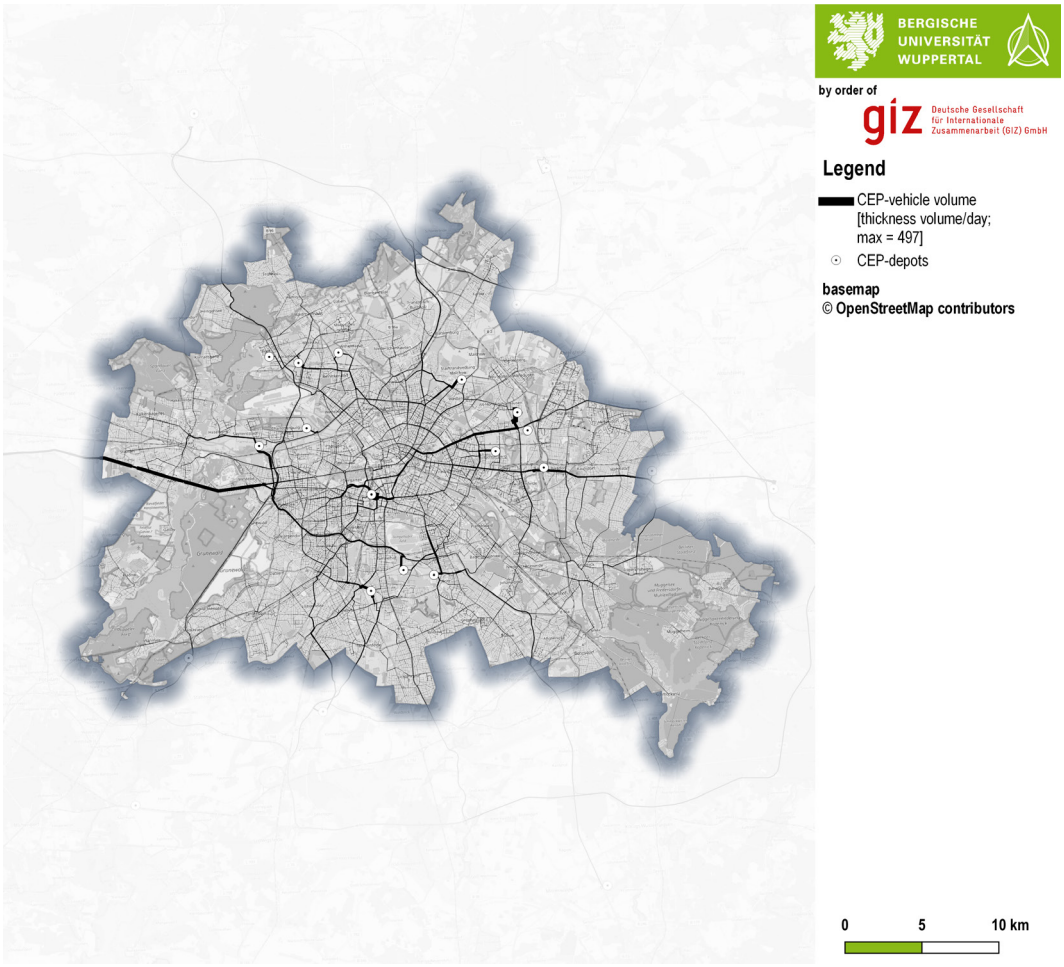


Figure 26: Vehicle Volume on the Road Network – Base-Scenario

parcel volume delivered with cargo bikes is substracted from the overall parcel volume within the catchment area. Then the routing is re-performed.

The analysis of the modelled delivery tours shows no significant change in mileage which is due to the fact that the overall CEP volume is only reduced by approximately 1 %, resulting in almost the same delivery tours and stops modelled for the base scenario. Because of the uncertainties regarding the catchment area of KoMoDo (a smaller catchment area with the same number of parcels delivered, results in a higher volume and therefore higher absolute mileage reduction within the area) the model is not used to map KoMoDo. Therefore, the mileage and CO_2 reduction stated by the final report of KoMoDo is used. NO_x and PM are not designated. It's stated that 11 t of CO_2 and 28,000 km of mileage are saved within a period of twelve months. (LNC LogisticNetwork

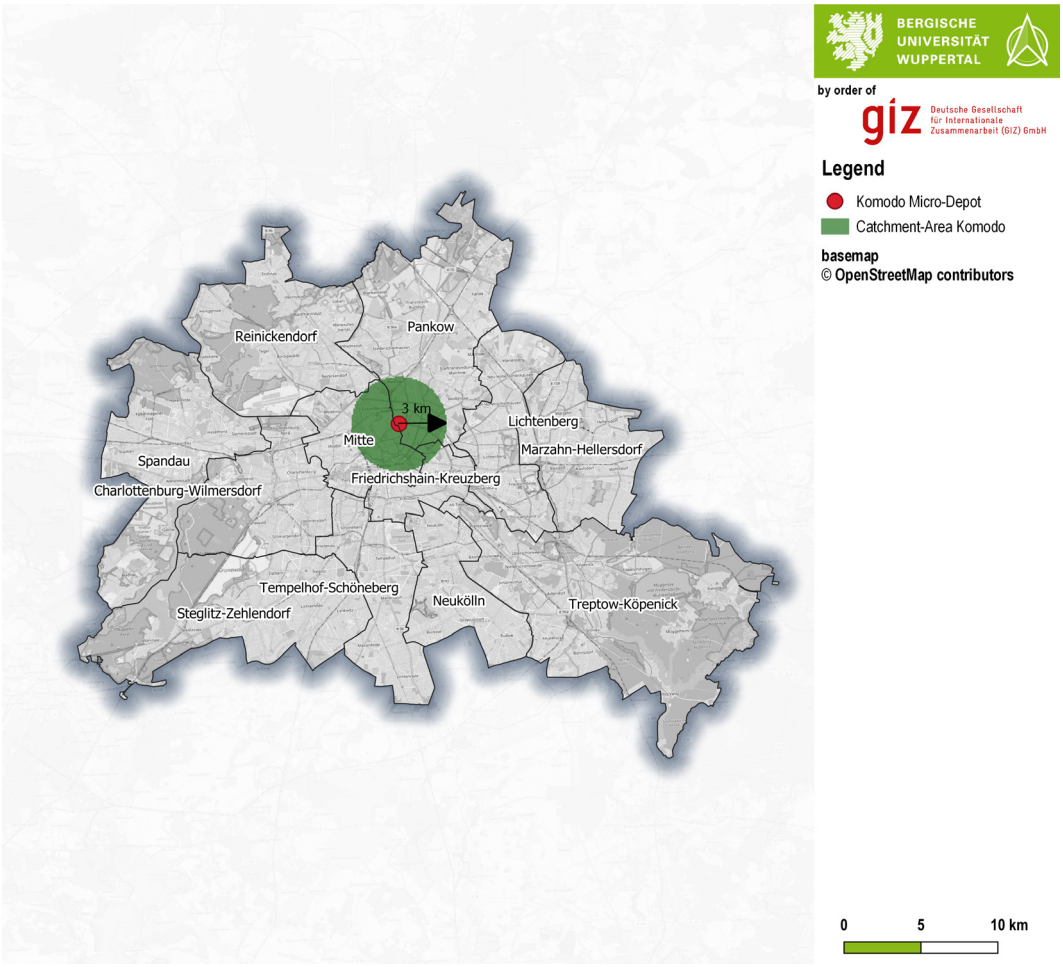


Figure 27: Catchment Area of KoMoDo

Consultants GmbH 2021)

4.3.3.3 Bundling on Existing Pick-up Point Network

The CEP service providers have a network of 2,793 pick-up points in Berlin. It is to be expected that delivery at pick-up points will become more and more important, as the density of pick-up points will increase due to the higher acceptance by the end customers and the CEP service providers will push this development due to the cost saving potential compared to doorstep delivery. As stated before, around 13 % of the parcel volume is delivered at the pick-up points, which has been mapped in the base scenario. This scenario serves to estimate the impacts of the optimal usage of the existing pick-up point infrastructure.

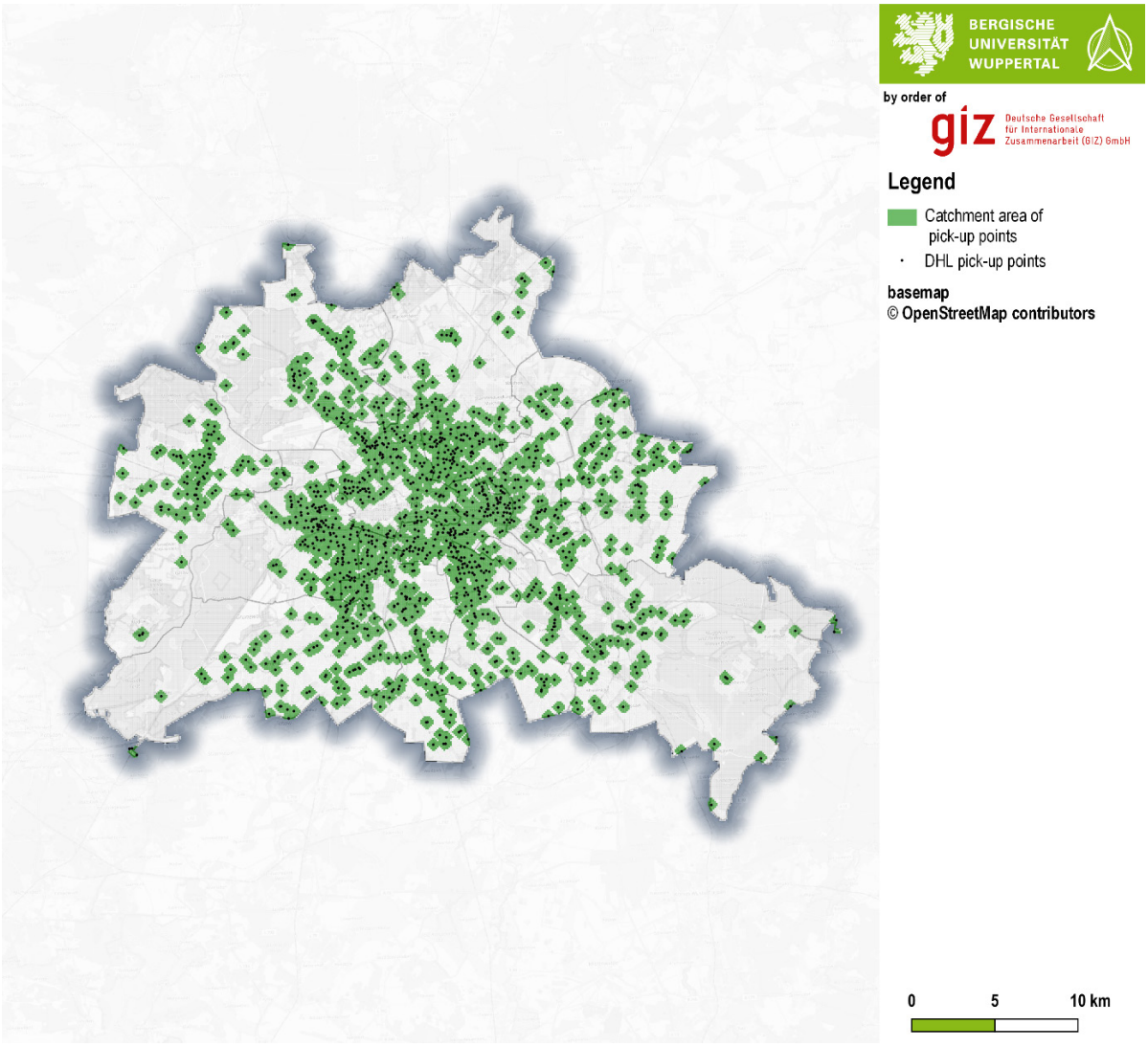


Figure 28: Catchment Area of DHL Pick-up Points

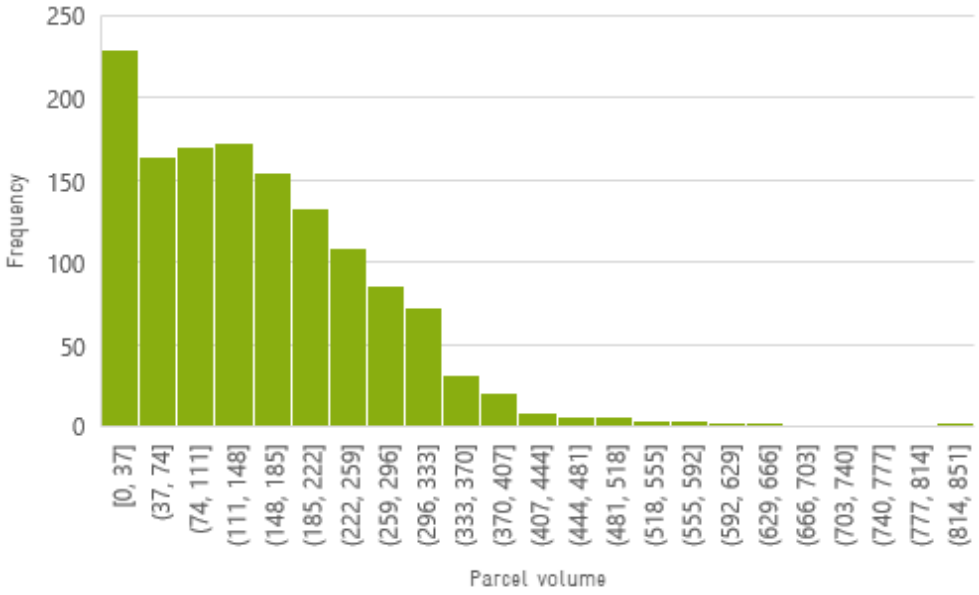


Figure 29: Aggregated Parcel Volume of DHL Pick-up Points per Day

For this purpose, the entire parcel volume within the catchment area of the pick-up points is allocated to the respective nearest pick-up point of each CEP service provider. Since there is no data available about the catchment area of pick-up points (missing information about the end customers' willingness to walk) the catchment area of bus stops, which is approx. between 300 m – 400 m within core city areas, is used for the estimation. As an example, Figure 28 shows the catchment areas of the pick-up points of DHL.

Given the example of DHL, the daily CEP volume which is aggregated on the pick-up points ranges between 37 and 851 parcels. The median is 139 parcels per day which is much higher than in the base scenario (in maximum 96 parcels per pick-up point and day with a median of 10). The distribution of the daily volume of the DHL pick-up points is shown in Figure 29.

Therefore, the space requirements of the storage areas also differ. Assuming a room-high storage area, a space of 4-5 m² is needed to store the median parcel volume of 139 parcels per day. Taking into account the much lower parcel volume per pick-up point in the base scenario, it can be assumed that most existing pick-up points could not handle a daily volume this high, which would require an adjustment of the existing structures.

In total a mileage of 57,095 km, of which 44,970 km (78.8 %) are driven within Berlin, is

obtained. Within Berlin 63.4 % of the mileage is accounted to the major road network. In total 16.8 t of CO_2, 218 kg NO_x and 2.4 kg PM are emitted.

4.3.3.4 Pick-up Points on Major Roads

A share of 32.7 % of the mileage of the delivery tours within the city of Berlin occurs on the access road network. The main part of the mileage is induced by the high parcel volume within these areas. In order to map the theoretical mileage optimum using shared pick up points of the CEP service providers the parcel delivery is restricted on the major road network. Parcels are only delivered to fictio-

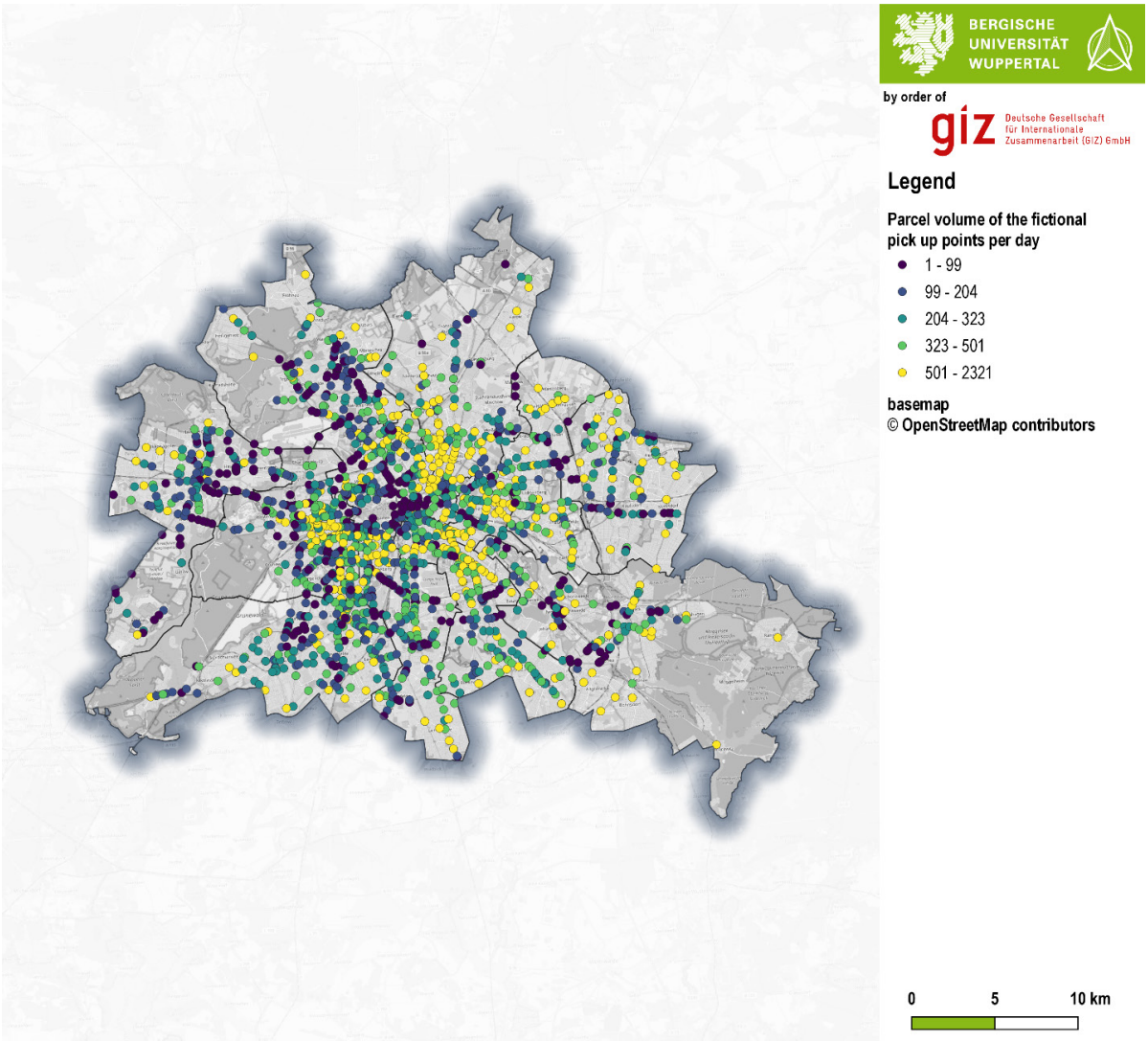


Figure 30: Parcel Volume of the Fictional Pick-up Points per Day

nal pick up points. These pick-up points are located on the major intersections of the road network. The entire parcel volume (B2C and B2B) of the grid cells is then aggregated to the nearest pick up points. This approach will show a theoretical optimum, without breaking up the CEP market structures. The implementation of the described scenario is unlikely to be realised in Germany, but is comparable to the compound delivery or Cainiao Parcel Station concept in China, where deliveries are bundled on building blocks, resulting in less stops compared to door delivery.

To model this approach, 1,811 pick-up points are needed in Berlin to which the entire parcel volume is attributed. The maximum parcel volume of the pick-up points is 2,321 per day, the median 240 parcels per day. The spatial distribution is shown in Figure 30.

The daily parcel volume differs greatly, resulting in different bundling potentials and space requirements in the streetscape (cp. Figure 31). Due to that, the use of commonly shared pick up points and the consolidation of the entire parcel volume might not be worth in terms of the effort that has to be made in city regions that only have marginal parcel volume, as it results in too big compartment sizes of the pick-up points in the streetscape. Assuming an average volume of 0.06 m³ per parcel, a calculative space of approx. 140 m³ is needed to store the maximum per day parcel volume, which is equivalent to two 40-foot Containers with a total space requirement of 56 m² (Holt-

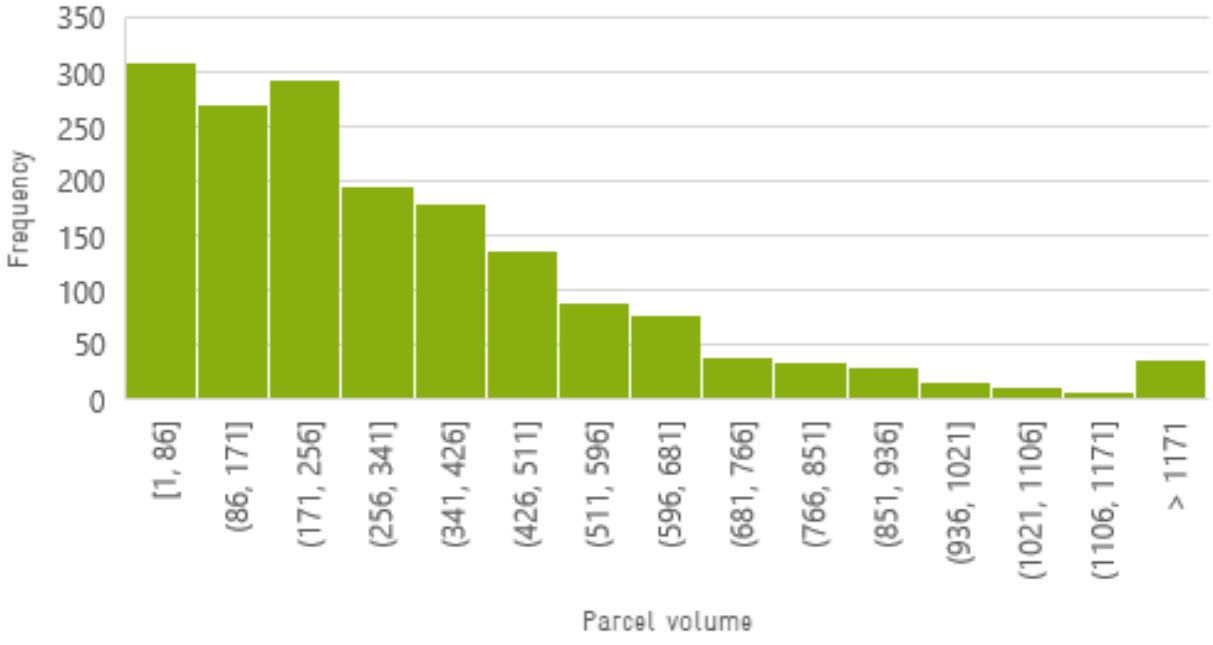


Figure 31: Histogram of the Parcel Volume of the Fictional Pick-up Points per Day

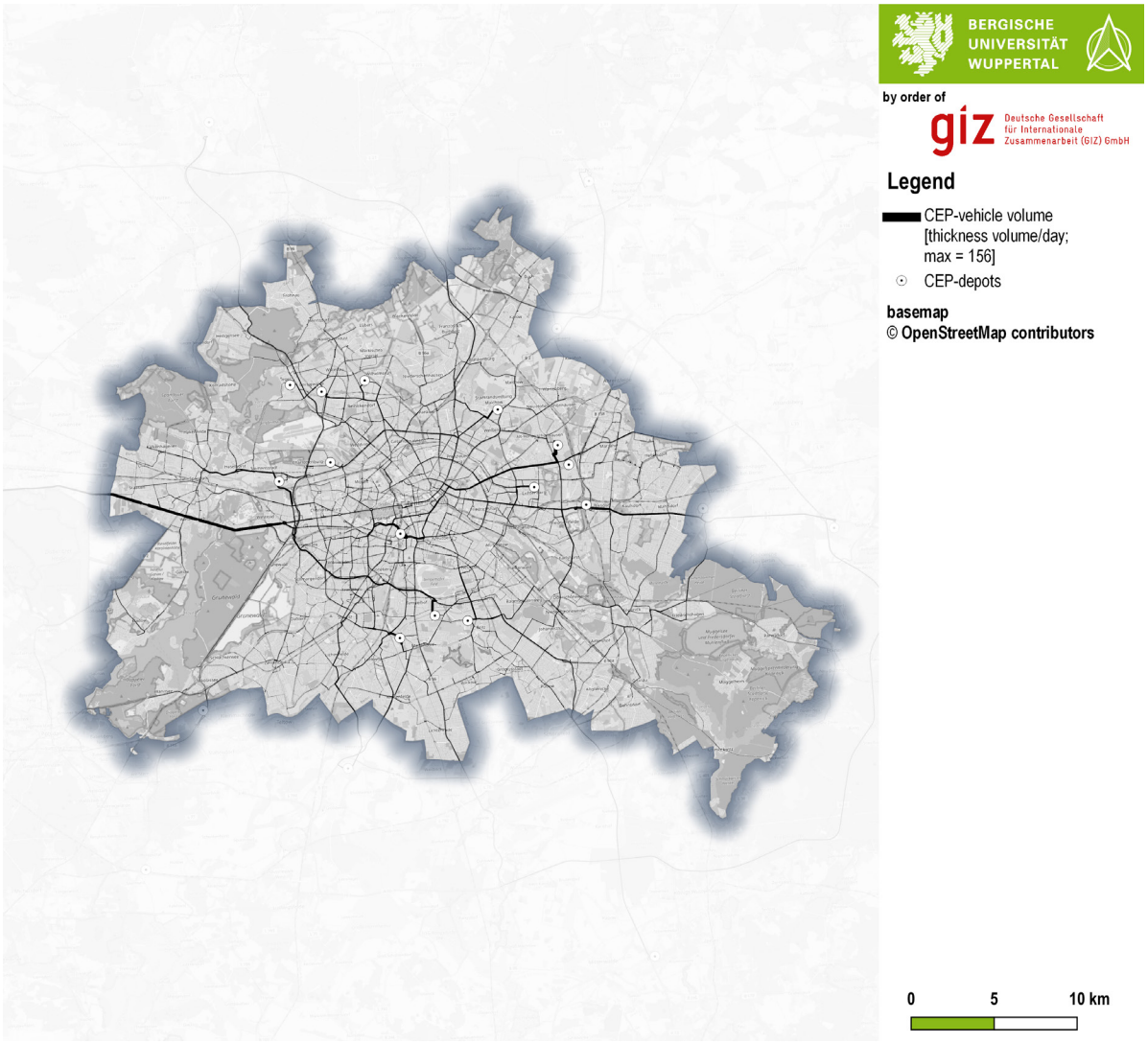


Figure 32: Vehicle Volume on the Road Network – Scenario Pick-up Points on Major Roads

haus et al. 2019). On the other hand, the median pick-up point volume of 240 parcels per day could be stored within a compartment of 14,4 m³ or approx. half the size of a 20-foot container resulting in a space requirement of 7 m², which is likely to fit into the expanse of most considered intersections.

In order to map the pick-up points within the tour model, it is assumed that the normal delivery vehicles (≤ 3.5 t gross vehicle weight) are replaced with bigger 12 t gross vehicle weight trucks, because they are commonly used by the CEP service providers. These trucks have a calculative shipment volume of 45 m³ (postbranche.de 2019). Therefore, approx. 750 parcels (0.06 m³ per parcel) can be delivered with

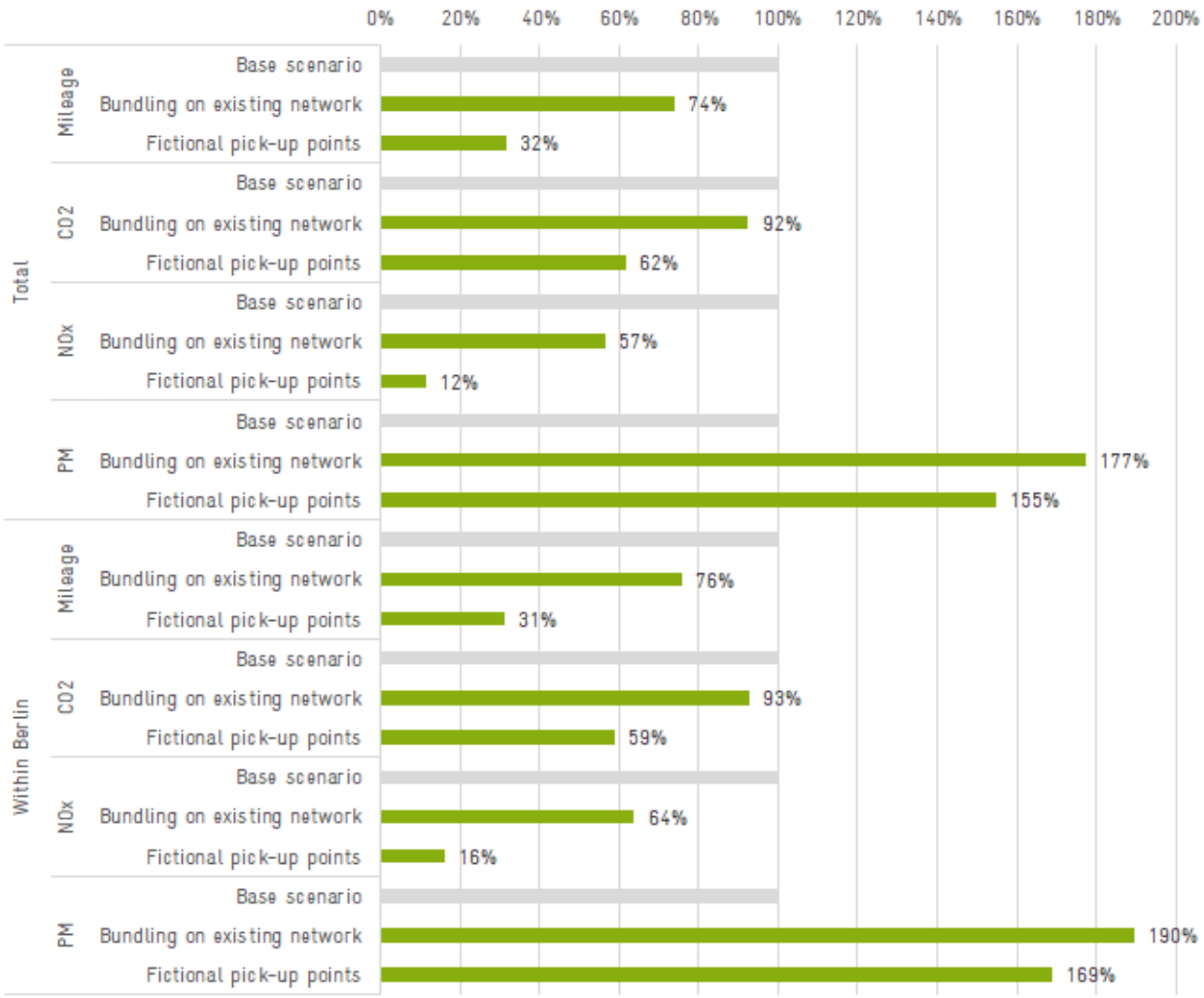


Figure 33: Percentage Change in Mileage, CO_2, NO_x, PM of the Alternative Delivery Scenarios

one truck.

This scenario results in a total daily mileage of 24,470 km per day. Of this, 18,482 km are in the area of Berlin (75.5 %). Within the city limits, the main road network is more heavily used than the access roads. Here, 92.9 % of the mileage is attributed to the major road network. In total (Berlin and surrounding area) 11.2 t of CO_2, 44.6 kg NO_x and 2.1 kg PM are emitted.

4.3.4 Comparison and Subsumption of the Delivery Scenarios

The base and alternative delivery scenarios dif-

fer in CO_2, NO_x and PM emissions.

The bundling of existing pick-up point network results in a mileage reduction of 26 % or 20,227 km in total of which 14,181 km of mileage are saved within Berlin. In the fictional pick-up point scenario, the mileage is reduced by 68 % in total, which is an absolute decrease of 52,850 km per day in total of which 40,670 km are within the city of Berlin. This reduction is explained by the use of larger vehicles resulting in less delivery tours and the fact that access roads no longer have to be used.

In both alternative scenarios the strongest and in comparison to the mileage reduction disproportionately higher decrease can be seen in NO_x emissions. The bundling on the existing pick-up points results in a NO_x reduction of 26 %, the fictional pick-up point scenario in an 88 % NO_x-reduction. This is mainly due to the better traffic flow that can be observed on the major roads, which accounts for significantly higher share of mileage than in the baseline scenario.

PM emissions on the other hand increase by 77 % respectively 55 %, as 12 t trucks have a higher specific PM emission than light good vehicles.

Particularly within the city limits of Berlin, PM emissions are even higher, as the share of stop and go driving situations increases. The percentual changes between the baseline and alternative delivery scenarios can be seen in Figure 33 below.

The mileage on the access roads is strongly reduced in the alternative delivery scenarios and amounts to 78 % respectively 7 % of the baseline scenario. The mileage on the major road

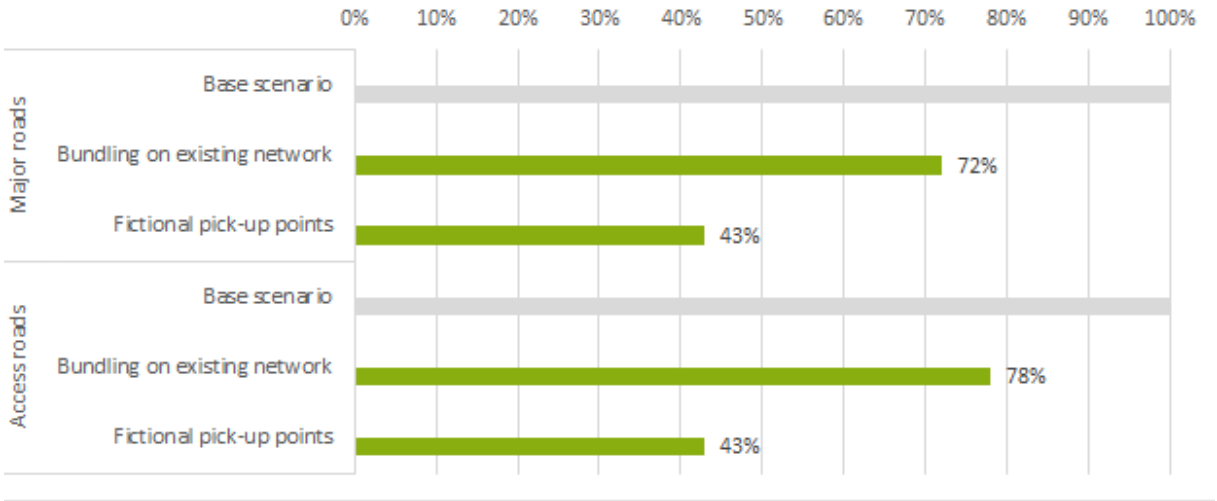


Figure 34: Percentage Change in the Alternative Delivery ScenariosMileage by Street Type

network amounts to 72 % respectively 43 % of the baseline scenario due to the bigger the use of higher capacity delivery vehicles and more optimal delivery tours on the major road network.

The bundling on the existing pick-up point network shows that even with the existing delivery network a high amount of mileage can be saved. Even if the 100 % of parcels delivered to the pick-up points in the 350 m catchment area assumed in this scenario are not achieved in reality, it can be shown that a reduction in mileage can be expected through bundling at the pick-up points. It is foreseeable that the reduction shown will also be partially transferable to the future development in the next few years due to the increased use of the pick-up points by the end customer and the increased promotion of pick-up point delivery by the CEP service providers due to the cost saving potential of pick-up point delivery in comparison to door delivery.

The fictional pick-up point scenario shows that with the full consolidation of parcel volumes at central locations on the main road network, there is significant potential for mileage and emission reduction. Even if this cannot be easily implemented in this form, a look at China shows that central pick-up points have a high value in end customer delivery. At the same time, it can be deduced that the projects that can currently be implemented in Germany, such as KoMoDo, show positive effects, but only have a small influence on the sustainability of the last mile when looking at the absolute figures. The potential savings of 28,000 km mileage and 11 t of CO_2 per year or 152 km and 44 kg CO_2 per day identified there, represent only a fraction of the 77,322 km of mileage per day in the base scenario.

In order to evaluate the model-based approach, the simplifications made regarding mileage and emissions must be considered. On the one hand, the traffic situation and the corresponding emission factor were modelled on the basis of FCDs, which represent an average vehicle on a network section. However, vehicles of CEP service providers are in a constant stop-and-go state in the delivery area, which leads to higher specific vehicle emissions. In addition, the fleet composition and thus the share of e-vehicles in the fleets of CEP service providers had to be calculated on the basis of the HBEFA, which in the case of light commercial vehicles represents the entirety of the specific vehicle class in Germany. However, it can be assumed that the share of e-vehicles in the fleets of CEP service providers has increased in recent years resulting in less emissions. Especially in the presented alternative delivery scenarios PM emissions show a significant increase due to the use of 12 t heavy good vehicles. The use of larger vehicles will be indispensable in the scenarios presented, in order to be able to handle the parcel volumes

of the pick-up points. Therefore, in addition to increasing the share of e-vehicles in the current fleet of the CEP service providers, the enforcement of comprehensive bundling solutions as regards the electrification of heavier delivery vehicles is needed to handle last mile sustainably.

Furthermore, the calculation of the CEP parcel volume is based on simplifications. Factors like the CEP parcel volume are also subject to weekly and seasonal fluctuations that lead to different load factors, mileage and emissions, which are not reflected in the model or the stated key figures but result in varying daily mileages.

A more accurate depiction of the situation can only be realised through better data availability.

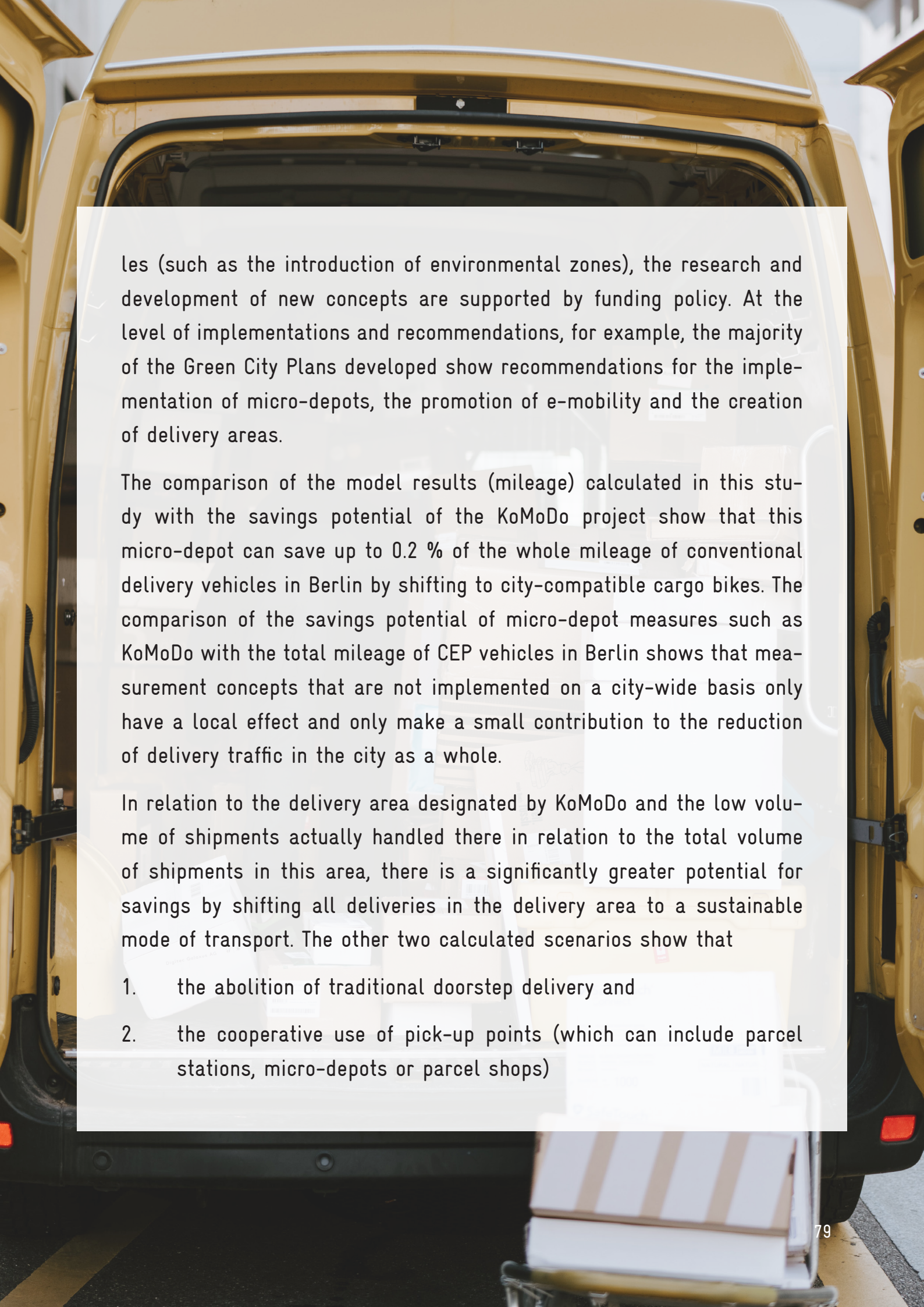
5 Conclusion

This study presents the current state of the last mile organisation in the CEP segment in Germany, with a focus on Berlin as case study. In a first step, it is shown that the CEP sector is influencing the time horizon for the delivery of consignments due to the increasing demands of e-commerce to satisfy end customer wishes. CEP products such as Same-Day Delivery respond to shippers' needs, but reduce bundling potentials. As a result, the last mile becomes more complex, which increases already high costs. Inefficient multiple delivery attempts and deliveries to inefficient areas, which are partly occupied with delivery windows to protect other city functions such as pedestrian zones, are to be avoided through the provider's own concepts such as the development of micro-depots and parcel stations.

In addition, there are social demands, political goals and other framework conditions that push for more sustainable logistics (within cities), especially in the context of air pollution control.

For a better understanding of the processes in the CEP sector on the part of the public sector as well as the evaluation of field trials, it is necessary to create a better data basis. From the point of view of urban transport planning, closer cooperation between transport planning and market participants is desirable, so that measures can be jointly developed that represent an improvement (cost reduction for the CEP sector, overall reduction in traffic and environmental pollution) for all under the given objectives (especially sustainability).

Besides new requirements in the form of regulations, laws and other ru-

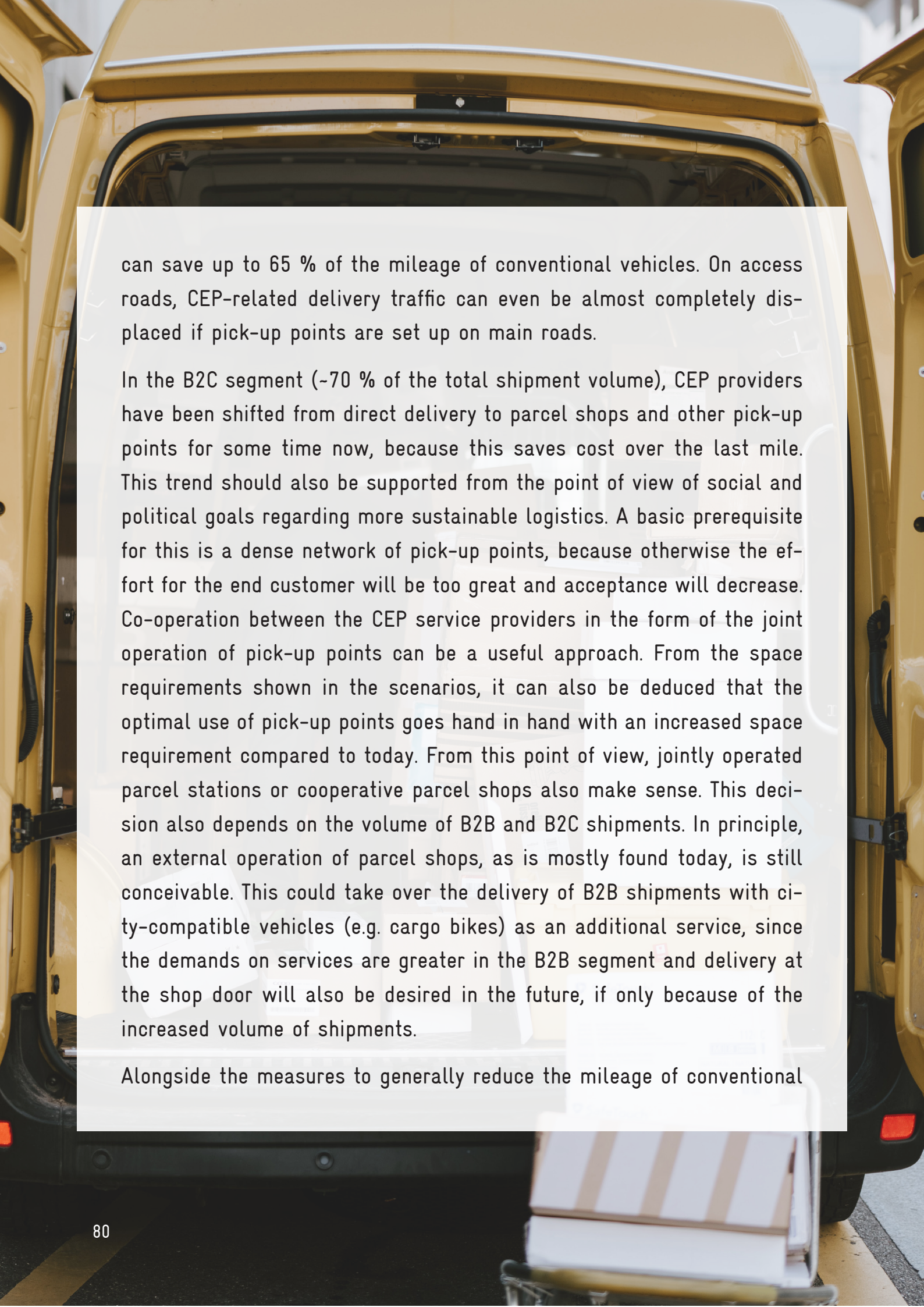


les (such as the introduction of environmental zones), the research and development of new concepts are supported by funding policy. At the level of implementations and recommendations, for example, the majority of the Green City Plans developed show recommendations for the implementation of micro-depots, the promotion of e-mobility and the creation of delivery areas.

The comparison of the model results (mileage) calculated in this study with the savings potential of the KoMoDo project show that this micro-depot can save up to 0.2 % of the whole mileage of conventional delivery vehicles in Berlin by shifting to city-compatible cargo bikes. The comparison of the savings potential of micro-depot measures such as KoMoDo with the total mileage of CEP vehicles in Berlin shows that measurement concepts that are not implemented on a city-wide basis only have a local effect and only make a small contribution to the reduction of delivery traffic in the city as a whole.

In relation to the delivery area designated by KoMoDo and the low volume of shipments actually handled there in relation to the total volume of shipments in this area, there is a significantly greater potential for savings by shifting all deliveries in the delivery area to a sustainable mode of transport. The other two calculated scenarios show that

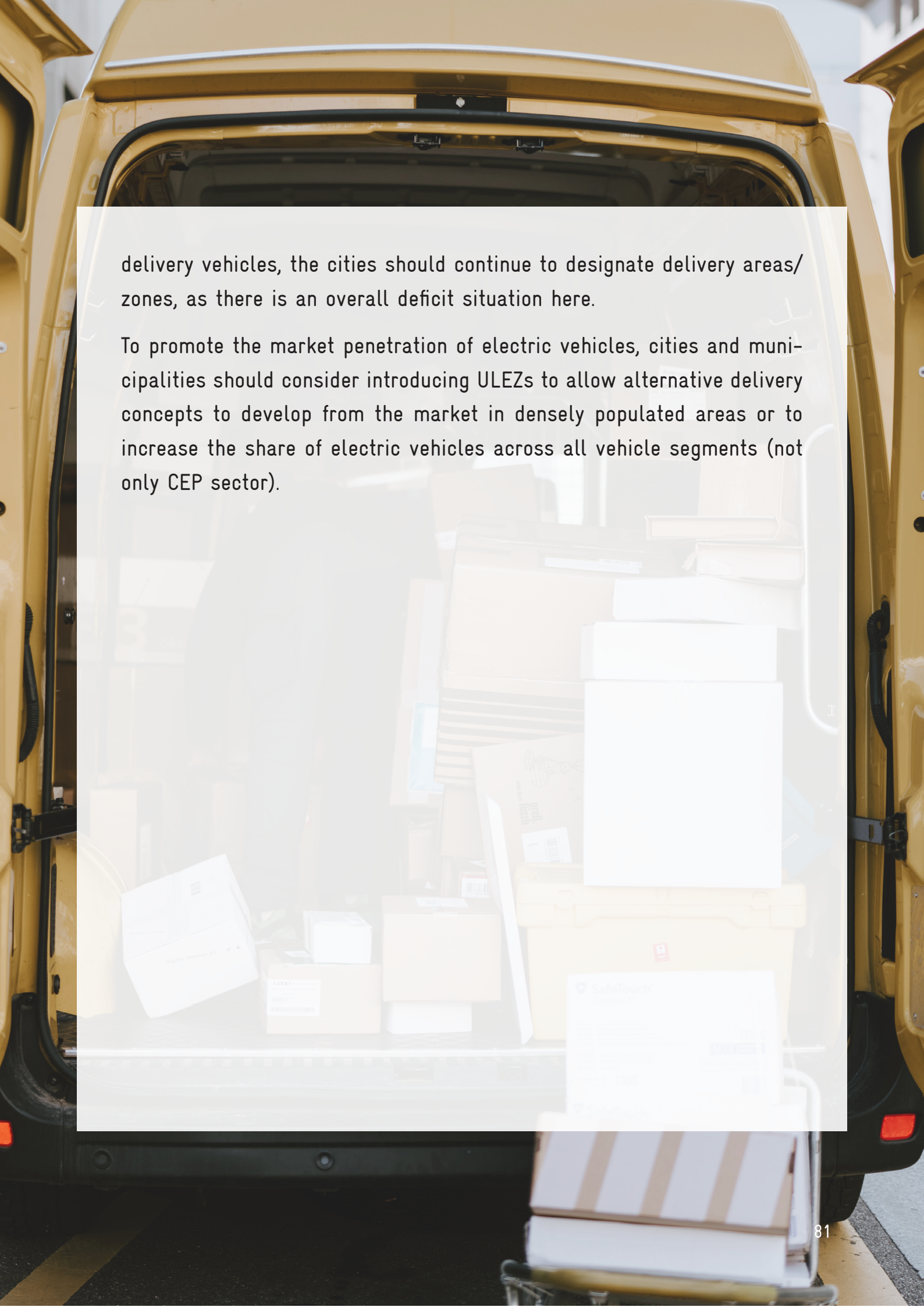
1. the abolition of traditional doorstep delivery and
2. the cooperative use of pick-up points (which can include parcel stations, micro-depots or parcel shops)



can save up to 65 % of the mileage of conventional vehicles. On access roads, CEP-related delivery traffic can even be almost completely displaced if pick-up points are set up on main roads.

In the B2C segment (~70 % of the total shipment volume), CEP providers have been shifted from direct delivery to parcel shops and other pick-up points for some time now, because this saves cost over the last mile. This trend should also be supported from the point of view of social and political goals regarding more sustainable logistics. A basic prerequisite for this is a dense network of pick-up points, because otherwise the effort for the end customer will be too great and acceptance will decrease. Co-operation between the CEP service providers in the form of the joint operation of pick-up points can be a useful approach. From the space requirements shown in the scenarios, it can also be deduced that the optimal use of pick-up points goes hand in hand with an increased space requirement compared to today. From this point of view, jointly operated parcel stations or cooperative parcel shops also make sense. This decision also depends on the volume of B2B and B2C shipments. In principle, an external operation of parcel shops, as is mostly found today, is still conceivable. This could take over the delivery of B2B shipments with city-compatible vehicles (e.g. cargo bikes) as an additional service, since the demands on services are greater in the B2B segment and delivery at the shop door will also be desired in the future, if only because of the increased volume of shipments.

Alongside the measures to generally reduce the mileage of conventional



delivery vehicles, the cities should continue to designate delivery areas/ zones, as there is an overall deficit situation here.

To promote the market penetration of electric vehicles, cities and municipalities should consider introducing ULEZs to allow alternative delivery concepts to develop from the market in densely populated areas or to increase the share of electric vehicles across all vehicle segments (not only CEP sector).

6 Bibliography

Academy for Territorial Development in the Leibniz Association (ARL) (n. d.a): 1.3 Basic Principles of the Political and Administrative System. Available online at https://www.arl-net.de/de/commin/deutschland-germany/13-basic-principles-political-and-administrative-system.

Academy for Territorial Development in the Leibniz Association (ARL) (n. d.b): Kommunale Planungshoheit. Available online at https://www.arl-net.de/de/lexica/de/kommunale-planungshoheit.

agiplan GmbH (2019): Handbuch: Mikro-Depots im interkommunalen Verbund. am Beispiel der Kommunen Krefeld, Mönchengladbach und Neuss. With assistance of Fraunhofer Institut für Materialfluss und Logistik, Luther Rechtsanwälte. Edited by IHK Mittlerer Niederrhein, Stadt Krefeld, Stadt Mönchengladbach, Stadt Neuss.

Agora Verkehrswende (2020): Städte in Bewegung. Zahlen, Daten, Fakten zu Mobilität in 35 deutschen Städten. Available online at https://www.agora-verkehrswende.de/fileadmin/Projekte/2020/Staedteprofile/Agora-Verkehrswende_Bewegung_in_Staedten_1-1.pdf, checked on 12/21/2020.

Allen, J.; Piecyk, M.; Piotrowska, M.; McLeod, F.; Cherrett, T.; Ghali, K. et al. (2018): Understanding the impact of e-commerce on last-mile light goods vehicle activity in urban areas: The case of London. In Transportation Research Part D: Transport and Environment 61, pp. 325–338. DOI: 10.1016/j.trd.2017.07.020.

Allen, J., Thorne, G., Browne, M. (2007): BESTUFS. Good Practice Guide on Urban Freight Transport. Available online at http://www.bestufs.net/download/BESTUFS_II/good_practice/English_BESTUFS_Guide.pdf, checked on 12/2/2020.

Assmann, Tom; Müller, Florian; Bobeth, Sebastian; Baum, Leonhard (2019): Planung von Lastenradumschlagknoten. Ein Leitfaden für Kommunen und Wirtschaft zur Planung von Umschlagspunkten für neue, urbane Logistikkonzepte.

BIEK (2018a): 3 FAHRZEUGBESTAND NACH EMISSIONSKLASSEN UND NACH ANTRIEBS- UND KRAFTSTOFFARTEN. ZAHLEN - DATEN - FAKTEN DER KEP-BRANCHE. Bundesverband Paket und Expresslogistik e. V. (BIEK). Available online at https://biek.de/download.html?getfile=1558, checked on 11/27/2020.

BIEK (2018b): Fahrzeugbestand und Fahrleistungen. Kompendium Teil 2: ZAHLEN-DATEN-FAKTEN DER KEP-BRANCHE.

BIEK (2018c): MARKTANTEILE DER ZUSTELLKONZEPTE IM B2C-SEGMENT. Kompendium Teil 6.

BIEK (2020): KEP-Studie 2020 - Analyse des Marktes in Deutschland. Eine Untersuchung im Auftrag des Bundesverbandes Paket und Expresslogistik e.V. (BIEK). Available online at https://www.biek.de/files/biek/downloads/papiere/BIEK_KEP-Studie_2020.pdf, checked on 11/23/2020.

Bogdanski, Ralf (2017): Nachhaltige Stadtlogistik durch Kurier-Express-Paketdienste. Studie über die Möglichkeiten und notwendigen Rahmenbedingungen. Edited by Bundesverband der Kurier-Express-Post-Dienste e.V. (BdKEP).

Boysen, Nils; Fedtke, Stefan; Schwerdfeger, Stefan (2020): Last-mile delivery concepts: a survey from an operational research perspective. In OR Spectrum. DOI: 10.1007/s00291-020-00607-8.

Brabänder, Christian (2020): Die Letzte Meile : Definition, Prozess, Kostenrechnung und Gestaltungsfelder. Wiesbaden: Springer (essentials). Available online at https://epub.uni-regensburg.de/43111/.

Breiden, Alicia (2020): Analyse von Maßnahmen für den Lieferverkehr in Green-City-Plänen. Bachelorarbeit. Bergische Universität Wuppertal, Wuppertal. Lehr- und Forschungsgebiet für Güterverkehrsplanung und Transportlogistik.

Bundesverband der Kurier-Express-Post-Dienste e.V. (BdKEP) (n. d.): BdKEP. Interessenvertretung, Innovationen und Einkaufsvorteile für die KEP Branche. Available online at https://bdkep.de/, checked on 11/27/2020.

Bundesverband E-Commerce und Versandhandel Deutschland e.V. (BEVH) (2020): Wir vertreten den E-Commerce. Bundesverband E-Commerce und Versandhandel. Available online at https://www.bevh.org/, checked on 11/27/2020.

Bundesverband Paket und Expresslogistik e. V. (BIEK) (n. d.): Verband. Available online at https://www.biek.de/ueber-uns/verband.html.

BUSINESS LOCATION CENTER: Güterverkehrszentren. Berlin Partner für Wirtschaft und Technologie GmbH. Available online at https://www.businesslocationcenter.de/infrastruktur/verkehr/%20gueterverkehrszentren/, checked on 3/12/2021.

Center for Political Education Berlin (n. d.): Der Senat. Center for Political Education Berlin, checked on 12/15/2020.

City of Amsterdam, Space and Sustainability, Air Quality Team (2019): Clean Air Action Plan. Emission-free Amsterdam. With assistance of Jeroen Schutter, Judith van Laarhoven, Wencke de Niet, Alex Osten, Marloes Dirkx. Amsterdam. Available online at https://assets.amsterdam.nl/publish/pages/867636/clean_air_action_plan_1.pdf, checked on 3/12/2021.

Dabidian, Peiman; Clausen, Uwe; Denecke, Esther (2016): An Investigation of Behavioural and Structural Characteristics of CEP Service Providers and Freight Demand Considering E-commerce in Germany. In Transportation Research Procedia 14, pp. 2795–2804. DOI: 10.1016/j.trpro.2016.05.473.

Deges, Frank (2020): Grundlagen des E-Commerce. Strategien, Modelle, Instrumente. Wiesbaden: Springer Gabler (Lehrbuch).

Deutsche Post DHL Group (n. d.): Umweltfreundlich versenden und empfangen mit DHL. Klimaschutz mit DHL. Deutsche Post DHL Group. Available online at https://www.dhl.de/de/privatkunden/kampagnenseiten/dhl-nachhaltigkeit.html.

Deutsche Post DHL Group (2019): MENSCHEN VERBINDEN. LEBEN VERBESSERN. Nachhatligkeitsbericht. Available online at https://www.dpdhl.com/content/dam/dpdhl/de/media-center/responsibility/dpdhl-nachhaltigkeitsbericht-2019.pdf, checked on 12/23/2020.

Deutscher Bundestag (11/26/2020): Straßenverkehrsgesetz. StVG. Available online at https://www.gesetze-im-internet.de/stvg/BJNR004370909.html.

Deutscher Städte- und Gemeindebund (DStGB) (n. d.): Wir über uns. Available online at https://www.dstgb.de/dstgb/Homepage/Wir%20%C3%BCber%20uns/, checked on 11/27/2020.

Deutscher Städtetag (DST) (n. d.): Aufgaben. Available online at https://www.staedtetag.de/ueber-uns/aufgaben, checked on 11/27/2020.

Deutscher Städtetag (DST); Deutscher Städte- und Gemeindebund (DStGB); Handelverband Deutschland (HDE); Bundesverband Paket und Expresslogistik e. V. (BIEK) (2018): GUTE LOGISTIK FÜR LEBENSWERTE INNENSTÄDTE. Gemeinsame Positionierung von Deutscher Städtetag, Deutscher Städte- und Gemeindebund, Handelsverband Deutschland und Bundesverband Paket und Expresslogistik. Available online at https://www.biek.de/download.html?getfile=1935.

Deutsches Institut für Normung e. V. (DIN) (n. d.): DIN - kurz erklärt. Available online at https://www.din.de/de/ueber-normen-und-standards/basiswissen, checked on 11/27/2020.

Deutsches Institut für Normung e. V. (DIN) (2015): Kurier-Express-Paket (KEP)-Branche entwickelt Standards für Paketboxen bei DIN. Available online at https://www.din.de/de/din-und-seine-partner/presse/mitteilungen/kurier-express-paket-kep-branche-entwickelt-standards-fuer-paketboxen-bei-din-91424, checked on 11/27/2020.

dpdgroup (n. d.): Klimaneutral seit 2012. Available online at https://www.dpd.com/de/de/nachhaltigkeit/klimaneutraler-paketversand/, checked on 12/23/2020.

dpdgroup (2020a): Driving Change. Corporate Social Responsibility Report 2019. Available online at https://brandcenter.dpdgroup.com/m/18a8c220a35233ce/original/DPDgroup_CSR-Report_2019.pdf, checked on 12/23/2020.

dpdgroup (2020b): Umweltfreundlicher Paketversand: DPDgroup führt bis 2025 emissionsarme Zustellung in 225 europäischen Städten ein. Available online at https://www.dpd.com/de/de/2020/10/02/umweltfreundlicher-paketversand-dpdgroup-fuhrt-bis-2025-emissionsarme-zustellung-in-225-europaischen-stadten-ein/, checked on 12/23/2020.

Drewes, Torsten (2017): Gastartikel: Paketstandard GS-1 – KEP-Branche vor Label-(R)-Evolution. Available online at https://www.logistik-watchblog.de/neuheiten/1098-gastartikel-paketstandard-gs-1-kep-branche-label-revolution.html, checked on 12/4/2020.

Ducret, Raphaëlle (2014): Parcel deliveries and urban logistics: Changes and challenges in the courier express and parcel sector in Europe — The French case. In Research in Transportation Business & Management 11, pp. 15–22. DOI: 10.1016/j.rtbm.2014.06.009.

EEA Report (2019): The first and last mile - the key to sustainable urban transport. Transport and environment report 2019. European Environment Agency.

Engels, Barbara (2019): Lage und Trends im deutschen Onlinehandel. IW-Report 33/19. Available online at https://www.econstor.eu/bitstream/10419/203254/1/1676371311.pdf, checked on 11/30/2020.

European Commission (NaN): Berlin - Internal Market, Industry, Entrepreneurship And Smes - European Commission. Available online at https://ec.europa.eu/growth/tools-databases/regional-innovation-monitor/base-profile/berlin, updated on 12/21/2020, checked on 12/21/2020.

European Commission (EC) (n. d.): Postal services. Available online at https://ec.europa.eu/growth/sectors/postal-services_en, checked on 3/18/2021.

European Commission (EC) (3/15/2006): Regulation (EC) No 561/2006 of the European Parliament and of the Council of 15 March 2006 on the harmonisation of certain social legislation relating to road transport and amending Council Regulations (EEC) No 3821/85 and (EC) No 2135/98 and repealing Council Regulation (EEC) No 3820/85 (Text with EEA relevance).

European Commission (EC) (6/20/2007): REGULATION (EC) No 715/2007 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 20 June 2007 on type approval of motor vehicles with respect to emissions from light passenger and commercialvehicles (Euro 5 and Euro 6) and on access to vehicle repair and maintenanceinformation. Available online at https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32007R0715&from=-de.

European Commission (EC) (6/11/2008): Directive 2008/50/EC of the European Parliament and of the Council of 21 May 2008 on ambient air quality and cleaner air for Europe. Available online at https://eur-lex.europa.eu/legal-content/DE/TXT/PDF/?uri=CELEX:32008L0050&from=EN.

European Commission (EC) (2011): Roadmap to a Single European Transport Area – Towards a competitive and resource efficient transport system.

European Commission (EC) (2012): Study on Urban Freight Transport. With assistance of MDS Transmodal Limited. Available online at https://ec.europa.eu/transport/sites/transport/files/themes/urban/studies/doc/2012-04-urban-freight-transport.pdf, checked on 3/12/2021.

European Commission (EC) (2/26/2014): REGULATION (EU) No 253/2014 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 26 February 2014amending Regulation (EU) No 510/2011 to define the modalities for reaching the 2020 target to reduce CO2emissions from new light commercial vehicles.

European Commission (EC) (6/1/2017): Commission Regulation (EU) 2017/1151 of 1 June 2017 supplementing Regulation (EC) No 715/2007 of the European Parliament and of the Council on type-approval of motor vehicles with respect to emissions from light passenger and commercial vehicles (Euro 5 and Euro 6) and on access to vehicle repair and maintenance information, amending Directive 2007/46/EC of the European Parliament and of the Council, Commission Regulation (EC) No 692/2008 and Commission Regulation (EU) No 1230/2012 and repealing Commission Regulation (EC) No 692/2008 (Text with EEA relevance).

European Commission (EC) (5/2/2018): Regulation (EU) 2018/644 of the European Parliament and of the Council of 18 April 2018 on cross-border parcel delivery services.

European Commission (EC) (4/17/2019a): REGULATION (EU) 2019/631 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 17 April 2019 setting CO2 emission performance standards for new passenger cars and for new light commercial vehicles, and repealing Regulations (EC) No 443/2009 and (EU) No 510/2011. Available online at https://eur-lex.europa.eu/legal-content/DE/TXT/PDF/?uri=CELEX%3A32017R1151&from=DE.

European Commission (EC) (6/20/2019b): 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. Available online at https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:32019R1242&from=EN.

European Commission (EC) (11/27/2019c): Regulation (EU) 2019/2144 of the European Parliament and of the Council of 27 November 2019 on type-approval requirements for motor vehicles and their trailers, and systems, components and separate technical units intended for such vehicles, as regards their general safety and the protection of vehicle occupants and vulnerable road users, amending Regulation (EU) 2018/858 of the European Parliament and of the Council and repealing Regulations (EC) No 78/2009, (EC) No 79/2009 and (EC) No 661/2009 of the European Parliament and of the Council and Commission Regulations (EC) No 631/2009, (EU) No 406/2010, (EU) No 672/2010, (EU) No 1003/2010, (EU) No 1005/2010, (EU) No 1008/2010, (EU) No 1009/2010, (EU) No 19/2011, (EU) No 109/2011, (EU) No 458/2011, (EU) No 65/2012, (EU) No 130/2012, (EU) No 347/2012, (EU) No 351/2012, (EU) No 1230/2012 and (EU) 2015/166. Available online at https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32019R2144.

European Commission (EC) (2020a): Marked improvement in Europe‘s air quality over past decade, fewer deaths linked to pollution. Available online at https://ec.europa.eu/commission/presscorner/detail/en/IP_20_2168.

European Commission (EC) (2020b): Road Infrastructure Charging – Heavy Goods Vehicles. Available online at https://ec.europa.eu/transport/modes/road/road_charging/charging_hgv_en.

Eurostat (n. d.): E-commerce statistics for individuals - Statistics Explained. Available online at https://ec.europa.eu/eurostat/statistics-explained/index.php/E-commerce_statistics_for_individuals#General_overview, updated on 11/23/2020, checked on 11/23/2020.

Federal Government (2019): Bundes-Klimaschutzgesetz. KSG.

Federal Ministry for Economic Affairs and Energy (2019): Eckpunkte für eine Novelle des Postgesetzes. Federal Ministry for Economic Affairs and Energy (BMWi). Available online at https://www.bmwi.de/Redaktion/DE/Downloads/E/eckpunkte-fuer-eine-novelle-des-postgesetzes.pdf?__blob=publicationFile&v=3.

Federal Ministry for Economic Affairs and Energy (BMWi) (1997): Postgesetz. Available online at https://www.biek.de/ueber-uns/verband.html, checked on 11/27/2020.

Federal Ministry for Economic Affairs and Energy (BMWi) (10/21/2020): Richtlinie zur Förderung des Absatzes von elektrisch betriebenen Fahrzeugen (Umweltbonus).

Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU) (7/22/2020): Förderaufruf für investive Kommunale Klimaschutz-Modellprojekte im Rahmen der Nationalen Klimaschutzinitiative (NKI) des Bundesministeriums für Umwelt, Naturschutz und nukleare Sicherheit(BMU). Available online at https://www.ptj.de/lw_resource/datapool/systemfiles/cbox/1364/live/lw_bekdoc/f-C3-B6rderaufruf-kommunale-klimaschutz-modell-projekte.pdf.

Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU) (1/29/2021a): Richtlinie zur Förderung von E-Lastenfahrräder für den fahrradgebundenen Lastenverkehr in der Wirtschaft und in Kommunen Rahmen der Nationalen Klimaschutzinitiative (E-Lastenfahrrad-Richtlinie). Available online at https://www.klimaschutz.de/sites/default/files/E-Lastenfahrrad_RL_fin_210129.pdf.

Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU) (1/29/2021b): Richtlinie zur Förderung von investiven Maßnahmen zur klimafreundlichen gewerblichen Nahmobilität (Mikro-Depot Richtlinie) im Rahmen der Nationalen Klimaschutzinitiative. Available online at https://www.klimaschutz.de/sites/default/files/Mikro-Depot-Richtlinie_fin_210129.pdf.

Federal Ministry of Education and Research (2019): Mobilität für den Menschen: sauber, sicher, attraktiv. Federal Ministry of Education and Research (BMBF). Available online at https://www.bmbf.de/de/mobilitaet-fuer-den-menschen-sauber-sicher-attraktiv-7849.html, updated on 2/8/2019, checked on 3/3/2021.

Federal Ministry of Justice and Consumer Protection (2021): Mehr Verbraucherschutz im Onlinehandel und bei Kaffeefahrten sowie mehr Rechtssicherheit für Influencer. Federal Ministry of Justice and Consumer Protection (BMJV). Available online at https://www.bmjv.de/SharedDocs/Pressemitteilungen/DE/2021/0120_GSVWG.html, updated on 1/20/2021, checked on 3/3/2021.

Federal Ministry of Transport and Digital Infrastructure (2018a): Energie auf neuen Wegen. Aktuelles zur Weiterentwicklung der Mobilitäts- und Kraftstoffstrategie der Bundesregierung. Federal Ministry of Transport and Digital Infrastructure (BMVI).

Federal Ministry of Transport and Digital Infrastructure (2019a): Förderrichtlinie „Städtische Logistik“. Federal Ministry of Transport and Digital Infrastructure (BMVI).

Federal Ministry of Transport and Digital Infrastructure (2019b): Innovationsprogramm Logistik 2030. Available online at https://www.bmvi.de/SharedDocs/DE/Anlage/G/innovationsprogramm-logistik-2030.pdf?__blob=publicationFile.

Federal Ministry of Transport and Digital Infrastructure (2020a): Gesamtkonzept klimafreundliche Nutzfahrzeuge. Mit alternativen Antrieben auf dem Weg zur Nullemissionslogistik auf der Straße. Federal Ministry of Transport and Digital Infrastructure (BMVI).

Federal Ministry of Transport and Digital Infrastructure (BMVI) (12/5/2017): Förderrichtlinie Elektromobilität. Available online at https://www.bmvi.de/SharedDocs/DE/Anlage/G/foerderrichtlinie-elektromobilitaet-2015-bmvi-anpassung-von-12-2017.pdf?__blob=publicationFile.

Federal Ministry of Transport and Digital Infrastructure (BMVI) (5/22/2018b): Richtlinie über die Förderung von energieeffizienten und/oder CO2-armen schweren Nutzfahrzeugen in Unternehmen des Güterkraftverkehrs. Available online at https://www.bag.bund.de/SharedDocs/Downloads/DE/Foerderprogramme/2018/EEN/EEN_01_Richtlinie_EEN.pdf?__blob=publicationFile.

Federal Ministry of Transport and Digital Infrastructure (BMVI) (2020b): Gesetz über die Erhebung von streckenbezogenen Gebühren für die Benutzung von Bundesautobahnen und Bundesstraßen. Bundesfernstraßenmautgesetz - BFStrMG.

Federal Ministry of Transport and Digital Infrastructure (BMVI) (1/23/2020c): Förderrichtlinie für die Ausrüstung von Kraftfahrzeugen mit Abbiegeassistenzsystemen. Available online at https://www.bag.bund.de/SharedDocs/Downloads/DE/Foerderprogramme/2020/AAS/Downloads/Foerderrichtllinie_AAS_2020.pdf?__blob=publicationFile.

Federal Ministry of Transport and Digital Infrastructure (BMVI) (4/20/2020d): Straßenverkehrs-Ordnung. StVO. Available online at https://www.gesetze-im-internet.de/stvo_2013/BJNR036710013.html#BJNR036710013BJNG000100000.

Federal Ministry of Transport, Building and Urban Development (BMVBS) (6/27/2005): Verordnung zur Durchführung des Fahrpersonalgesetzes (Fahrpersonalverordnung). FPersV.

Federal Ministry of Transport, Building and Urban Development (BMVBS) (2/3/2011): Verordnung über die Zulassung von Fahrzeugen zum Straßenverkehr (Fahrzeug-Zulassungsverordnung). FZV.

Federal Network Agency (2017): Nicht lizenzpflichtige Postdienstleistungen. Federal Network Agency (BNetzA). Available online at https://www.bundesnetzagentur.de/DE/Sachgebiete/Post/Unternehmen_Institutionen/Marktbeobachtung/NichtlizenzpflPostdienstleistungen/nichtlizenzpflpostdienstleistungen-node.html, checked on 11/26/2020.

Federal Network Agency (2019): Zahl der Beschwerden über Postdienstleistungen steigt erneut an. Vizepräsident Franke: „"Verbraucher beschweren sich vermehrt über verspätet zugestellte Post und über regelmäßig wiederkehrende Zustellausfälle"". Federal Network Agency (BNetzA). Available online at https://www.bundesnetzagentur.de/SharedDocs/Pressemitteilungen/DE/2019/20191230_Post.html, updated on 12/2/2020.

Federal Network Agency (2020): Schlichtung Post. Federal Network Agency (BNetzA). Available online at https://www.bundesnetzagentur.de/DE/Sachgebiete/Post/Verbraucher/Schlichtung/Schlichtung-node.html, checked on 11/27/2020.

Federal Office for Goods Transport (2020): Erdgasantrieb: Verlängerung der Mautbefreiung bis zum 31. Dezember 2023. Federal Office for Goods Transport (BAG). Available online at https://www.bag.bund.de/SharedDocs/Kurzmeldungen/DE/2020/Mautbefreiung_Gasantrieb_2020.html.

Federal Statistical Office (2020a): Bevölkerungsstand. Bevölkerungsstand nach Geschlecht und Staatsangehörigkeit. Federal Statistical Office (Destatis). Available online at https://www.destatis.de/DE/Themen/Gesellschaft-Umwelt/Bevoelkerung/Bevoelkerungsstand/Tabellen/zensus-geschlecht-staatsangehoerigkeit-2019.html, checked on 12/4/2020.

Federal Statistical Office (Destatis) (2020b): 81000-0013. VGR des Bundes - Bruttowertschöpfung (nominal/preisbereinigt): Deutschland, Jahre, Wirtschaftsbereiche. Available online at https://www-genesis.destatis.de/genesis//online?operation=table&code=81000-0013&bypass=true&levelindex=0&levelid=1608630032906#abreadcrumb, checked on 12/22/2020.

Forschungsgesellschaft für Straßen- und Verkehrswesen (2005): Empfehlungen für Anlagen des ruhenden Verkehrs - EAR 05. Ausg. Februar 2005. Köln: FGSV (FGSV, 283).

Forschungsgesellschaft für Straßen- und Verkehrswesen (FGSV) (2018): Empfehlungen für Verkehrsplanungsprozesse. EVP. Ausgabe 2018. Köln (FGSV R2 - Regelwerke, FGSV 116).

Forschungsgruppe Retourenmanagement, Universität Bamberg (2019a): Praeventives Retourenmanagement und Ruecksendegebuehren - Neue Studienergebnisse. Bamberg. Available online at http://www.retourenforschung.de/info-praeventives-retourenmanagement-und-ruecksendegebuehren---neue-studienergebnisse.html, checked on 3/23/2021.

Forschungsgruppe Retourenmanagement, Universität Bamberg (2019b): Retourentacho 2018/2019 ausgewertet. Available online at http://www.retourenforschung.de/info-retourentacho2019-ausgewertet.html, checked on 3/23/2021.

Freie und Hansestadt Bremen (n. d.): Deutschlands erste Fahrradzone in Bremen. Freie und Hansestadt Bremen. Available online at https://www.bremen.de/leben-in-bremen/fahrradstadt-bremen/fahrradzone, updated on 4/9/2021, checked on 4/9/2021.

Geppert, Kurt; Gornig, Martin (2012): Wettbewerb der Regionen - Berlin auf einem guten Weg. In A. Kauffmann, & M.T.W. Rosenfeld (Ed.): Städte und Regionen im Standortwettbewerb: neue Tendenzen, Auswirkungen und Folgerungen für die Politik. Hannover: ARL. Available online at https://www.ssoar.info/ssoar/bitstream/handle/document/33726/ssoar-2012-geppert_et_al-Wettbewerb_der_Regionen_-_Berlin.pdf?sequence=1&isAllowed=y&lnkname=ssoar-2012-geppert_et_al-Wettbewerb_der_Regionen_-_Berlin.pdf, checked on 12/20/2020.

Gerike, Regine; Hubrich, Stefan; Ließke, Frank; Wittig, Sebastian; Wittwer, Rico (2019): MOBILITÄTSSTECKBRIEF FÜR BERLIN. TU Dresden - INTEGRIERTE VERKEHRSPLANUNG UND STRAßENVEREHRSTECHNIK, checked on 12/21/2020.

German Bundestag (6/6/1994): Arbeitszeitgesetz. ArbZG.

German Bundestag (7/12/2011): Gesetz über die Erhebung von streckenbezogenen Gebühren für die Benutzung von Bundesautobahnen und Bundesstraßen (Bundesfernstraßenmautgesetz). BFStrMG.

German Bundestag (2014): Technikfolgenabschätzung (TA) Postdienste und moderne Informations- und Kommunikationstechnologien. Berichtdes Ausschusses für Bildung, Forschung undTechnikfolgenabschätzung (18. Ausschuss) gemäß § 56a der Geschäftsordnung. Drucksache 18/582. Deutscher Bundestag. Berlin. Available online at http://dipbt.bundestag.de/doc/btd/18/005/1800582.pdf, checked on 11/27/2020.

German Bundestag (11/15/2019): Gesetz zur Einführung einer Nachunternehmerhaftung in der Kurier-, Express- und Paketbranche zum Schutz der Beschäftigten.

German Environment Agency (2020): Umweltzonen in Deutschland. Umweltbundesamt. Available online at https://www.umweltbundesamt.de/themen/luft/luftschadstoffe/feinstaub/umweltzonen-in-deutschland#1-wie-ist-der-aktuelle-stand-der-umweltzonen, updated on 11/1/2020, checked on 11/27/2020.

German Environment Agency (2021): Pkw und leichte Nutzfahrzeuge. Available online at https://www.umweltbundesamt.de/themen/verkehr-laerm/emissionsstandards/pkw-leichte-nutzfahrzeuge#die-prufmethoden-wltp-und-rde-, updated on 2/28/2021, checked on 2/28/2021.

Gevaers, Roel; van de Voorde, Eddy; Vanelslander, Thierry (2014): Cost Modelling and Simulation of Last-mile Characteristics in an Innovative B2C Supply Chain Environment with Implications on Urban Areas and Cities. In Procedia - Social and Behavioral Sciences 125, pp. 398–411. DOI: 10.1016/j.sbspro.2014.01.1483.

GLS Germany (n. d.): 100 Prozent klimaneutraler Versand mit GLS KlimaProtect. Available online at https://gls-group.eu/DE/de/gls-informiert/klima-protect, checked on 12/23/2020.

Greater London Authority (2018): Mayor‘s Transport Strategy. London. Available online at https://www.london.gov.uk/sites/default/files/mayors-transport-strategy-2018.pdf, checked on 3/12/2021.

GS1 Germany GmbH (2016): Wegweisende Lösungen für die KEP-Branche. Wachsende Sendungsmengen und vielfältige Serviceanforderungen mit GS1 Standards optimal managen. Available online at https://www.gs1-germany.de/fileadmin/gs1/basis_informationen/wegweisende_loesungen_fuer_die_kep_branche.pdf, checked on 12/4/2020.

LNC LogisticNetwork Consultants GmbH (Ed.) (2021): KoMoDo. Available online at https://www.komodo.berlin/, checked on 3/12/2021.

Logistische Informationssysteme AG (2021): LiS. Greven. Available online at https://www.lis.eu/, checked on 3/12/2021.

Małecki, Krzysztof; Iwan, Stanisław; Kijewska, Kinga (2014): Influence of Intelligent Transportation Systems on Reduction of the Environmental Negative Impact of Urban Freight Transport Based on Szczecin Example. In Procedia - Social and Behavioral Sciences 151, pp. 215–229. DOI: 10.1016/j.sbspro.2014.10.021.

Manner-Romberg, Horst; Miller, Jona; Müller-Steinfahrt, Ulrich; Symanczyk, Wolf (2017a): Marktuntersuchung und Entwicklungstrends von Kurier-, Expresss- und Paktdienstleistungen 2017. Available online at https://www.bundesnetzagentur.de/SharedDocs/Downloads/DE/Sachgebiete/Post/Unternehmen_Institutionen/Marktbeobachtung/Briefdienstleistungen/MarktuntersuchungKEP2017.pdf?__blob=publicationFile&v=2, checked on 12/21/2020.

Manner-Romberg, Horst; Müller-Steinfahrt, Ulrich; Kille, Christian (2017b): Digitalisierung im Postmarkt: Neue Entwicklungen in den Bereichen KEP und Brief sowie deren Auswirkungen auf die Regulierung. Available online at https://www.bundesnetzagentur.de/SharedDocs/Downloads/DE/Sachgebiete/Post/Unternehmen_Institutionen/Marktbeobachtung/Briefdienstleistungen/KEPStudie2016.pdf?__blob=publicationFile&v=5, checked on 2/18/2021.

Manner-Romberg, Horst; Symanczyk, Wolf; Miller, Jona (2016): Die Individualisierung der Lieferung Wie neue Konzepte den E-Commerce verändern. Eine Kurzstudie des BEVH. MRU GmbH. Available online at https://m-r-u.de/site/assets/files/1051/individualisierung_der_lieferung.pdf.

McLeod, F. N.; Cherrett, T. J.; Bektas, T.; Allen, J.; Martinez-Sykora, A.; Lamas-Fernandez, C. et al. (2020): Quantifying environmental and financial benefits of using porters and cycle couriers for last-mile parcel delivery. In Transportation Research Part D: Transport and Environment 82, p. 102311. DOI: 10.1016/j.trd.2020.102311.

McLeod, Fraser N.; Cherrett, Tom (2011): Loading bay booking and control for urban freight. In International journal of logistics : research and applications 14 (6), pp. 385–397.

hamburg.de GmbH & Co. KG, Behörde für Wirtschaft und Innovation (2020): Das Konzept von SmaLa. Vorgehen. Hamburg. Available online at https://www.hamburg.de/bwi/smarte-ladezonen/13633832/vorgehen/, checked on 3/12/2021.

Handelverband Deutschland (n. d.): Nachhaltigen Wohlstand sichern – dafür engagiert sich der HDE. Available online at https://einzelhandel.de/derverband, checked on 12/23/2020.

Hardi, Lukas (2019): Modellgestützte Energie- und CO2-Bilanz der letzten Meile des Lieferverkehrs mit quelloffenen Geodaten. Dissertation, TU München. Lehrstuhl für Energiewirtschaft und Anwendungstechnik. Available online at https://mediatum.ub.tum.de/doc/1482321/file.pdf, checked on 12/23/2020.

Hochschule für Technik und Wirtschaft Berlin (2021): Kiezbote. Berlin. Available online at https://kiezbote.berlin/, checked on 3/12/2021.

Hoffmann, Hansjoachim; Schwenkner, Ferdinand (2010): Kommunalpolitik in Berlin. In Andreas Kost, Hans-Georg Wehling (Eds.): Kommunalpolitik in den deutschen Ländern. Eine Einführung. 2., aktualisierte und überarbeitete Auflage. Wiesbaden: VS Verlag für Sozialwissenschaften / GWV Fachverlage GmbH Wiesbaden, pp. 63–78.

Holthaus, T.; Leerkamp, B.; Wittenbrink, P. (2019): Städtisches Güterverkehrskonzept Basel. In Heike Proff (Ed.): Mobilität in Zeiten der Veränderung. Wiesbaden: Springer Fachmedien Wiesbaden, pp. 351–369.

Hütten, Frank (2020): EU-Staaten einig über Wegekostenrichtlinie. In Deutsche Verkehrszeitung (DVZ), 12/18/2020. Available online at https://www.dvz.de/rubriken/detail/news/eu-staaten-einig-ueber-wegekostenrichtlinie.html.

Hütten, Frank; Landwehr, Susanne (2020): Mautbefreiung in Deutschland wackelt. In Deutsche Verkehrszeitung (DVZ), 10/6/2020. Available online at https://www.dvz.de/rubriken/politik/detail/news/mautbefreiung-in-deutschland-wackelt.html.

Incoterms (2020): Gemeinsam zum Ziel. Available online at https://www.incoterms2020.de/gemeinsam-zum-ziel/, updated on 11/17/2020, checked on 2/28/2021.

INFRAS Bern/Schweiz with MKC Consulting GmbH und IVT/TU Graz (2019): Handbuch Emissionsfaktoren des Straßenverkehrs, Version 4.1 (HBEFA 4.1), akualisierte Version 03.11.2019. Edited by Umweltbundesamt.

Janjevic, Milena; Winkenbach, Matthias (2020): Characterizing urban last-mile distribution strategies in mature and emerging e-commerce markets. In Transportation Research Part A: Policy and Practice 133, pp. 164–196. DOI: 10.1016/j.tra.2020.01.003.

Junk, Petra; Wielgosch, Julia (2019): City-Logistik für den Paketmarkt. WIK Diskussionsbeitrag. Bad Honnef. Available online at https://www.econstor.eu/bitstream/10419/227057/1/WIK-Diskussionsbeitrag-Nr-446.pdf, checked on 1/19/2021.

Kersten, Wolfgang (2021): KEP-Logistik. Available online at https://www.forschungsinformationssystem.de/servlet/is/290020/, updated on 2/7/2021, checked on 2/7/2021.

Kienzler, Hans-Paul; Mauer, Alex auf der; Altenburg, Sven; Esser, Klaus; Kurte, Judtih (2019): Marktanalyse urbaner Wirtschaftsverkehr in Deutschland. Available online at https://www.xn--starterset-elektromobilitt-4hc.de/content/3-Infothek/2-Publikationen/7-marktanalyse-urbaner-wirt-schaftsverkehr-in-deutschland/now_marktanalyse-urbaner-wirtschaftsverkehr.pdf, checked on 11/27/2020.

Kille, Christian (2012): KEP-Märkte und Dienste. In Peter Klaus (Ed.): Gabler Lexikon Logistik. Management logistischer Netzwerke und Flüsse, 5. Aulage. 5. Aufl. Wiesbaden: Springer Gabler.

Kultu, Cidgem; Bioly, Sascha; Klumpp, Matthias (2013): Demografic change in the CEP sector. In Schriftenreihe Logistikforschung (No. 38). Available online at https://www.econstor.eu/bitstream/10419/93104/1/779872770.pdf, checked on 2/7/2021.

Leerkamp, Bert; Thiemermann, Andre; Schlott, Marian; Holthaus, Tim; Aichinger, Wolfgang; Wittenbrink, Paul (2020): Liefern ohne Lasten. Available online at https://static.agora-verkehrswende.de/fileadmin/Projekte/2019/Staedtischer-Gueterverkehr/Agora-Verkehrswende_Liefern-ohne-Lasten_1-1.pdf, checked on 10/23/2020.

Lengauer, Efrem; Gierlinger, Doris; Kellermayr-Scheucher, Marike; Koll, Oliver; Kreuzer, Maria; Herry, Max; Sedlack, Norbert (2015): eComTraf. Auswirkungen von E-Commerce auf das Gesamtverkehrssystem, checked on 2/19/2021.

Menge, Julius (n. d.): Wirtschaftsverkehr in Berlin - Ansatz und Strategie. Input Smart Mobility Forum. Senatsverwaltung für Umwelt, Verkehr und Klimaschutz. Berlin, n. d.

Ministry of Economic Affairs, Innovation, Digitalisation and Energy (MWIDE NRW) (6/15/2020): Richtlinie über die Gewährung von Zuwendungen aus progres.nrw -Programmbereich Emissionsarme Mobilität-. Available online at https://www.bezreg-arnsberg.nrw.de/themen/p/progres_nrw_emissionsarme_mobilitaet/foerdergrundlagen/Richtlinie-Emissionsarme-Mobilitaet.pdf#page=8.

ministry of transport nrw (VM NRW) (5/3/2019): Richtlinien zur Förderung der vernetzten Mobilität und des Mobilitätsmanagements (FöRi-MM). Available online at https://recht.nrw.de/lmi/owa/br_vbl_detail_text?anw_nr=7&vd_id=17777&sg=0.

MRU GmbH (Ed.) (2016): Empfängerbefragung.

Paddeu, D. (2017): The Bristol-Bath Urban freight Consolidation Centre from the perspective of its users. In Case Studies on Transport Policy 5 (3), pp. 483–491. DOI: 10.1016/j.cstp.2017.06.001.

postbranche.de (2019): DHL Freight setzt erste 30 hochmoderne Lkw für erfolgreiche Fahrerinitiative ein. Available online at https://www.postbranche.de/2019/06/04/dhl-freight-setzt-erste-30-hochmoderne-lkw-fuer-erfolgreiche-fahrerinitiative-ein/, updated on 6/4/2019, checked on 3/18/2021.

Pütz, Thomas; Schönfelder, Stefan (2018): Angebotsqualitäten und Erreichbarkeiten im öffentlichen Verkehr. BBSR-Analysen Kompakt 8/2018. Available online at https://www.bbsr.bund.de/BBSR/DE/veroeffentlichungen/analysen-kompakt/2018/ak-08-2018-dl.pdf?__blob=publicationFile&v=1, checked on 12/22/2020.

Ritter, Ernst-Hasso (Ed.) (2003): Spatial development policy in the European Constitutional Treaty. Position paper from the ARL, Hanover = Raumentwicklungspolitik im Europäischen Verfassungsvertrag = La politique de développement de l'espace communautaire dans le Traité Constitutionnel de l'Union Européenne. Hannover: Akademie für Raumforschung und Landesplanung (Studies in spatial development, 3).

Rode, Philipp (2019): Urban planning and transport policy integration: The role of governance hierarchies and networks in London and Berlin. In Journal of Urban Affairs 41 (1), pp. 39–63. DOI: 10.1080/07352166.2016.1271663.

Rudzio, Wolfgang (2011): Das politische System der Bundesrepublik Deutschland. 8. Auflage. Wiesbaden: VS Verlag für Sozialwissenschaften.

Russo, Francesco; Comi, Antonio (2011): Measures for Sustainable Freight Transportation at Urban Scale: Expected Goals and Tested Results in Europe. In J. Urban Plann. Dev. 137 (2), pp. 142–152. DOI: 10.1061/(ASCE)UP.1943-5444.0000052.

Schlautmann, Christoph (2018): Hermes, DHL: In der Paketbranche sinken trotz Boom die Gewinne. In Handelsblatt, 7/16/2018. Available online at https://www.handelsblatt.com/unternehmen/dienstleister/paketdienste-trotz-boom-bei-dhl-und-hermes-sinken-die-gewinne-was-hinter-dem-paket-paradox-steckt/22799070.html?ticket=ST-2680944-WRbP4bUhz9Xxckg2iwfp-ap3, checked on 11/23/2020.

Schlautmann, Christoph (2019): Bundesweite Razzia – Jede dritte Zustellfirma verstößt gegen Arbeitsrecht. Fahren ohne Führerschein, gefälschte Pässe, Lohndumping: Eine Zollrazzia könnte für Hermes, GLS, DPD und DHL harte juristische Konsequenzen haben. In Handelsblatt, 2/17/2019. Available online at https://www.handelsblatt.com/unternehmen/handel-konsumgueter/paketbranche-bundesweite-razzia-jede-dritte-zustellfirma-verstoesst-gegen-arbeitsrecht/23992134.html.

Schmidt-Eichstaedt, Gerd; Weyrauch, Bernhard; Zemke, Reinhold (2019): Städtebaurecht. Einführung und Handbuch : mit allen Neuerungen bis zur Neubekanntmachung des BauGB vom 3. November 2017 (BGBl. I S. 3634). Stand: Dezember 2018, 6., erweiterte und überarbeitete Auflage. Stuttgart: Verlag W. Kohlhammer (Rechtswissenschaften und Verwaltung. Studienbücher).

Schneider, Philipp (2018): So unzufrieden sind die Deutschen mit den Paketdiensten. Vor allem Städter haben Probleme mit der Paketzustellung. Packstationen sind nicht für alle eine Lösung. Bekommen DHL, Hermes und Co. die Situation nicht besser in den Griff, könnte Amazon die Schwäche nutzen. Available online at https://www.wiwo.de/unternehmen/dienstleister/brandindex-so-unzufrieden-sind-die-deutschen-mit-den-paketdiensten/22920838.html, checked on 12/2/2020.

Schwemmer, Martin (2018): TOP 100 der Logistik. Marktgrößen, Marktsegmente und Marktführer. Eine Studie der Fraunhofer Arbeitsgruppe für Supply Chain Services SCS.

Schwemmer, Martin (2019): TOP 100 in European Transport and Logistics Services 2019/2020. Hamburg: DVV Media Group.

Schwemmer, Martin; Dürrbeck, Konrad; Klaus, Peter (2020): TOP 100 der Logistik 20/21. Marktgrößen, Marktsegmente und Marktführer.

Seidel, Saskia; Blanquart, Corinne (2020): E-commerce in France and Germany a comparative analysis. 13 pages / RTS - Recherche Transports Sécurité, volume 2020 / RTS - Recherche Transports Sécurité, volume 2020. DOI: 10.25578/RTS_ISSN1951-6614_2020-08.

Senate Administration for Urban Development of Berlin: Integriertes Wirtschaftsverkehrskonzept Berlin. Available online at https://www.berlin.de/senuvk/verkehr/politik_planung/gueter/konzept/download/iwvK_2005-11-14.pdf, checked on 11/25/2020.

Senate Administration for Urban Development of Berlin: Stadtentwicklungsplan Wirtschaft 2030. Entwicklungspotenziale für Gewerbe und Industrie. Available online at https://www.stadtentwicklung.berlin.de/planen/stadtentwicklungsplanung/download/wirtschaft/StEP_Wirtschaft_2030_Online.pdf, checked on 12/2/2020.

Senate Administration for Urban Development of Berlin (2016): Klimaneutrales Berlin 2050. Empfehlungen für ein Berliner Energie- und Klimaschutzprogramm (BEK). Senatsverwaltung für Stadtentwicklung und Umwelt.

Senate Administration for Urban Development of Berlin (2019): Bericht zur Bevölkerungsprognose für Berlin und die Bezirke 2018 – 2030. Available online at https://www.stadtentwicklung.berlin.de/planen/bevoelkerungsprognose/download/2018-2030/Bericht_Bevprog2018-2030.pdf, checked on 12/22/2020.

Senate Department for the Environment, Transport and Climate Protection (n. d.): Neuauflage des Integrierten Wirtschaftsverkehrskonzepts für Berlin (IWVK). - Kurzinformation -. Available online at https://www.berlin.de/senuvk/verkehr/politik_planung/gueter/konzept/download/iwvk_prozessdarstellung.pdf, checked on 1/20/2021.

Senate Department for the Environment, Transport and Climate Protection (2020a): Organisationsplan. Stand: 28. Juli 2020.

Senate Department for the Environment, Transport and Climate Protection (2020b): Referententwurf Abschnitt Wirtschaftsverkehr - Stand 10.09.2020.

Shuihua Han; L. Zhao; Kui Chen; Z. Luo; Deepa Mishra (2017): Appointment scheduling and routing optimization of attended home delivery system with random customer behavior. In European Journal of Operational Research. Available online at https://www.semanticscholar.org/paper/Appointment-scheduling-and-routing-optimization-of-Han-Zhao/83edbef0199b44bdf84e6d030627e70fc303a063.

Slabinac, Maša (2015): Innovative Solutions For A "Last-Mile" Delivery – A European Experience. In 15th international scientific conference Business Logistics inModern Management.

State capital Stuttgart (2021): Dr. Manuela Wohlhüter. Wirtschaftsverkehrsbeauftragte. Landeshauptstadt Stuttgart. Stuttgart. Available online at https://www.stuttgart.de/vv/personen/wohlhueter-manuela.php, checked on 3/12/2021.

Statista GmbH: Bruttoinlandsprodukt (BIP) je Einwohner nach Bundesländern im Jahr 2019. Available online at https://de.statista.com/statistik/daten/studie/73061/umfrage/bundeslaender-im-vergleich---bruttoinlandsprodukt/, checked on 12/22/2020.

Statistical Office for Berlin-Brandenburg (2020a): Bevölkerungsentwicklung und Bevölkerungsstand in Berlin 2. Quartal 2020. Available online at https://www.statistik-berlin-brandenburg.de/publikationen/stat_berichte/2020/SB_A01-01-00_2020q02_BE.pdf, checked on 11/20/2020.

Statistical Office for Berlin-Brandenburg (2020b): Volkswirtschaftliche Gesamtrechnungen in Berlin und Brandenburg | Offene Daten Berlin. Available online at https://daten.berlin.de/datensaetze/volkswirtschaftliche-gesamtrechnungen-berlin-und-brandenburg, updated on 12/20/2020, checked on 12/20/2020.

Stodick, Klaus; Deckert, Carsten (2019): Sustainable Parcel Delivery in Urban Areas with Micro Depots. In Eric Sucky, Reinhard Kolke, Niels Biethahn (Eds.): Mobility in a globalised world 2018 (Logistik und Supply Chain Management).

Straube, Frank; Figiel, Anna; Nitsche, Benjamin (2018): Herausforderungen und Lösungen für den städtischen Wirtschaftsverkehr auf der letzten Meile – neue Konsumententrends beeinflussen die Logistik der Zukunft. In : Handbuch kommunale Verkehrsplanung, p. 1. Available online at https://www.researchgate.net/publication/335353010_Herausforderungen_und_Losungen_fur_den_stadtischen_Wirtschaftsverkehr_auf_der_letzten_Meile_-_neue_Konsumententrends_beeinflussen_die_Logistik_der_Zukunft.

Thaller, Carina (2018): Strategische Verkehrsprognose. With assistance of Technische Universität Dortmund.

Transics International BV (2021): transics. Ieper. Available online at https://www.transics.com/, checked on 3/12/2021.

Transport for London (2016): The Directory of London Construction Consolidation Centres. London. Available online at https://constructionlogistics.org.uk/wp-content/uploads/2017/07/The-Directory-of-London-Construction-Consolidation-Centres-1.pdf, checked on 3/12/2021.

Transport for London (2021): Congestion Charge. London. Available online at https://tfl.gov.uk/modes/driving/congestion-charge, checked on 3/12/2021.

Unfallforschung der Versicherer (2016): Sicherheitsbewertung von Fahrradstraßen und der Öffnung von Einbahnstraßen. Available online at https://udv.de/de/publikationen/forschungsberichte/sicherheitsbewertung-fahrradstrassen-und-der-oeffnung-einbahnstrassen, updated on 4/9/2021, checked on 4/9/2021.

United Nations (UN) (2019): Basic Data Selection. GDP, Per capita GDP - US Dollars Germany.

Verbraucherzentrale Bundesverband (n. d.): Über uns. Available online at https://www.verbraucherzentrale.de/ueber-uns, checked on 11/27/2020.

Vereinte Dienstleistungsgewerkschaft (ver.di) (n. d.): ver.di Postdienste, Speditionen und Logistik. Available online at https://psl.verdi.de/, checked on 11/27/2020.

Vereinte Dienstleistungsgewerkschaft (ver.di) (2013): Die ver.di-Kampagne Kurier-, Express- und Paketdienste (KEP). FAIRSAND ORGANISIEREN! Fair zugestellt statt ausgeliefert. Available online at https://psl.verdi.de/++file++5ab0e86ae58deb05e92a20a3/download/FB10_Brosch2013_KEP_96dpi.pdf, checked on 12/4/2020.

Verkehrsverbund Berlin-Brandenburg (n. d.): Datensätze (GTFS, Haltestellen, Linienfarben). Available online at https://www.vbb.de/unsere-themen/vbbdigital/api-entwicklerinfos/datensaetze, updated on 12/22/2020, checked on 12/22/2020.

Wambach, Achim; Kollmann, Dagmar; Kühling, Jürgen; Nöcker, Thomas; Westerwelle, Angelika (2019): Die Novelle des Postgesetzes: Neue Chancen für den Wettbewerb. 11. Sektorgutachten Post (2019). Monopolkommission. Available online at https://www.monopolkommission.de/images/PDF/SG/11sg_post.pdf.

Witten, Peer; Schmidt, Carmen (2019): Globale Trends und die Konsequenzen für die Logistik der letzten Meile. In Meike Schröder, Kirsten Wegner (Eds.): Logistik im Wandel der Zeit - Von der Produktionssteuerung zu vernetzten Supply Chains. Festschrift für Wolfgang Kersten zum 60. Geburtstag. With assistance of Wolfgang Kersten. 1. Auflage 2019. Wiesbaden: Springer Fachmedien Wiesbaden, pp. 303–319.

WORLD ECONOMIC FORUM (2020): The Future of the Last-Mile Ecosystem. Transition Roadmaps for Public- and Private-Sector Players. Available online at http://www3.weforum.org/docs/WEF_Future_of_the_last_mile_ecosystem.pdf, checked on 10/27/2020.

Zentrum für europäische Wirtschaftsforschung GmbH (ZEW) (2019): INNOVATIONEN ZEW BRANCHENREPORT. Post- und Kurierdienste. Available online at http://ftp.zew.de/pub/zew-docs/brarep_inno/issue/2018/30_Post.pdf, checked on 12/3/2020.

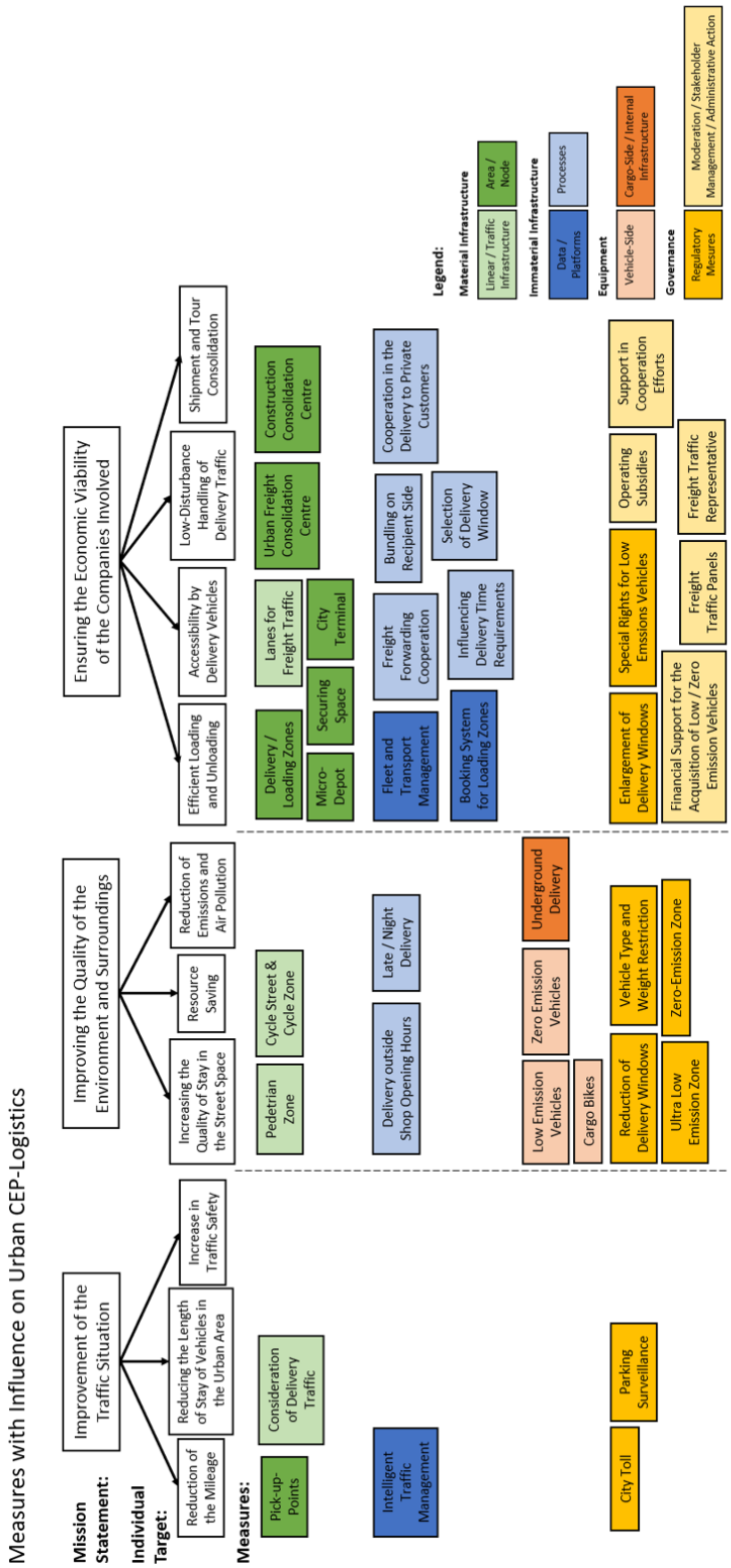
Appendix I: Instruments/Regulations of Spatial and Transport Planning According to Planning Levels in Germany

REFERENCE AREA	SPATIAL PLANNING	TRANSPORT PLANNING	ENVIRONMENTAL PLANNING
WORLD			Paris Agreement under the United Nations Framework Convention on Climate Change 2015 UNECE Convention on Long-Range Transboundary Air Pollution (the Air Convention).
EUROPEAN UNION	Territorial agenda of the European union	TEN (Trans-European Networks) EU WHITE PAPER "Roadmap to a Single European Transport Area" Funding programs	Regulations on air pollutants emissions and greenhouse gases from vehicles Regulations on air quality
NATIONWIDE GERMANY	National Port Concept for Sea and Inland Ports 2015 Guiding principles of spatial planning Laws on administrative action	Federal Transport Infrastructural Plan/ Acts on Transport Infrastructure Expansion Road Traffic Act (regulates the use of traffic signs) Technical standards and specifications of the Road and Transport Research Association (FGSV) Funding programs	Climate protection law Federal Immission Control Act Ordinance on air quality standards and emission thresholds
FEDERAL STATES	Spatial structure plan	State Transport Infrastructure Plan Funding programs	State climate protection laws State sustainability strategy
REGION	Regional plan	Regional Plans content description of important transport infrastructure (roads, railways, inland waterways) as a precondition for project development	Clean air action plan[15]
MUNICIPALITY	1st level: Urban land-use plans	**Urban transport planning** (→ *Informal planning, not regulated by a higher-level law*)	Clean air action plan Noise Action Plan Municipal climate protection concept
	2nd level: master plan	Road design, access to estates, parking	Measures to fulfil noise and air quality requirements, compensation for sealed natural area
	3rd level: construction permission (for buildings only)	Details of access, parking lots, delivery zones (related to a single building)	Additional technical instructions for noise and air pollution measures

Instruments/Regulations of Spatial and Transport Planning According to Planning Levels in Germany, Own Figure Based on (Ritter 2003; FGSV 2018)

15 Responsible planning level varies by federal state.

Appendix II: Overview of Measures in Freight Transport and Descriptive Profiles



Overview of Measures in Freight Transport and Descriptive Profiles

Descriptive Profile 1: Consideration of Delivery Infrastructure in Streetscape Design

ACTION	CONSIDERATION OF DELIVERY INFRASTRUCTURE IN STREETSCAPE DESIGN
DESCRIPTION	When the road is built/rebuilt, the needs of delivery traffic are considered so that good conditions are available for this traffic.
AREA OF APPLICATION	public street space, city streets
RELEVANT STAKEHOLDERS	Impulse giver: administration, Chamber of Industry and Commerce
	addressee: administration
TIME REFERENCE	long-term
RELATED OBJECTIVES	avoidance of traffic problems/delivery problems (e.g., due to lack of delivery zones)
PREREQUISITES FOR IMPLEMENTATION	participation of the affected companies in the planning process
RELATED MEASURES	noise-reducing road surfaces; delivery/loading zones; consideration of freight traffic aspects in planning processes
EXAMPLE	cf. „Recommendations for Facilities for Stationary Traffic "(„Empfehlungen für Anlagen des ruhenden Verkehrs")
SOURCE	(Holthaus et al. 2019; Forschungsgesellschaft für Straßen- und Verkehrswesen 2005)

Descriptive Profile 2: Pedestrian Zone

ACTION	PEDESTRIAN ZONE
DESCRIPTION	A pedestrian zone is a traffic area on which pedestrians have priority or exclusive right of use over other road users. Delivery traffic is usually given fixed time slots.
AREA OF APPLICATION	city centre
RELEVANT STAKEHOLDERS	impulse giver: city administration
	addressee: motorised traffic, recipients
TIME REFERENCE	medium-term
RELATED OBJECTIVES	increase the quality of stay for people
PREREQUISITES FOR IMPLEMENTATION	• examination of accessibility, determination of the types of traffic that are still desired. • identification of urban attractive/sensitive areas, exemptions for delivery traffic, sanctioning of unauthorised journeys
RELATED MEASURES	• micro-depots • area-specific bundling • use of low-emission/free vehicles (e-vehicles, cargo bikes) • eliminate delivery window for zero-emission vehicles • creation of loading zones
EXAMPLE	common in many inner-city areas
SOURCE	(Leerkamp et al. 2020)

Descriptive Profile 3: Cycle Street/Cycle Zone

ACTION	CYCLE STREET / CYCLE ZONE
DESCRIPTION	In cycle streets or cycle zones, bicycles have priority over other modes of transport. Motorised traffic must be explicitly allowed access, otherwise it is prohibited.
AREA OF APPLICATION	City centre
RELEVANT STAKEHOLDERS	Impulse giver: city administration
	Addressee: motorised traffic, recipients
TIME REFERENCE	Medium-term
RELATED OBJECTIVES	Ban on motorised delivery vehicles in inner cities
PREREQUISITES FOR IMPLEMENTATION	• Examination of accessibility, determination of the types of traffic that are still welcome. • Identification of urban attractive/sensitive areas, exemptions for delivery traffic, sanctioning of unauthorised journeys.
RELATED MEASURES	• Micro-depots • Area-specific bundling • Use of low-emission/free vehicles (e-vehicles, cargo bikes) • Creation of loading zones • Delivery windows
EXAMPLE	Cycle streets: common occurrence in city centres Cycle zone: The bicycle zone in Bremen's Neustadt comprises 12 streets and around 2.5 kilometres of road space.
SOURCE	(Freie und Hansestadt Bremen n. d.) (Unfallforschung der Versicherer 2016)

Descriptive Profile 4: Privileging of Lanes for Freight Traffic

ACTION	PRIVILEGING OF LANES FOR FREIGHT TRAFFIC
DESCRIPTION	Release of special lanes for delivery traffic
AREA OF APPLICATION	Core city
RELEVANT STAKEHOLDERS	Impulse giver: city administration
	Addressee: freight traffic
TIME REFERENCE	Short-term
RELATED OBJECTIVES	Acceleration of delivery traffic; avoidance of congestion for delivery traffic
PREREQUISITES FOR IMPLEMENTATION	Existing special lanes; signage
RELATED MEASURES	Consideration of freight transport aspects in planning processes
SOURCE	(EC 2012)

Descriptive Profile 5: Delivery/Loading Zones

ACTION	DELIVERY / LOADING ZONES
DESCRIPTION	• Establishment of loading zones on main roads every 50 metres • With a maximum parking time of 30 minutes • Monitoring of the loading zones and sanctioning of illegal parkers
AREA OF APPLICATION	Pedestrian zones, city centres, main roads
RELEVANT STAKEHOLDERS	Impulse giver: administration
	Addressee: CEP service providers; urban freight transport
TIME REFERENCE	Current
RELATED OBJECTIVES	Delivery traffic out of the pedestrian zone → increased attractiveness Increasing the availability of loading areas
PREREQUISITES FOR IMPLEMENTATION	• Survey of the delivery processes in the respective road section • Coordination with local economic actors
RELATED MEASURES	• Micro-depots • Securing areas for logistical uses
EXAMPLE	Hannover-Linden: As part of a pilot project, loading zones were set up there – with the participation of five delivery services – covering the entire area, one every 185 metres on average. 20 of these loading zones are only kept free for delivery traffic temporarily, from 9:00 to 17:00, and are otherwise available as parking spaces. Two loading zones that are permanently kept free for delivery traffic are also used as a location for a micro-depot.
SOURCE	(Leerkamp et al. 2020)

Descriptive Profile 6: Urban Freight Consolidation Centres

ACTION	URBAN FREIGHT CONSOLIDATION CENTRES
DESCRIPTION	"Urban freight consolidation are collection and distribution centres that are usually located on the periphery of cities and thus have short routes into the delivery area. All consignments destined for the delivery area are delivered to city logistics centres, temporarily stored, picked and consolidated for bundled delivery to the recipients located in the delivery area. The delivery vehicles of the city logistics centre can be adapted to urban conditions, which can further increase the compatibility of delivery traffic in the city. In the process, the delivery can be carried out by a neutral logistics company, which can also be founded by the companies involved in the city logistics centres."
AREA OF APPLICATION	Edge of town
RELEVANT STAKEHOLDERS	Impulse giver: city administration
	Addressee: freight operators
TIME REFERENCE	Long-term
RELATED OBJECTIVES	Bundling of urban freight traffic overall less delivery traffic in the city
PREREQUISITES FOR IMPLEMENTATION	• Relatively high space requirement • Willingness of the companies to participate
RELATED MEASURES	Cooperation via existing forwarding facilities; bundling
EXAMPLE	Bristol-Bath Urban freight Consolidation Centre (BBUCC): "The BBUCC is managed by DHL. It is connected with the major corridors coming from the North and the Midlands by motorways. It is primarily a cross-dock centre and it is occasionally used for storage. It usually holds stocks for a few days if retailers are experiencing some sort of storage space problems. The goods primarily arrive from the Midland (Birmingham) by means of articulated vehicles, 18-tonne trucks, 7.5-tonne trucks and vans. Deliveries to the city centre are made by 9-ton electric vans with a load factor of 5-tonnes. The 3.5-tonne diesel vans are occasionally used for break-down problems or busy periods (Christmas)."
SOURCE	(Holthaus et al. 2019) (Paddeu 2017)

Descriptive Profile 7: Securing Space for Decentralised Logistics Locations

ACTION	SECURING SPACE FOR DECENTRALISED LOGISTICS LOCATIONS
DESCRIPTION	• Retaining public areas for pick-up-points and micro-depots • Including areas for decentralised logistics locations in development planning procedures
AREA OF APPLICATION	Core cities
RELEVANT STAKEHOLDERS	Impulse giver: city administration
	Addressee: city administration, companies
TIME REFERENCE	Continuous
RELATED OBJECTIVES	Facilitating the subsequent establishment of decentralised logistics locations
PREREQUISITES FOR IMPLEMENTATION	• Target concept to secure suitable areas • Identification of suitable transhipment areas and actors
RELATED MEASURES	• Loading zones, • Micro-depots, city terminal • Bundling (by area/recipient)
EXAMPLE	The Berlin "Urban Development Plan for the Economy 2030" was adopted in 2019 and, in addition to regional freight centres, its spatial model also includes several existing and planned locations for so-called sub-distribution centres near the city centre. As an informal instrument, the plan only has the character of a recommendation.
SOURCE	(Leerkamp et al. 2020) (Senate Administration for Urban Development of Berlin)

Descriptive Profile 8: Installation of Pick-up Points / Parcel Boxes

ACTION	INSTALLATION OF PICK-UP-POINTS / PARCEL BOXES
DESCRIPTION	Pick-up points and parcel boxes are stationary facilities without staff that are usually accessible to all city residents throughout the day. They are used for the temporary storage of shipments for transfer between the CEP service provider and the recipient or sender. While the parcel station is used for sending and receiving items, the parcel box is used exclusively for sending items."
AREA OF APPLICATION	Core city
RELEVANT STAKEHOLDERS	Impulse giver: CEP service providers, providers of pick-up-points / parcel boxes
	Addressee: recipients
TIME REFERENCE	Current
RELATED OBJECTIVES	Avoidance of incorrect deliveries, bundling
PREREQUISITES FOR IMPLEMENTATION	Availability of space
RELATED MEASURES	Securing space for decentralised logistics locations; providing space for pick-up-points, micro-depots
EXAMPLE	Packstation (DHL) (pick-up point)
SOURCE	(Holthaus et al. 2019)

Descriptive Profile 9: Construction Consolidation

ACTION	CONSTRUCTION CONSOLIDATION
DESCRIPTION	Temporary storage of construction materials in a Construction Consolidation Centre. In case of material requirements: Compilation and delivery of the required materials as one load just-in-time. In addition, return transport of waste, pallets and loads to the Construction Consolidation Centre.
AREA OF APPLICATION	Core areas, construction sites
RELEVANT STAKEHOLDERS	Impulse giver: municipality, logistics company
	Addressee: construction company, logistics company, municipality
TIME REFERENCE	Current
RELATED OBJECTIVES	Reducing the mileage and number of delivery vehicles in the urban area
PREREQUISITES FOR IMPLEMENTATION	Necessary: construction consolidation centre available (special form of city terminal) Information of stakeholders, mediation between construction companies and logisticians, Creation of incentives for construction site consolidation (e.g. through the establishment of space-saving construction site installation areas/ issuing of time-limited permits for construction site and waste disposal traffic/ city tolls/ low emission zones/ zero emission zones).
RELATED MEASURES	City tolls, low emission zones, zero emission zones
EXAMPLE	London Construction Consolidation Centres: A series of CCCs from different operators ensures extensive coverage of the London metropolitan area.
SOURCE	(Leerkamp et al. 2020; Transport for London 2016)

Descriptive Profile 10: Intelligent Traffic Management

ACTION	INTELLIGENT TRAFFIC MANAGEMENT

DESCRIPTION	"Traffic management systems (e.g. access control systems, traffic management and information systems) [consist of]:
	• Urban Traffic Management and Control (UTMC) systems:
	  ○ Urban Traffic Control (UTC) systems to co-ordinate traffic signal timings,
	  ○ Variable message signs (VMS) to communicate information to drivers via roadside signs,
	  ○ Car park occupancy sensors,
	  ○ Journey-time measurement systems via automatic number-plate recognition technology;
	• the provision of mapping or route guidance,
	• and automated vehicle access controls."

AREA OF APPLICATION	Area-wide
RELEVANT STAKEHOLDERS	Impulse giver: city administration
	Addressee: traffic
TIME REFERENCE	Long-term
RELATED OBJECTIVES	• "Increasing the capacity of the street network by 20 – 25%, • Improving road traffic safety (decreasing the number of accidents by 40 – 80%), • Reducing travel times and decreasing energy consumption (by 45 – 70%), • Improving the quality of the natural environment (reducing pollutants emissions by 30 – 50%), • Improving the travel comfort and traffic conditions for drivers, • Collective transport users and pedestrians, • Reducing the costs of road fleet management, • Reducing the costs of road surface repair and maintenance, • and increasing the economic benefits in the region."
PREREQUISITES FOR IMPLEMENTATION	• Telematics (on the part of the city and the transport companies) implementation concept
RELATED MEASURES	Fleet and transport management, consideration of delivery infrastructure in planning processes
EXAMPLE	Strategy of Szczecin development 2025
SOURCE	(Małecki et al. 2014)

Descriptive Profile 11: Micro-depots

ACTION	MICRO-DEPOTS
DESCRIPTION	Parcel shipments are delivered from the depot by truck to a micro-depot and from there they are delivered by cargo bike, handcart, or delivery robot.
AREA OF APPLICATION	Core town
RELEVANT STAKEHOLDERS	Impulse giver: package delivery companies, administration, Chamber of Industry and Commerce, or similar
	Addressee: package delivery companies
TIME REFERENCE	Currently
RELATED OBJECTIVES	Low-emission delivery, ban on delivery vehicles in inner cities
PREREQUISITES FOR IMPLEMENTATION	Location for micro-depot → container, mobile micro depot, rental space Good connections for lorries and cargo bicycles Short distances to the destination (customer, trade, ...)
RELATED MEASURES	Delivery by cargo bike, low emission zone, zero emission zone, pedestrian zone
EXAMPLE	Komodo, Berlin • Operator: BEHALA - Berliner Hafen- und Lagerhausgesellschaft mbh (Berlin Port and Warehouse Company) • Project coordinator: LNC logisticnetwork Consultants GmbH • Project partners: DHL Delivery Berlin GmbH, DPD Deutschland GmbH, GLS General Logistics Systems Germany GmbH, Hermes Germany GmbH, UPS United Parcel Service Deutschland S.a.r.l. & Co. OHG • Associate partners: senuvk Senatsverwaltung für Umwelt, Verkehr und Klimaschutz (Senate Department for the Environment, Transport and Climate Protection) • Associated associations: bdkep Bundesverband der Kurier-Express-Post-Dienste e.V. (Federal Association of Courier Express Mail Services), BIEK Bundesverband Paket und Expresslogistik (Federal Association of Parcel and Express Logistics), bvdp Bundesverband Deutscher Postdienstleister e.V. (Federal Association of German Postal Service Providers), DIN Deutsches Institut für Normung e.V. (German Institute for Standardisation)
SOURCE	(Junk und Wiegosch 2019) (LNC logisticnetwork Consultants gmbh 2021)

Descriptive Profile 12: Establishment of City Terminals

ACTION	ESTABLISHMENT OF CITY TERMINALS
DESCRIPTION	Establishment of a transhipment area (size 1-10 ha, possibly with rail connection) for bundled core city supply with cargo bikes, e-vehicles
AREA OF APPLICATION	Core areas, city centre
RELEVANT STAKEHOLDERS	Impulse giver: city administration, logistics companies
	Addressee: logistics companies
TIME REFERENCE	Long-term
RELATED OBJECTIVES	Bundling → less freight traffic
PREREQUISITES FOR IMPLEMENTATION	• Necessary: provision and securing of areas close to the centre for logistical use • Encourage business cooperation • Information of the actors • Create incentives for business cooperation and transhipment on the last mile (e.g. through congestion charge/low emission zone/zero emission zone)
RELATED MEASURES	• Use of cargo bikes and e-vehicles • Securing of sidings • Recipient-related bundling/shipper-related bundling • Special permits for cargo bikes/emission-free vehicles
EXAMPLE	City Terminal Berlin Westhafen: With an area of 430,000 m², the city terminal is the city's largest port and one of the most important inner-city logistics centres. It is connected to the Moabit freight station and has a container terminal for inland waterway vessels and railways. The city terminal is a member of KoMoDo and thus promotes sustainable city logistics.
SOURCE	(BUSINESS LOCATION CENTER; Leerkamp et al. 2020)

Descriptive Profile 13: Booking System for Loading Zones

ACTION	BOOKING SYSTEM FOR LOADING ZONES
DESCRIPTION	„ […] a managed, bookable loading bay system, whereby advanoe bookings oan be made by the users of the system and enforoement and oontrol measures are used to ensure effeotive operation."
AREA OF APPLICATION	City oenters, loading zones
RELEVANT STAKEHOLDERS	Impulse giver: oity administration
	Addressee: CEP servioe providers
TIME REFERENCE	Medium-term
RELATED OBJECTIVES	„Guaranteed loading and unloading spaoes" □ no parking searoh traffio
PREREQUISITES FOR IMPLEMENTATION	• Development of software • Control system
RELATED MEASURES	Delivery / loading zones; parking surveillanoe; fleet and transport management
EXAMPLE	SmaLa, Hamburg: (test phase) The projeot "SmaLa" is implemented in the distriot Hamburg-Mitte. For this purpose, 4–5 "Smart Delivery and Loading Zones" will be installed in Hamburg-Mitte and the virtual booking system will be available to suppliers and deliverers for testing with limited funotions.
SOURCE	(MoLeod and Cherrett 2011) (hamburg.de GmbH & Co. KG, Behörde für Wirtsohaft und Innovation 2020)

Descriptive Profile 14: Fleet and Transport Management

ACTION	FLEET AND TRANSPORT MANAGEMENT
DESCRIPTION	Use of telematics with various functions: • "locating the vehicle and calling up the current status (in motion, not in motion, ...) • electronic transmission of transport orders and automatic transfer of destination addresses in the navigation system • transmission of text messages and designation directly to the display in the vehicle and possibility of immediate confirmation by the driver • automatic recording of time and kilometre data via GPS positioning • possibility of changing transport orders at short notice • reduction of (time-consuming) telephone calls between dispatch and driver"
AREA OF APPLICATION	Area-wide
RELEVANT STAKEHOLDERS	Impulse giver: CEP service providers; management system providers
	Addressee: CEP service providers
TIME REFERENCE	Ongoing
RELATED OBJECTIVES	• "[...] To increase the efficiency of journeys through intelligent traffic management, • Optimise processes and reduce operating costs through fleet and transport management, • Manage driving and rest times within the framework of time management, and • To meet the special requirements for certain logistics services through additional modules such as "cooling data management" or "security"."
PREREQUISITES FOR IMPLEMENTATION	Management system; technical equipment
RELATED MEASURES	Bundling; route optimisation
EXAMPLE	Transics; LiS AG
SOURCE	(Logistische Informationssysteme AG 2021; Holthaus et al. 2019; Transics International BV 2021)

Descriptive Profile 15: Appointment Scheduling

ACTION	APPOINTMENT SCHEDULING
DESCRIPTION	Delivery at appointed times
AREA OF APPLICATION	No restrictions
RELEVANT STAKEHOLDERS	Impulse giver: package delivery companies, customers, providers
	Addressee: package delivery companies, customers
TIME REFERENCE	Currently
RELATED OBJECTIVES	Avoidance of multiple delivery attempts
PREREQUISITES FOR IMPLEMENTATION	• Willingness of customers • (if necessary, provider who takes over last mile)
RELATED MEASURES	Use of delivery bicycles or handcarts, route optimisation
EXAMPLE	Kiezbote, berlin • Takes over delivery at the appointed time. • Kiezbote is specified as the delivery address when ordering. Postal code areas 10589, 14059, 10585, 10587
SOURCE	(Shuihua Han et al. 2017; Hochschule für Technik und Wirtschaft Berlin 2021)

Descriptive Profile 16: Bundling on the Recipient Side

ACTION	BUNDLING ON THE RECIPIENT SIDE
DESCRIPTION	End customers (e.g. City centre traders, local government) enter the city terminal of a service provider (c/o address) as the delivery address, which organises transport on the "last mile" into the city centre.
AREA OF APPLICATION	No restrictions
RELEVANT STAKEHOLDERS	Impulse giver: companies, municipality/city
	Addressee: (logistics) companies, administration
TIME REFERENCE	Currently
RELATED OBJECTIVES	Avoidance of multiple delivery attempts
PREREQUISITES FOR IMPLEMENTATION	• Necessary: city terminal available • Information of stakeholders, mediation between companies and logisticians, creation of incentives for business cooperation (e.g. Through congestion charge/low emission zone/zero emission zone)
RELATED MEASURES	• City toll, low-emission zone, zero-emission zone • Use of cargo bikes, e-vehicles
EXAMPLE	Kiezbote, Berlin • Takes over delivery at the appointed time. • Kiezbote is specified as the delivery address when ordering. • postal code areas 10589, 14059, 10585, 10587
SOURCE	(Leerkamp et al. 2020) (Hochschule für Technik und Wirtschaft Berlin 2021)

Descriptive Profile 17: Influencing Delivery Time Requirements

ACTION	INFLUENCING DELIVERY TIME REQUIREMENTS
DESCRIPTION	Addressing customers creates awareness of the negative traffic and environmental impacts of delivery time requirements and thus avoids them.
AREA OF APPLICATION	Area-wide
RELEVANT STAKEHOLDERS	Impulse giver: CEP service providers
	Addressee: recipients
TIME REFERENCE	Ongoing
RELATED OBJECTIVES	Optimisation of the routes to be driven; avoidance of unnecessary routes
PREREQUISITES FOR IMPLEMENTATION	Contact to the customer; readiness to change customer behaviour
RELATED MEASURES	Transport management
SOURCE	(Holthaus et al. 2019)

Descriptive Profile 18: Cooperation in the Delivery to Private Customers

ACTION	COOPERATION IN THE DELIVERY TO PRIVATE CUSTOMERS
DESCRIPTION	Joint delivery or a joint commissioning of neutral service providers for delivery
AREA OF APPLICATION	Area-wide possible
RELEVANT STAKEHOLDERS	Impulse giver: CEP service providers
	Addressee: CEP service providers
TIME REFERENCE	Medium-term
RELATED OBJECTIVES	Bundling
PREREQUISITES FOR IMPLEMENTATION	• Willingness to cooperate • Neutral service provider if necessary
RELATED MEASURES	Freight forwarding cooperation via existing facilities
SOURCE	(Holthaus et al. 2019)

Descriptive Profile 19: Delivery Outside Shop Opening Hours

ACTION	DELIVERY OUTSIDE SHOP OPENING HOURS
DESCRIPTION	Shifting the delivery to the period outside the shop opening hours
AREA OF APPLICATION	City centre
RELEVANT STAKEHOLDERS	Impulse giver: CEP service providers
	Addressee: CEP service providers; retail
TIME REFERENCE	Medium-term
RELATED OBJECTIVES	Fewer vehicles in pedestrian zones/city centres during the day
PREREQUISITES FOR IMPLEMENTATION	• Willingness of the recipient • Trust between cep service provider and recipient • Secured storage area or key for suppliers
RELATED MEASURES	Delivery time restrictions; noise-reducing road surfaces
SOURCE	(Holthaus et al. 2019)

Descriptive Profile 20: Locally Emission-free Vehicles

ACTION	LOCALLY EMISSION-FREE VEHICLES
DESCRIPTION	Use of vehicles that do not emit emissions on site. This means battery-powered vehicles in particular.
AREA OF APPLICATION	Inner cities (e.g. Low emission zones); area-wide
RELEVANT STAKEHOLDERS	Impulse giver: city administration
	Addressee: CEP service providers
TIME REFERENCE	Current
RELATED OBJECTIVES	No air pollutants; higher quality of stay
PREREQUISITES FOR IMPLEMENTATION	• Willingness to bear higher acquisition costs • Suitable vehicles
RELATED MEASURES	Special rights for zero-emission vehicles; zero emission zone; promotion of zero-emission vehicles
EXAMPLE	StreetScooter and other car manufacturers
SOURCE	(Holthaus et al. 2019)

Descriptive Profile 21: Cargo-bikes

ACTION	CARGO BIKES
DESCRIPTION	Use of motorised or non-motorised cargo bikes for "last mile" delivery, e.g. From a micro-depot
AREA OF APPLICATION	Core cities
RELEVANT STAKEHOLDERS	Impulse giver: city administration, CEP service providers
	Addressee: CEP service providers
TIME REFERENCE	Current
RELATED OBJECTIVES	Emission-free delivery traffic
PREREQUISITES FOR IMPLEMENTATION	• Nearby starting point for delivery (e.g. Micro-depot) • Desirable: adapted bicycle infrastructure
RELATED MEASURES	• Designation/securing of space in case of need for freight forwarding transhipment centres • Micro-depots, e.g. As storage for bicycle deliveries • Consideration of delivery traffic concerns in street space design • Shared use of micro-depots • Special rights for low-emission vehicles
EXAMPLE	Komodo Berlin (cf. Descriptive profile 11)
SOURCE	(Holthaus et al. 2019)

Descriptive Profile 22: Reduction of Delivery Windows

ACTION	REDUCTION OF DELIVERY WINDOWS
DESCRIPTION	The delivery windows provided in the pedestrian zones are shortened.
AREA OF APPLICATION	City centres, pedestrian zones
RELEVANT STAKEHOLDERS	Impulse giver: city administration
	Addressee: CEP service providers
TIME REFERENCE	Short-term
RELATED OBJECTIVES	Increasing the attractiveness of the city centre
PREREQUISITES FOR IMPLEMENTATION	• Existing pedestrian zone • Delivery volume must be able to be handled in the shorter time span. • No increase in the potential for conflict with other road users
RELATED MEASURES	• Pedestrian zone; special rights for low-emission vehicles
SOURCE	(Holthaus et al. 2019)

Descriptive Profile 23: Enlargement of Delivery Windows

ACTION	ENLARGEMENT OF DELIVERY WINDOWS
DESCRIPTION	Delivery windows in pedestrian zones are extended.
AREA OF APPLICATION	Pedestrian zones
RELEVANT STAKEHOLDERS	Impulse giver: city administration
	Addressee: CEP service providers
TIME REFERENCE	Short-term
RELATED OBJECTIVES	Equalisation of peak volumes fewer conflicts between deliverers
PREREQUISITES FOR IMPLEMENTATION	• Provision of the necessary personnel (additional costs for the recipient) or • Access for the deliverer to the storage rooms outside shop opening hours (creation of a basis of trust) or • Goods lock (possibly additional costs for the recipient)
RELATED MEASURES	Delivery outside shop opening hours
SOURCE	(Holthaus et al. 2019)

Descriptive Profile 24: Parking Surveillance

ACTION	PARKING SURVEILLANCE
DESCRIPTION	Surveillance of the parking area and especially the delivery zones for illegally parked vehicles.
AREA OF APPLICATION	City centres
RELEVANT STAKEHOLDERS	Impulse giver: city administration
	Addressee: motorised vehicles
TIME REFERENCE	Current
RELATED OBJECTIVES	Delivery zones are available for delivery traffic less parking search traffic
PREREQUISITES FOR IMPLEMENTATION	• Delivery zones / stopping restrictions • Staff
RELATED MEASURES	Delivery zones
EXAMPLE	Everyday administrative business of municipalities
SOURCE	(Holthaus et al. 2019)

Descriptive Profile 25: Special Rights for Low-emission Vehicles

ACTION	SPECIAL RIGHTS FOR LOW-EMISSION VEHICLES
DESCRIPTION	The granting of special rights for low-emission vehicles tends to lead to bundling effects in that the acquisition and operation of these vehicles is worthwhile, especially within the framework of cooperation concepts.
AREA OF APPLICATION	Inner city
RELEVANT STAKEHOLDERS	Impulse giver: city administration
	Addressee: CEP service providers
TIME REFERENCE	Medium-term
RELATED OBJECTIVES	Improving the quality of the environment and surroundings
PREREQUISITES FOR IMPLEMENTATION	• Legal assessment of the introduction of a special right • Formulation of certain vehicle types that may make use of the special right or receive a (free) permit. • Development of a possible implementation concept including a time schedule for the orientation of interested freight forwarders and integration into the existing traffic concepts
RELATED MEASURES	Ultra-low emission zone; promotion of low-emission vehicles
SOURCE	(Holthaus et al. 2019)

Descriptive Profile 26: Ultra Low Emission Zone

ACTION	ULTRA LOW EMISSION ZONE
DESCRIPTION	Ban on vehicles above a certain emission level in a limited area
AREA OF APPLICATION	Core city areas and areas with high emissions
RELEVANT STAKEHOLDERS	Impulse giver: administration
	Addressee: motorised traffic
TIME REFERENCE	Medium-term
RELATED OBJECTIVES	Less traffic emissions in the city centre (noise, pollutants, ...)
PREREQUISITES FOR IMPLEMENTATION	• Early announcement of the introduction/establishment of transitional arrangements. • Determine the polluter share of all emitters to maintain proportionality • Identify and promote vehicle retrofits/new purchases • Define hardship cases for exemptions
RELATED MEASURES	City toll, use of emission-free/low-emission vehicles
EXAMPLE	London: • 2019: Introduction of the Ultra Low Emission Zone (ULEZ) in the congestion charging area. The standard is Euro 6 for diesel passenger cars and light diesel commercial vehicles (LCV), Euro VI for heavy commercial vehicles (HCV) and Euro 4 for petrol passenger cars and petrol lcvs. If these are not met, a fee of £12.50 per day for cars and lcvs and £100 per day for hcvs. • 2020: Stricter Low Emission Zone in the Greater London Region (Low Emission Zone) for trucks at Euro VI level. • 2021: Extension of the Ultra Low Emission Zone to large parts of the city area.
SOURCE	(Leerkamp et al. 2020) (Greater London Authority 2018)

Descriptive Profile 27: Zero-emission Zone

ACTION	ZERO-EMISSION ZONE
DESCRIPTION	Ban on vehicles with pollutant emissions
AREA OF APPLICATION	Core city areas and areas with high emissions
RELEVANT STAKEHOLDERS	Impulse giver: administration
	Addressee: motorised traffic
TIME REFERENCE	Long-term
RELATED OBJECTIVES	No traffic emissions in the city centre (noise, pollutants, ...)
PREREQUISITES FOR IMPLEMENTATION	• Early announcement of the introduction/establishment of transitional arrangements. • Determine the polluter share of all emitters to maintain proportionality • Identify and promote vehicle retrofits/new purchases Define hardship cases for exemptions
RELATED MEASURES	City toll, use of emission-free/low-emission vehicles
EXAMPLE	Amsterdam: • 2022 city centre emission-free – for buses • 2025 area within the ring road emission-free – for taxis, buses, delivery vehicles and ferries 2030 entire city area emission-free – for all means of transport
SOURCE	(Leerkamp et al. 2020; City of Amsterdam, Space and Sustainability, Air Quality Team 2019)

Descriptive Profile 28: City Toll

ACTION	CITY TOLL
DESCRIPTION	• Pricing of entries into defined areas (pricing depending on mileage, time or frequency of passing toll stations) • If necessary, differentiation according to environmental criteria • If necessary, gradual expansion of the area and pricing
AREA OF APPLICATION	Core areas, city centre
RELEVANT STAKEHOLDERS	Impulse giver: city administration
	Addressee: motorised traffic
TIME REFERENCE	Medium-term
RELATED OBJECTIVES	Less traffic → less emissions in inner city areas
PREREQUISITES FOR IMPLEMENTATION	• Early communication, pricing • Development of control infrastructure, integration into national toll system
RELATED MEASURES	• Ultra-low emission zone or zero emission zone, • Special permits for zero-emission vehicles, • Bundling (construction sites/recipient-related, shipper-related)
EXAMPLE	London: A one-off charge of £11.50 will be levied for driving a car or commercial vehicle into the tolled area from 7am to 6 pm Monday to Friday. The charge is for unlimited entry into the tolled area on the day in question, including multiple entries and exits. The vehicles are charged by means of registration plates on entry.
SOURCE	(Leerkamp et al. 2020) (Transport for London 2016) (Transport for London 2021)

Descriptive Profile 29: Support for Private Actors in Cooperation Efforts

ACTION	SUPPORT FOR PRIVATE ACTORS IN COOPERATION EFFORTS
DESCRIPTION	The city administration supports initiatives of CEP service providers in the initial implementation of cooperation's (e.g. Ensuring customer protection, compatibility of quality assurance systems, harmonisation of IT systems, definition of the transfer of risk, data protection issues and ensuring the corporate identity of the companies).
RELEVANT STAKEHOLDERS	Impulse giver: city administration
	Addressee: city administration; CEP service providers
TIME REFERENCE	Medium-term
RELATED OBJECTIVES	Bundling
PREREQUISITES FOR IMPLEMENTATION	• Willingness to cooperate
RELATED MEASURES	Operating subsidies; freight forwarding cooperation; delivery cooperation
SOURCE	(Holthaus et al. 2019)

Descriptive Profile 30: Freight Transport Panels

ACTION	FREIGHT TRANSPORT PANELS
DESCRIPTION	Freight traffic panels are informal discussion rounds between interest groups and the administration in which contentious issues concerning freight traffic can be discussed and solutions can be worked out together.
AREA OF APPLICATION	Municipality or region
RELEVANT STAKEHOLDERS	Impulse giver: city administration
	Addressee: city administration
TIME REFERENCE	Ongoing
RELATED OBJECTIVES	• Better recognition of conflict potentials • Shortening of the planning process
PREREQUISITES FOR IMPLEMENTATION	• Organisation (by administration if applicable) • Participation of as many stakeholders as possible
RELATED MEASURES	Freight transport representative; consideration of delivery infrastructure in streetscape design
EXAMPLE	Forum for City Logistics Aalborg, Aarhus und Kopenhagen
SOURCE	(Holthaus et al. 2019)

Descriptive Profile 31: Establishment of the Position of a Freight Transport Representative

ACTION	ESTABLISHMENT OF THE POSITION OF A FREIGHT TRANSPORT REPRESENTATIVE
DESCRIPTION	Central coordination point for freight transport issues within municipal transport and urban land use planning
AREA OF APPLICATION	Municipality
RELEVANT STAKEHOLDERS	Impulse giver: city administration
	Addressee: city administration
TIME REFERENCE	Ongoing; medium-term
RELATED OBJECTIVES	• Bundle specialist competences and contribute to an appropriate consideration of the interests of freight traffic in planning processes • First point of contact for businesses and citizens who can answer enquiries and concerns quickly and efficiently and, if necessary, initiate further activities on the part of the city administration
PREREQUISITES FOR IMPLEMENTATION	• Provision of funds • Clear definition of the tasks of a freight transport representative • Integration into administrative structures
RELATED MEASURES	Freight transport panels; consideration of delivery infrastructure in streetscape design
EXAMPLE	The city of Stuttgart has established the position of a freight transport officer.
SOURCE	(State capital Stuttgart 2021; Holthaus et al. 2019)

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