short study

Key Measures to reduce Road Transport Emissions in Germany

Focus on E-Mobility and emission reduction effects

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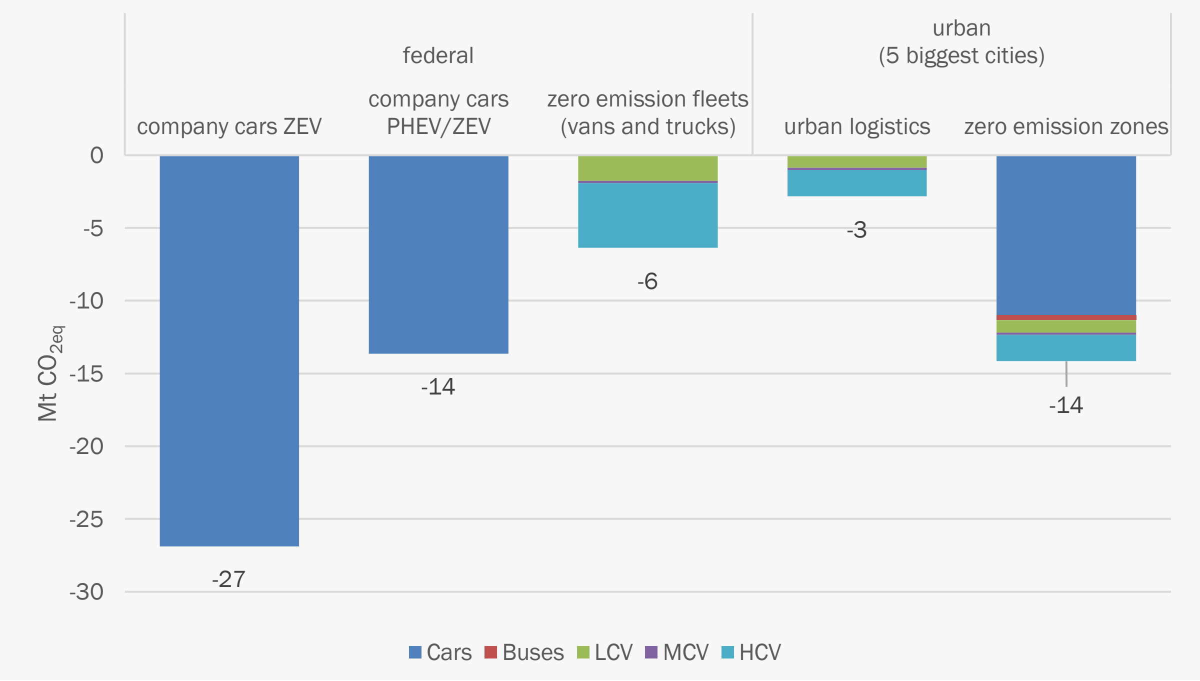
Executive Summary

This short study examines the effect on greenhouse gas (GHG) and pollutant emissions of the various measures to reduce the emissions of road transport and accelerate electromobility. Electrification is an essential lever for reducing greenhouse gas emissions in road transport. Road transport is responsible for 96% of the GHG-emissions in the transport sector. There is concern that the transport sector will be primarily responsible for failing to meet the 55% cross-sectoral reduction target by 2030[1]. According to current scenario calculations, which represent most of the political measures in place[2], the emissions of the transport sector are 30 million tonnes CO_{2eq} above the sector target of 95 million tonnes CO_{2eq} by 2030. In the light of the Judgment of the Federal Constitutional Court the climate targets are currently being tightened again. This would mean that the Transport Sector sub-target would be 85 million tonnes CO_{2eq} in 2030, meaning that the gap would not be 30 million tonnes but 40 million tonnes CO_{2eq}.

Figure 1: CO_2-Emission reductions by measure and vehicle category

2030, in Mt CO_{2eq}



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[1] The extension of the reduction target by 55% to 65% (part of the green deal) has not yet been considered in the scenario (CPP), which is the basis for this study.

[2] Political measures, which were decided on after 2020 were not considered when modelling the KSP scenario. Thus, the increased buyer's premium (innovation bonus), the hydrogen strategy, or the national implementation of the RED II are not part of the KSP scenario.

To determine the effect of the measures on emissions, the effects of the individual measures were compared against the reference scenario[3] and the emission reductions estimated.

With the measures "company cars ZEV" and the variant "company cars PHEV / ZEV", newly registered corporate cars must be locally emission-free or at least have a plug-in possibility to charge electricity from an outlet. The measure "vans and trucks" addresses commercial vehicles and foresees an increasing number of newly registered lorries to be locally emission-free. The measure "urban logistics" sets the frame for vehicles used in urban logistics in five major German cities. The measure "zero emission zones" describes the expansion of zero emission zones to the entire city area of these cities. At the urban level, the effect of locally emission-free taxis, carsharing cars, and buses in the five cities is examined. Although their direct absolute reductions are comparatively small, these measures increase the visibility of zero-emission powertrains and, thus, may have an indirect impact, but that could not be covered in this study.

Although the measures examined contain strict requirements regarding electrification, none of the measures alone is sufficient to close the target gap of 30 million tonnes CO_{2eq} by 2030.

A combination of various ambitious measures is, therefore, necessary to achieve the climate protection target in the transport sector. The measure "company cars ZEV" has the greatest GHG reduction potential. This measure alone could almost close the target gap. On the urban level the measure "zero emission zones" has the greatest impact on the GHG-emissions. Implementing zero emission zones in the five biggest cities of Germany, would reduce the GHG-emission in the transport sector by 14 million tonnes CO_{2eq} in 2030, according to the calculations of this study.

These results also show that significant emissions reductions can be achieved at both national and urban level. The greatest emission reductions can be achieved by the electrification of cars, as these also make up the largest share of emissions in the transport sector. In contrast, freight transport, especially in urban areas, plays a comparatively greater role in reducing pollutant emissions, especially particular matter.

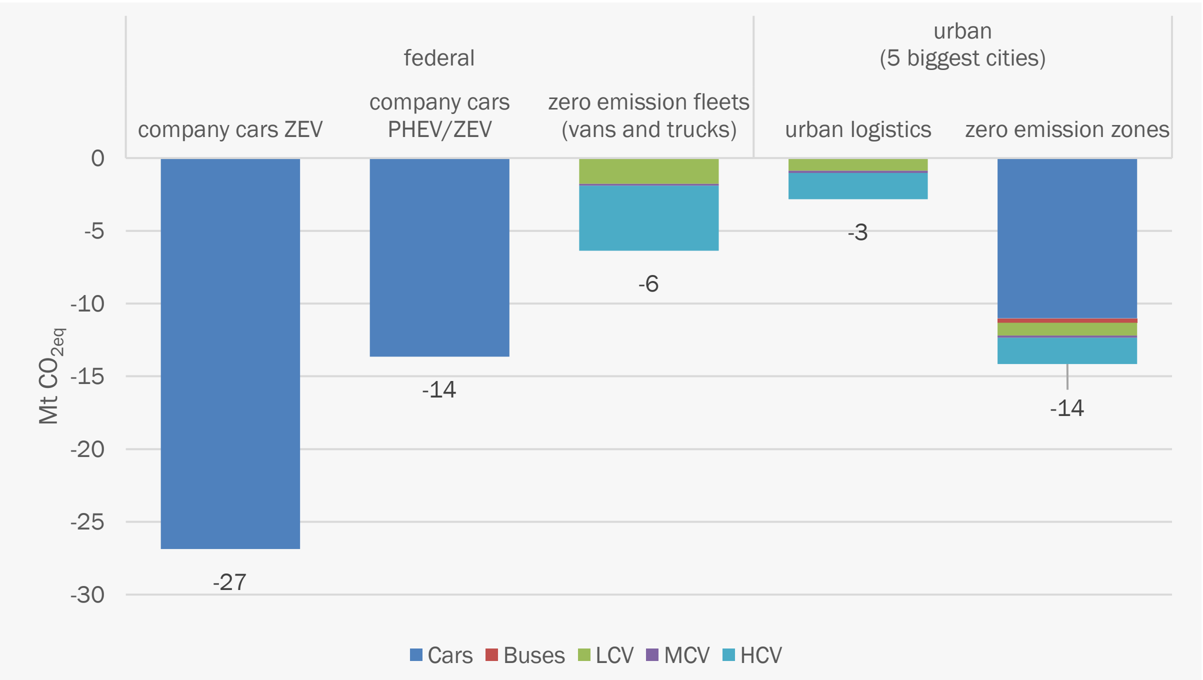
[3] The reference scenario in this study is essentially the same as the KSP scenario. It differs slightly with regards to plug-in hybrids, according to new findings.

Zusammenfassung für Entscheidungsträger

In der vorliegenden Kurzstudie „Maßnahmen zur Reduktion von THG Emissionen des Verkehrssektors und zur Beschleunigung des Hochlaufs von Elektromobilität“ wurden verschiedene Maßnahmen zur Beschleunigung des Hochlaufs der Elektromobilität in Ihrer Wirkung auf Treibhausgas- und Schadstoffemissionen untersucht. Elektrifizierung ist ein wesentlicher Hebel, um Treibhausgasemissionen im Straßenverkehr zu senken. Dieser ist für 96% der Emissionen im Verkehrssektor verantwortlich. Der Verkehrssektor läuft Gefahr, hauptverantwortlich für eine Verfehlung des sektorübergreifenden Minderungsziels von minus 40% im Jahr 2030 zu werden[4]. Gemäß dem Szenario „Klimaschutzprogramm“(KSP), welches den aktuellen Stand der Politik abbildet[5], liegen die Emissionen des Verkehrssektors im Jahr 2030 um 30 Mio. Tonnen CO_{2eq} über dem Sektorziel von 95 Mio. Tonnen. Angesichts des Urteils des Bundesverfassungsgerichts werden die Klimaziele derzeit erneut verschärft. Dies würde bedeuten, dass das Sektorziel Verkehr im Jahr 2030 85 Millionen Tonnen CO_{2eq} betragen würde. Damit würde die Lücke von 30 Millionen Tonnen auf 40 Millionen Tonnen CO_{2eq} anwachsen.

Figure 1:-Emissionsminderungen nach Maßnahme und Fahrzeugkategorie

2030, in Mio. t CO_{2eq}



Hinweis: Maßnahmen, welche die gleiche Fahrzeugkategorien betreffen sind nicht additiv. Prognos AG

[4] Die Zielverschärfung im Rahmen des Green Deals von minus 55% auf minus 65% wurde bei dem zugrundeliegenden Szenario (KSP) noch nicht berücksichtigt.

[5] Politische Maßnahmen, welche nach erst im Jahr 2020 oder später beschlossen wurden, konnten bei der Modellierung nicht berücksichtigt werden. So zum Beispiel ist der erhöhte Umweltbonus (Innovationsprämie), die Wasserstoffstrategie oder die nationale Umsetzung der RED II nicht Teil des KSP-Szenarios.

Um die Wirkung der Maßnahmen auf die Emissionen zu ermitteln wurde analysiert, welche Auswirkungen die einzelnen Maßnahmen in Abweichung zu einem Referenzszenario[6] bewirken und welche Emissionsminderungen resultieren.

Bei den Maßnahmen „company cars ZEV“ (Firmenwagen Nullemissionsfahrzeuge) und der Variante „company cars PHEV/ZEV“ (Firmenwagen Nullemissionsfahrzeuge und Plug-In-Hybride) müssen neu zugelassene Pkw lokal emissionsfrei sein bzw. zumindest die Möglichkeit haben, elektrisch geladen zu werden. Bei der Maßnahme „vans and trucks“ (Lieferwagen und Lkw) müssen Nutzfahrzeuge beim Neukauf zunehmend lokal emissionsfrei sein. Die Maßnahme „urban logistics“ schreibt für Fahrzeuge der städtischen Logistik in fünf deutschen Großstädten vor, dass nur noch lokal emissionsfreie Antriebe eingesetzt werden dürfen. Die Maßnahme „zero emission zones“ beschreibt die Ausweitung von Nullemissionszonen auf das gesamte städtische Gebiet von fünf deutschen Großstädten. Innerhalb dieser Städte wurde auch untersucht, welche Wirkung durch den Einsatz von lokal emissionsfreien Taxis, Carsharing-Autos und Bussen erreicht wird. Die direkten absoluten Minderungen fallen vergleichsweise gering aus. Andererseits kann durch diese Maßnahmen eine schnelle Sichtbarkeit von Nullemissionsantrieben erreicht und dadurch indirekt weitere Minderungen erzielt werden.

Obwohl die untersuchten Maßnahmen jeweils strenge Vorgaben bezüglich der Elektrifizierung enthalten, reicht keine der untersuchten Maßnahmen allein aus, um die Ziellücke von 30 Mio. Tonnen CO_{2eq} im Jahr 2030 vollständig zu schließen.

Eine Kombination von verschiedenen ambitionierten Maßnahmen ist folglich notwendig, um die Erreichung des Klimaschutzzieles im Sektor Verkehr sicherzustellen. Die Maßnahme „company cars ZEV“ hat die größte THG-Reduktionswirkung. Mit dieser Maßnahme allein lässt sich die Ziellücke beinahe schließen. Auf lokaler Ebene hat die Maßnahme „zero emission zones“ das größte THG-Reduktionspotenzial. Würden die fünf größten Städte Deutschlands emissionsfreie Zonen in den Innenstädten definieren, könnten im Sektor Verkehr rund 14 Mio. Tonnen CO_{2eq} reduziert werden im Jahr 2030, gemäß den Berechnungen dieser Studie.

Dieses Ergebnis zeigt auch, dass, sowohl auf nationaler als auch auf städtischer Ebene, wesentliche Emissionsminderungen erreicht werden können. Die größten Erfolge können über Maßnahmen zur Elektrifizierung von Pkw erreicht werden, da diese auch den größten Anteil an den Emissionen ausmachen. Für die Minderung von Schadstoffemissionen, insbesondere von Feinstaub spielt hingegen der Güterverkehr, insbesondere im städtischen Raum, eine vergleichsweise größere Rolle.

[6] Das Referenzszenario stimmt im Wesentlichen mit dem KSP-Szenario überein. Es weicht von diesem, bezüglich Plug-In-Hybriden, basierend auf neuen Erkenntnissen leicht ab.

1 Introduction

Seven measures which aim to accelerate e-mobility in Germany are analysed (Table 1). Three measures are applied to the federal level and five measures to the urban level.

Table 1: Overview of analysed measures

	Measure	Title	Description
federal level	M1.1.1	ZEV company cars	New registrations - rising quota for ZEV
	M1.1.2	ZEV/PHEV company cars	New registrations - rising quota for ZEV/PHEV
	M1.2	Purchase target for vans and trucks	New registrations - rising quota for ZEV
urban level	M2.1	Taxis and car-sharing vehicles	2025: new registrations must be ZEV 2030: fleet must be ZEV
	M2.2	Public transport buses	2023: new registrations must be ZEV 2027: fleet must be ZEV
	M2.3	Urban logistics	Rising quota must be ZEV
	M2.4	Zero emission zones	Introduction of zero emission zones in 5 biggest cities

Chapter 2 describes the reference scenario applied in the calculation of the emission effects and the emission estimation approach. Chapter 3 describes each measure, their calculated emission effects and methodology. Chapter 4 provides a comparative overview of the individual measures.

2 Method to Estimate the Effects of the Analysed Measures

For each measure, the difference between the analysed measure to the reference scenario are analysed for the emissions of carbon dioxide (CO_2), nitrogen oxide (NO_X), and particulate matter (PM). Chapter 2 proceeds by first describing the reference scenario. Following, chapter 2.2 describes how the emission effects were calculated for each measure. For each measure and vehicle category, the number of additionally registered zero-emission vehicles[7] (ZEV) were estimated and the reduction of the corresponding mileage and emissions deduced.

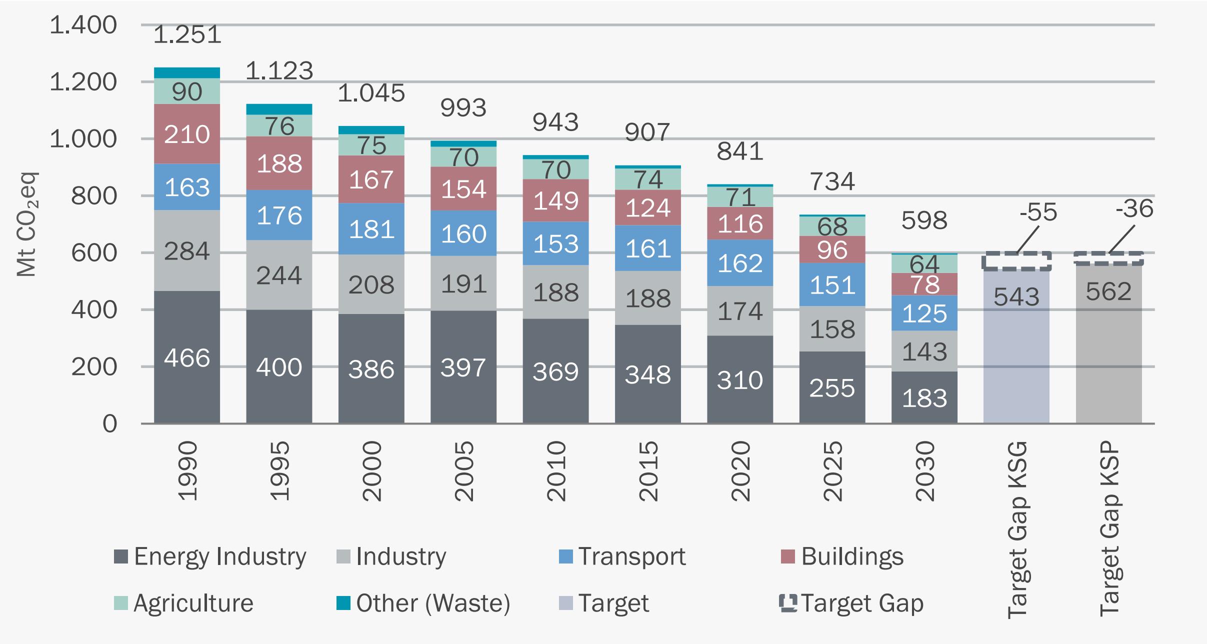
2.1 Reference Scenario

The basis of the reference scenario for this analysis is provided by the Climate Protection Program (CPP) scenario. This scenario was developed for the German Federal Ministry for Economic Affairs and Energy (BMWI) as part of the study "Energy Economic Projections and Impact Assessments 2030/2050." [Prognos, 2020]. The scenario maps the effects of the measures of the 2030 Climate Protection Program (CPP). The set of measures also include the Renewable Energy Directive II (RED II) and the CO_2-emission standards for new registered vehicles. In the CPP scenario, GHG emissions are reduced over all sectors to 598 Mt CO_2eq by 2030 (see Figure 2). The 2030 climate protection targets are not achieved. The shortfall is primarily attributed to the transport sector.

[7] ZEV: vehicles without local emissions

Figure 2: GHG-Emissions by sector (Scenario Climate Protection Program)

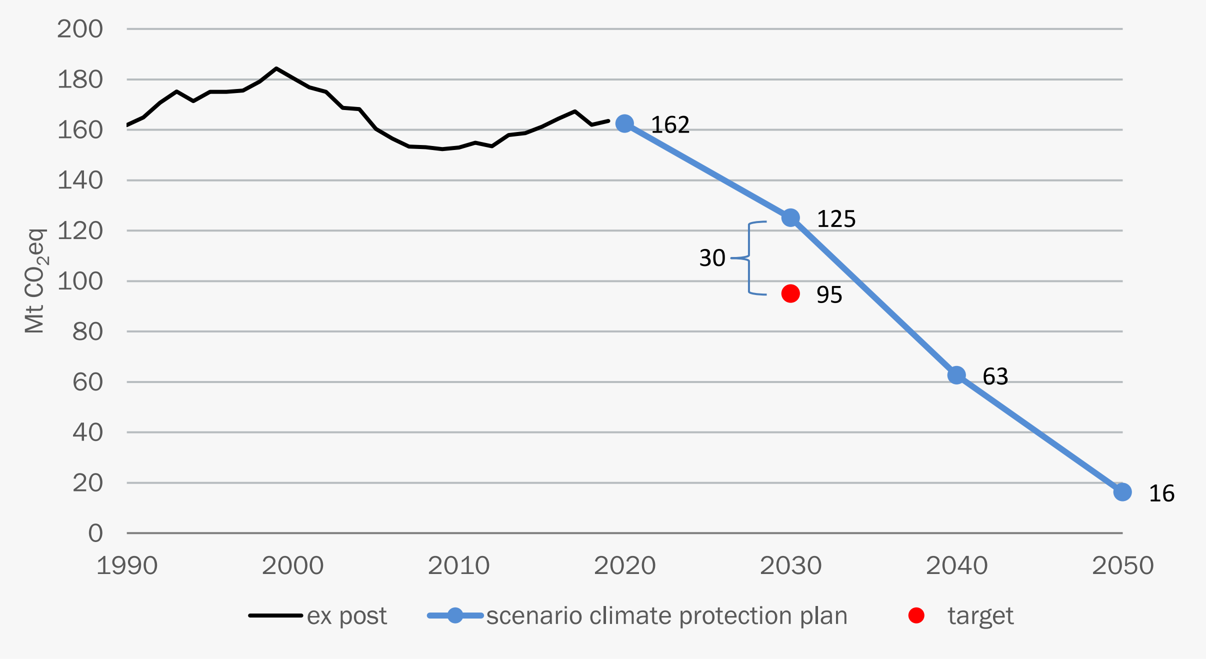
1990 - 2030, in Mt CO_2eq



Sources: [Prognos, 2021], emissions of farming and waste based on [Öko-Institut, 2020], values until 2016 based on [UBA, 2020]

The policy instruments of the 2030 Climate Protection Program would reduce emissions of the transport sector to 125 Mt CO_2eq (see Figure 3). However, a gap of 30 Mt CO_2eq to achieving the target value of 95 Mt CO_2eq would remain.

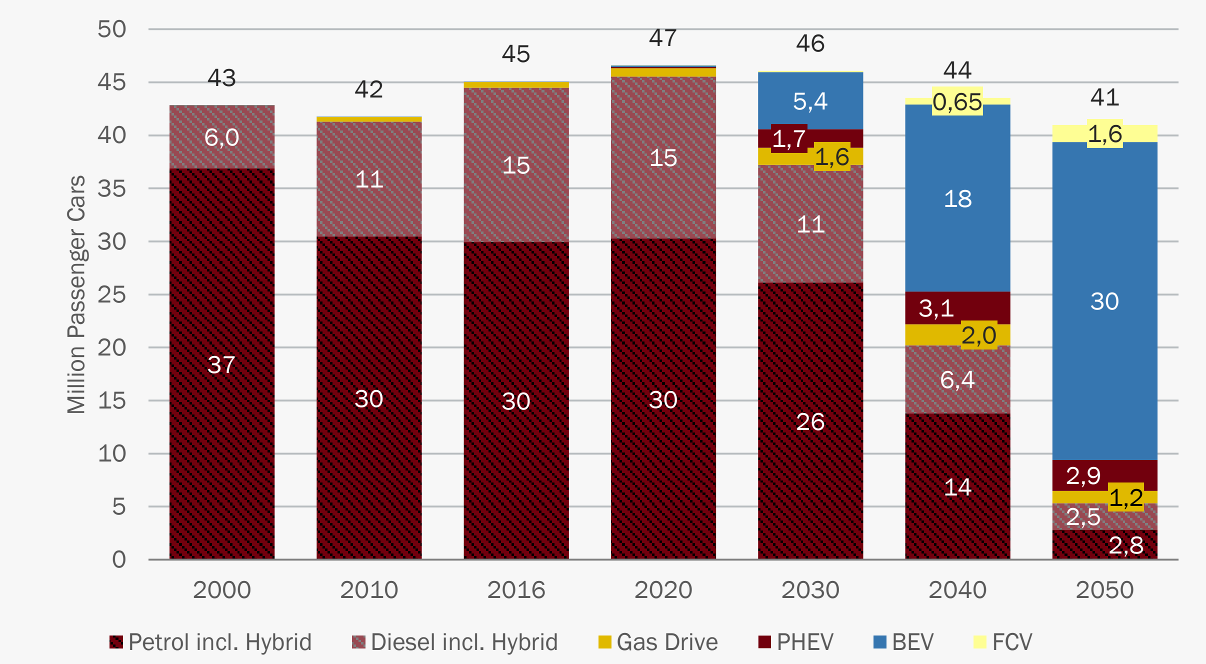
Figure 3: GHG-Emissions of the transport sector (Scenario Climate Protection Program)
1990 - 2030, in Mt CO_2eq



Sources: [Prognos, 2021], values until 2019: [UBA, 2020]

The CPP scenario describes the complete energy system covering all sectors, including conversion. For each sector, the energy consumption by energy source and the greenhouse gas emissions are modelled. For the reference scenario, all vehicle stocks, mileage, energy consumption, and CO_2 emissions by vehicle category and drive are taken from the road transport of the CPP scenario. The development of the passenger car stock by powertrain is exemplarily shown in Figure 4.

Figure 4: Passenger car stock by powertrain (Scenario Climate Protection Program)
2000 - 2050, in million cars



Sources: [Prognos 2021], values until 2016: [KBA, 2021]

Since the development of the CPP scenario, new information on the efficiency and the usage of PHEV vehicles have been published [Öko-Institut, 2020; ICCT, 2020]. The reference scenario of this study uses this information and, thus, deviates from the CPP scenario for these vehicles. Fuel consumption in charge-sustaining mode and electricity consumption in charge-depleting mode are assumed in study to be +8% compared to standard gasoline vehicle / to standard BEV. The utility factor increases from 30% in 2025 to 40% in 2035.

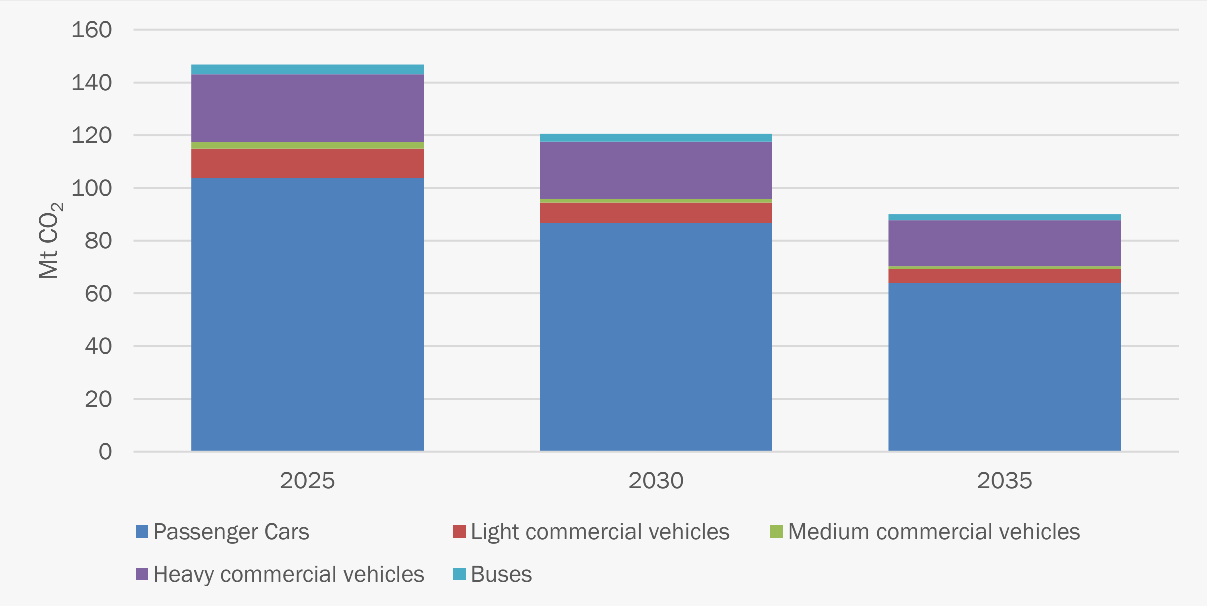
In road freight transport, the reference scenario differentiates between light commercial vehicles (LCV), medium commercial vehicles (MCV), and heavy commercial vehicles (HCV) [8]. The differentiation by lorry class differs from that used in the CPP scenario. The calculations for the more differentiated lorry classes are based on the national statistics of vehicle registrations [KBA, 2021] and information about mileage and energy consumption analysed in the project "Energieeffizienzgespreizte Lkw-Maut – Implementierung von Effizienzklassen"[9] on behalf of the Federal Ministry of Transport and Digital Infrastructure (BMVI) [Prognos, 2018].

Greenhouse gas emissions were calculated according to methodology of the emission inventory. The CO_2-emissions of the reference scenario used in this study differs slightly from the CPP scenario[10]. Figure 5 shows the CO_2 emissions of road transport in the reference scenario by vehicle type between 2025 and 2035. Overall, emissions decrease by almost 40% from 2025 to 2035,

[8] LCV are defined here as trucks <3.5 t gvm, including vans, that are not registered as passenger cars, MCV are defined as trucks >3.5 t gvm and <12 t gvm, HCV are defined as trucks >12 t gvm and truck trailers.
[9] "Energy Efficiency Spreaded Truck Toll, Implementation of Efficiency Classes"
[10] In comparison to German GHG-emissions of the transport sector excluding non-CO_2 greenhouse gases of the transport sector (1.2%), emissions of two-wheelers, tractors for farming and special vehicles (3% of road transport). Mileage, energy consumption and emissions which are mapped correspond to vehicles registered in Germany, whereas the emission inventory maps the emissions of fuel sold in Germany.

from 145 to 89 million tonnes. Passenger cars make up the largest share in the three portrayed years (about 70%). With a share of about 20%, heavy duty vehicles constitute the second largest share of the emissions in the transport sector. Emissions from light commercial vehicles and medium commercial vehicles will decrease by over 50% from 2025 to 2035, mainly due to electrification. According to the reference scenario, significant CO_2-reductions can be achieved for all vehicle types (passenger cars: -38%; heavy trucks: -32% and buses: -39%) in the period from 2025 to 2035.

Figure 5: CO_2 – Emissions by vehicle type (reference scenario)
2025-2035, in Mt CO_{2eq}



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Based on the mileage/energy consumption differentiated by drive, the NO_x and PM emissions were estimated for each vehicle category. The calculation used emission factors differentiated by year, vehicle category, and vehicle drive. Corresponding factors are based on the Handbook of Emission Factors for Road Transport (HBEFA). The HBEFA factors were converted into factors relative to energy consumption and, therefore, consider different energy efficiency developments. Regarding PM, only emissions from combustion and not from tyre abrasion were considered since the latter do not differ by powertrain. The resulting NO_x and PM emissions by vehicle category are shown for the years 2025, 2030, and 2035 in the following figures.

Figure 6: NO_X – Emissions by vehicle type (reference scenario)
2025-2035, in kt NO_X

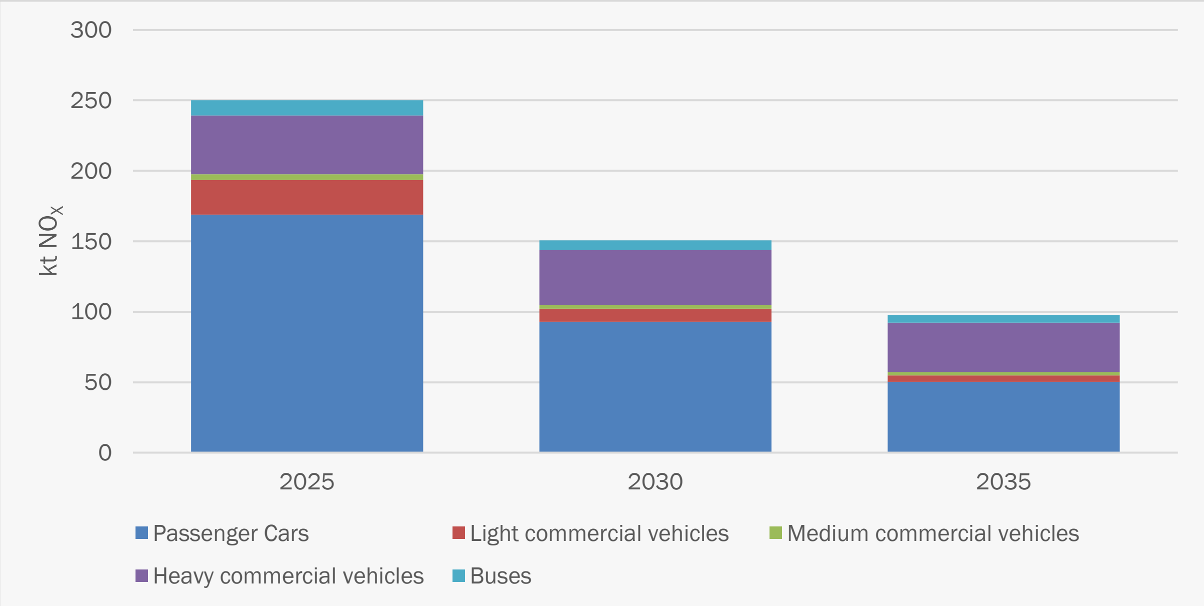

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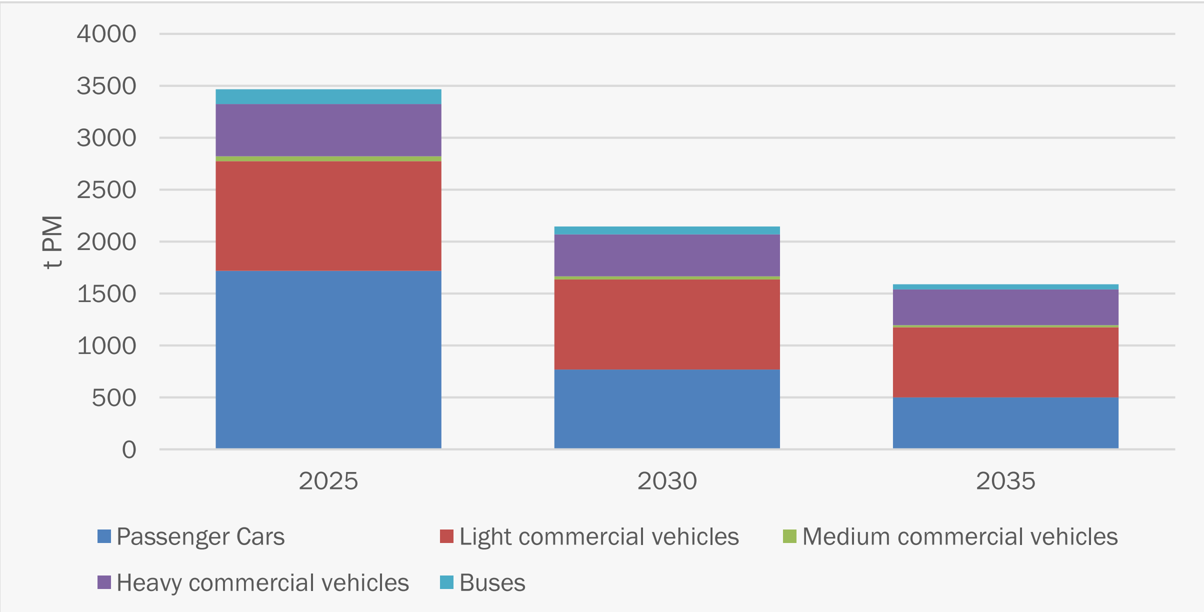
Figure 7: Particulate matter emissions by vehicle type (reference scenario)
2025-2035, in t PM



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In 2018, total NO_X emissions in Germany were 1,198 kt. With 513 kt, the transport sector constitutes the main source [UBA, 2019]. Figure 6 shows the NO_X emissions of road transport in the reference scenario, which fall from 246 kt in 2025 to 96 kt in 2030. Although NO_x emissions also fall for heavy-duty vehicles, they do not decrease as sharply as for passenger cars. Thus, the share of heavy-duty vehicles in total emissions shifts from 17% to 37%, while the share of passenger cars drops from 69% to 52%, and the share of light-duty vehicles is halved from 10% to 5% from 2025 to 2030.

In 2018, the total PM emissions in Germany were 210,000 t. Industrial processes accounted for the largest share with almost 100,000 t. This is followed directly by the transport sector with 39,000 t of particulate matter emissions including PM from non-exhaust sources (e.g., road, tyre wear), which amounts to a share of 18.5% [UBA, 2019]. Figure 7 shows the emissions of particulate matter (excluding PM from non-exhaust sources) in the reference scenario, which almost halve between 2025 and 2035 from 3,400 tonnes to 1,500 tonnes (decreases by 54%). The shares of the vehicle classes in the total emissions also change. Passenger cars' share decreases by 18% to only 31%, whereas light commercial vehicles increase their share to 42% (from 31%).

2.2 Calculation of Emission Reductions

Within the framework of this analysis, no detailed modelling of the cohort of vehicles is possible, as is usual in scenario analysis. In the cohort calculation vehicle stock and vehicle mileage are differentiated by the age and powertrain. These deviations from the reference scenario were examined to determine the effects of the analysed measures for each case with a necessary pragmatic approach given the scope of the study. In a first step, by the vehicles affected by the measures were identified. Given that only company cars are affected by the measure, but most of the cars are being privately owned, a distinction between two phases of use was necessary. In their first use period of four years the cars are considered as company cars with higher mileage per year before these vehicles change to private ownership. The average mileage per drive category was taken from the reference scenario and adjusted according to the usage profile of the vehicles concerned, as far as information was available.

To determine the effects of the individual measures, the deviations of each of the following variables from the reference scenario were examined by powertrain:

- Vehicle stock
- Mileage
- Emissions (CO_2, NO_X, PM)

The number of vehicles affected by the measure were calculated and the corresponding vehicle stock and mileage deduced. The number of ZEV in total is higher than the number of affected vehicles (by the measure). Already in the reference scenario an uptake of ZEV-vehicles is assumed. A measure addressing vehicles to be ZEV, which are already ZEV in the reference scenario, was taken into account.

In result, the effects of each measure are shown as emission reductions in comparison to the reference scenario for the emissions CO_2, NO_X, and PM for road transport in Germany differentiated by vehicle category. The reductions for the individual years 2025, 2030 and 2035, and cumulative reductions are presented in the following chapters.

3 Electrification of Vehicle Fleets on a Federal Level

On the federal level, measures were analysed that lead to an accelerated electrification of new registrations in corporate fleets. The first measure, which accelerate the electrification of company cars, is analysed in two variants (M1.1.1/1.1.2). The second measure on the federal level accelerates the electrification of corporate freight vehicles (M1.2).

3.1 Company Passenger Car Fleets

The two versions of the measure to accelerate the electrification of company cars on a federal level are:

Measure 1.1.1 "ZEV company cars"

From 2025, all new company cars belonging to the "true fleet" (25% of all new registered cars) are zero-emission, from 2030 onward all new registrations of company cars (65% of all new registered cars) are zero-emission. Linear increase of share of affected vehicles between 2025 and 2030.

Measure 1.1.2 "ZEV/PHEV company cars"

As Measure 1.1.1 - with the difference, that affected vehicles may either be zero-emission or plug-in hybrids.

As of January 2021, a total of 48.2 million passenger cars were registered in Germany. 11% of all cars were registered by commercial owners[11], 89% by private owners (see Figure 8) [KBA, 2021]. In contrast, considering the newly registered cars, commercial owners registered the largest share (63%) in 2020 [KBA, 2021]. After a usage of around four years commercial cars are resold, thus, influencing the supply of used cars in Germany. The calculation considers the effect on the emissions of the cars after being sold and operated by private owners. Commercially owned vehicles are used in various ways. Some information about the usage can be deduced from the owner category. Special usage profiles can be assumed for registrations made by rental and carsharing companies, registrations made by dealerships[12] and registrations made by manufacturer/OEM for their own use[13]. It is assumed that the commercial cars not belonging to the above-mentioned categories are mainly used in leasing and long-term rental contracts and define the term "true fleet".

During the years 2015 to 2019 an average share of 25% of newly registered cars belonged to the "true fleet" [Transport & Environment, 2020], the corresponding share of new commercial cars is 65%. Measures imposing zero-emission or PHEV powertrains to commercial cars are likely to reduce the share of cars registered as commercial cars. Employees might be more interested in a higher salary and buy their cars privately, if they are not interested in a zero emission car. In the scope of this study, these effects were not considered. The effect of the measure is calculated with

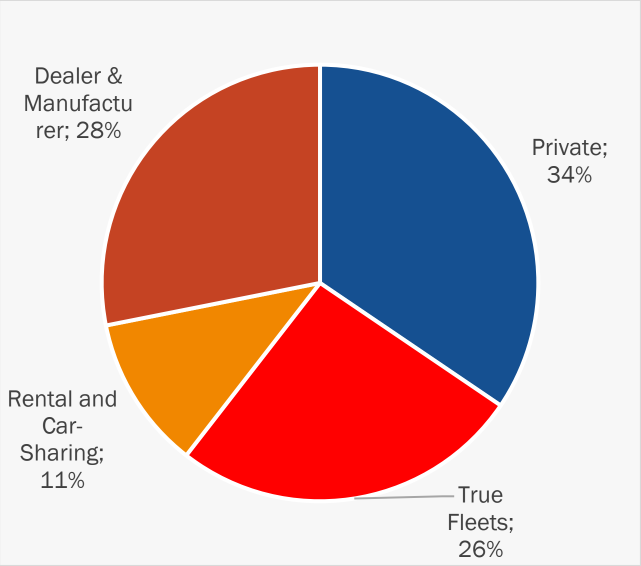
[11] here defined as non-private owners including e.g. publically procured vehicles
[12] i.e. Demo's, service loan cars, one day registrations, 0km registrations/pre-registered
[13] predominately made up of employee car schemes but also utilised for other purposes.

the assumption of a constant share of "true fleet" and commercial cars until 2035. An interpretation of the results needs to take this into account.

Figure 8: New registrations and stock of private and corporate vehicles
2020, in 1,000

Source: [KBA, 2021]

Figure 9: Share of new registration vehicles by type of registration
2019



Source: [Transport & Environment, 2020]

Whilst in the reference scenario 49% of new registrations of cars in 2030 are ZEV, the measure increases this value to 82%. The share of ZEV in the car stock increases by the measure from 12% (5.5 Million ZEV) to 28% (12.8 Million ZEV) by 2030.

The survey “Mobilität in Deutschland” shows that the average mileage of company cars is 95% higher than the average [Mobilität in Tabellen, 2017]. The calculation takes this into account, as well as the usage of the car after being used as a company car and being resold in Germany. The usage duration as a company car was assumed to be four years.

The additional electricity consumption caused by the accelerated electrification is considered and presented in the following table 2. It is assumed that all additional zero emission vehicle registrations induced by this measure are run by battery electric drives, and that in the reference scenario a share of the affected vehicles is already BEV or PHEV.

Table 2 shows the emission reductions compared to the reference scenario caused by measure M1.1.1 “ZEV company cars”: Between 2025 and 2035 the annual reductions of CO_2-emissions increase from 3 to 35 Mt compared to the reference scenario. Consequently, in 2030 the emissions from cars are 31% lower compared to the reference scenario. The cumulative CO_2-emissions between 2025 and 2035 are 256 Mt lower (-12% compared to the reference scenario). In the year 2030 the measure allows closing the gap to the emission target (30 Mt) by 90%. The cumulative NO_x-emissions between 2025 and 2035 are 261 kt lower (-24% compared to the reference scenario). The cumulative PM-emissions between 2025 and 2035 are 2.4 kt lower (-23% compared to the reference scenario). The additional electricity consumption increases to 54 TWh in 2035.

Table 2: Effects of the measure “ZEV company cars” (M1.1.1)

by years and emission type, expressed as the difference compared to the reference scenario

Type	Unit	2025	2030	2035	2025-2030	2031-2035	2025-2035
CO_2	Mt	-3	-27	-35	-91	-166	-256
NO_X	kt	-5	-29	-28	-112	-148	-261
PM	t	-55	-238	-274	-1,016	-1,362	-2,378
additional electricity consumption	TWh	5	38	54	128	246	374

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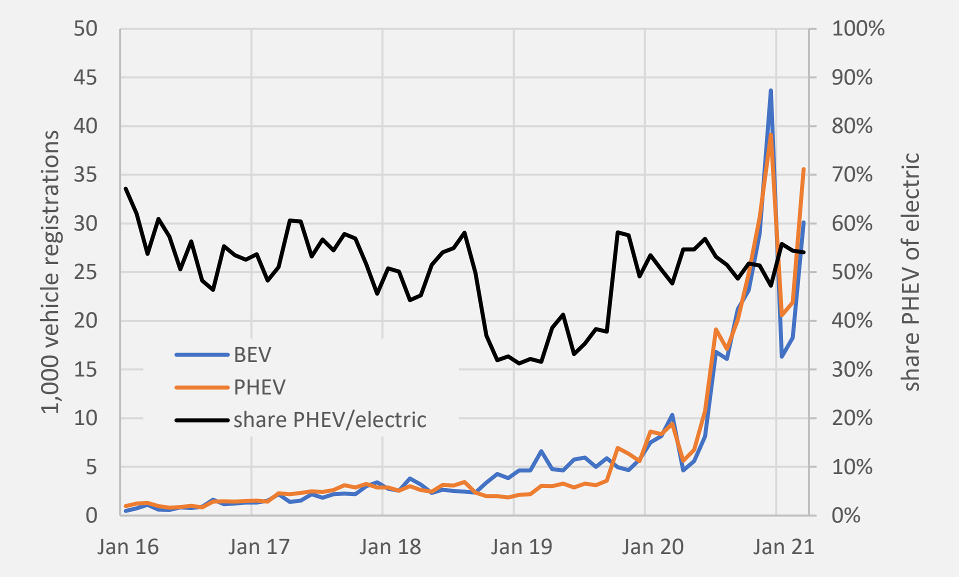
Measure 1.1.2 “ZEV/PHEV company cars” allows the affected new registered vehicles either to be ZEV or PHEV and, thus, run by electric powertrains. Whilst the share of PHEV in the total of PHEV and ZEV new registrations had been falling since 2016 with a rapid to January 2019 to around 30%, by the end of 2019 the share recovered to around 50% (see Figure 10). It is, therefore, assumed, that an equal number of PHEV and ZEV are deployed. The number of electric company cars increases to 14.3 million cars by 2030 (31%) compared to 7.1 million electric cars in the reference scenario. New studies show that the utility factor for PHEV, which states the share of milage run in electric mode differs largely depending on whether being owned by companies (18%) or private persons (43%) [Öko-Institut, 2020; ICCT, 2020]. This difference was taken into account. In the period up to 2035 an increase of the utility factors was assumed to be 24% for company cars and 57% for private cars.

Figure 10: New registrations of Battery Electric Vehicles and Plug-In-Hybrid Vehicles, Share of PHEV
monthly, January 2016 – March 2021, in 1,000 vehicles



Source: [KBA, 2021b]

Table 3 shows the emission reductions compared with the reference scenario caused by measure M1.1.2 "ZEV/PHEV company cars": Between 2025 and 2035 the annual reductions of CO_2-emissions compared to the reference scenario increases from 2 Mt to 18 Mt. By 2030 the emissions from cars are, thereby, lowered by 16% compared to the reference scenario. The cumulative CO_2-emissions between 2025 and 2035 are lowered by 130 Mt (-14% versus cars in reference scenario). The cumulative NO_x-emissions between 2025 and 2035 are lowered by 198 kt (-11% versus cars in reference scenario). The cumulative PM-emissions between 2025 and 2035 are lowered by 1.5 kt (-6% versus cars in reference scenario). The additional electricity consumption increases to 38 TWh by 2030. The CO_2 effect of measure M1.1.2 is smaller than for measure M1.1.1, due to the emissions from PHEVs running in charge sustaining mode. It is important to point out that these emission reductions have a higher uncertainty, as it depends on whether more PHEV or BEV are used and the extent PHEVs' are used in electric drive mode. Reduction results in PM and NOx emission are closer to those of M1.1.1, as PHEV are run by petrol, while PM and NOx emissions mainly originate from Diesel powertrains.

Table 3: Effects of the measure "ZEV/PHEV company cars" (M1.1.2)
by years and emission type, expressed as the difference compared to the reference scenario

Type	Unit	2025	2030	2035	2025-2030	2031-2035	2025-2035
CO_2	Mt	-2	-14	-18	-46	-84	-130
NO_X	kt	-4	-22	-19	-89	-109	-198
PM	t	-36	-155	-153	-656	-811	-1,468
additional electricity consumption	TWh	3	24	38	79	166	245

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3.2 Purchase Target for Vans and Trucks in big fleets

The following measure aims at accelerating the electrification of road freight transport on a federal level. Owners of larger fleets are mandated to hold an increasing share of zero-emission vehicles.

The measure differentiates between light commercial vehicles (LCV, trucks < 3.5t gvm), medium commercial vehicles (MCV, trucks >3.5 t but <12 t gvm), and heavy commercial vehicles (HCV, trucks >12 t gvm and tractor trailers).

Measure M1.2: "Purchase target for vans and trucks"
Share of newly registered vehicles, not belonging to small fleets (< 10 vehicles), that must be ZEV:

	2025	2027	2030	2032	2035
LCV	20%	50%	100%		
MCV	14%	35%	77%	100%	
HCV	10%	25%	63%	84%	100%

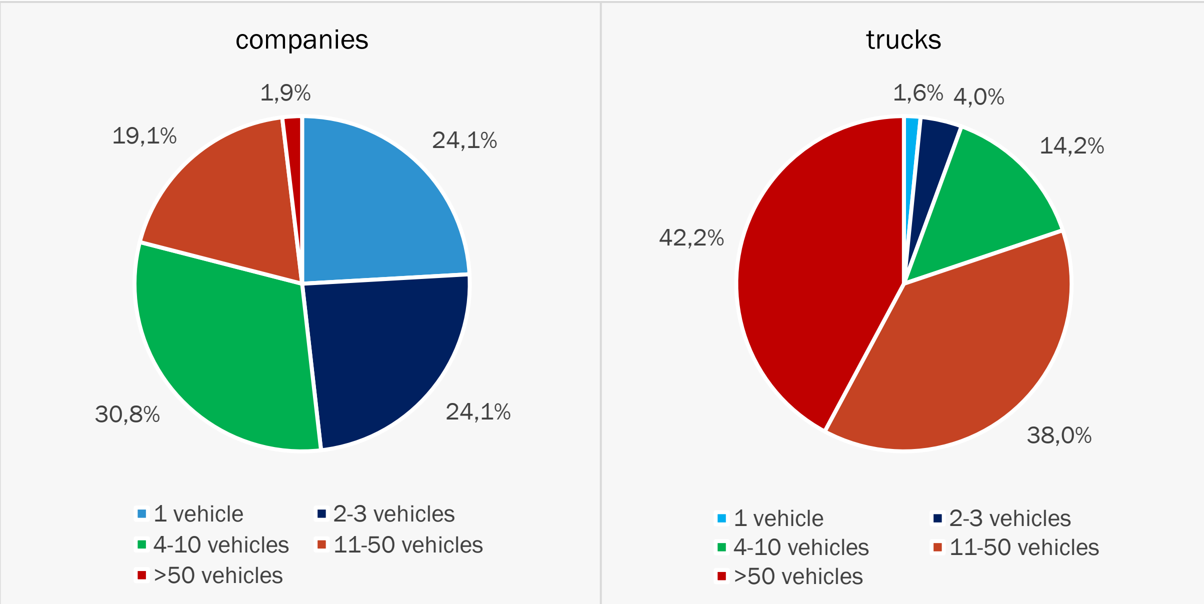
Since vehicles belonging to small fleets should be excluded from the measure, the proportion of vehicles belonging to small fleets was estimated. There is no statistical information available about the distribution of fleet size. An idea of the share of vehicles in small fleets can be obtained from the company statistic of the Federal Office for Goods Transport [BAG 2016], which provides information on how many companies have a certain number of vehicles. The vehicles include trucks >3.5 t gvm, tractor-trailers and trailers[14]. No information is provided about fleet sizes of LCV. The distribution of fleet sizes is provided in ranges. By estimating the average value of the fleet size for each category, the distribution of vehicles by fleet size can be deduced (see Figure 11 and Table 4).

Around 20% of the vehicles are owned by companies with fleets smaller or equal to 10 vehicles. For each vehicle category the share of vehicles belonging to small fleets varies. As no differentiated information is available, the further analysis assumed that for every vehicle category 20% of the vehicles belong to small fleets and are not affected by the measure. The measure might lead to reduced fleet sizes and, thereby, have a weaker effect. As the influence on fleet size is difficult to

[14] including 290,000 trailers, 209,000 trucks and 171,000 tractor- trailers

determine, the effect was not considered in the calculation. This must be considered when interpreting the results.

Figure 11: Shares of companies and trucks by number of vehicles[15]



[15] Vehicles include heavy goods vehicles and trailers with more than 3.5 t gvm; Own calculations (based on [BAG, 2016])

The share of trucks by fleet size as estimated is shown in Table 4.

Table 4: Shares of companies and vehicle by fleet size

Vehicles include heavy goods vehicles and trailers with more than 3.5 t gvm

	Total					
Fleet size (vehicles)		0-1	2-3	4-10	11-50	>50
Number of companies	45,051	10,858	10,860	13,855	8,622	856
Estimated fleet size		1	2.5	7	30	335
Vehicles by fleet size category	680,659	10,858	27,150	96,985	258,660	287,006
Share of vehicles by fleet size category		1.6%	4.0%	14%	38%	42%

Prognos AG (based on [BAG, 2016])

According to this analysis only 1,9% (see Figure 11) of the companies own a fleet with more than 50 vehicles. However, these 1,9% of companies own 40% of all heavy goods vehicles. Regarding the affected trucks, belonging to large fleets (> 10 vehicles) only 20% of the companies are affected, but 80% of the vehicles.

In addition to vehicles registered by companies in small fleets, also privately new registered vehicles belonging to a small fleet are excluded from the measure. Vehicles not being affected by the measure follow the electrification path of the reference scenario.

Table 5 shows the emission reductions compared with the reference scenario caused by measure M1.2 “Purchase target for vans and trucks”. The reduction of the CO_2-emissions by 2030 of 6 Mt corresponds to a relative reduction of 21% of the emissions of these vehicle categories (LCV, MCV and HCV). The reduction of the NOx-emissions in 2030 of 10 kt corresponds to a relative reduction of 20% of the emissions of these vehicle categories. The reduction of the PM-emissions in 2030 of 285 tonnes corresponds to a relative reduction of 22% of the emissions of these vehicle categories.

Table 5: Effects of measure “Purchase targets for vans and trucks” (M1.2)
by years and emission type, expressed as the difference compared to the reference scenario

Type	Unit	2025	2030	2035	2025-2030	2031-2035	2025-2035
CO_2	Mt	-0.3	-6	-14	-16	-58	-75
NO_X	kt	-0.5	-10	-25	-27	-100	-126
PM	t	-9	-285	-637	-691	-2,629	-3,320

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4 Electrification of Road Transport: City Level

The possible impact on emissions from four measures at the city level were analysed for five major cities in Germany: Berlin, Hamburg, Munich, Cologne and Stuttgart. The total population of the five cities is 8.8 million, which accounts for 11% of the national population. The individual measures analysed were:

- M2.1 “Taxis and Car-Sharing vehicles”: electrification of the city fleet of this segment
- M2.2 “Public Transport Buses”: electrification of the city fleet of this segment
- M2.3 “Urban Logistics”: electrification of the fleet of vehicles used for urban logistic
- M2.4 “Zero Emission Zones“: electrification induced by the introduction

Vehicle usage and efficiency depend on the local situation, geography, and infrastructure. These individual circumstances could not be considered in this study. Therefore, the estimated emission effects by the measures on city level show a higher degree of uncertainty in comparison to the analysed measures on federal level. Nonetheless, they provide an estimate on the magnitude of effect that can be achieved.

4.1 Taxis and Car-Sharing Vehicles

Measure M2.1 ”taxis and car-sharing vehicles”: All new car registrations of cars used as taxis or as part of sharing services are zero-emission from 2025.
From 2030, the entire fleet in these segments are zero-emission.

The basis for evaluating this measure is the number of vehicles used as taxis or in car-sharing in the five cities Berlin, Hamburg, Munich, Cologne, and Stuttgart (see Table 6).

Table 6: Number of vehicles used as taxis or in car-sharing by city
2019

City	Taxi	Car-Sharing
Berlin	8,138	5,814
Hamburg	3,171	2,968
Munich	3,336	3,133
Cologne	1,184	1,542
Stuttgart	686	886
Total	14,343	16,151

Sources: [Bundesverband CarSharing, 2019], [Bundesverband Taxi und Mietwagen e.V., 2020]

The average mileage per year used in the calculations for both segments is given in Table 7.

Table 7: Average annual mileage and car ownership of taxi and-carsharing vehicles

Vehicle category	Average mileage per year (km)	Average car ownership (years)
Taxi	63,000	3
Car-Sharing	21,000	2

Sources: [Erneuerbar Mobil, 2016], [Statistisches Amt für Hamburg und Schleswig-Holstein, 2017]

The effect of the measure is shown in Table 8. By electrifying taxis and car-sharing many people could have experience with zero-emission vehicles, which may have an indirect beneficial effect. Such an effect is not considered in this study, as it is hard to quantify.

Table 8: Effects of the measure "Taxi and car-sharing vehicles" (M2.1)
by years and emission type, expressed as the difference compared to the reference scenario

Type	Unit	2025	2030	2035	2025-2030	2031-2035	2025-2035
CO_2	Mt	-0.08	-0.25	-0.27	-1.1	-1.3	-2.5
NO_X	kt	-0.12	-0.27	-0.21	-1.5	-1.2	-2.6
PM	t	-1.27	-2.20	-2.08	-13.6	-10.8	-24.4

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4.2 Public Transport Buses in 5 biggest cities

Measure M2.2 "public transport buses in 5 biggest cities": All new registered public transport buses will be zero-emission from 2023. From 2027, the entire fleet of public buses will be zero-emission.

The analysis is based on the number of public buses used by the transport organisations of the cities, which was collected from the statistics of the individual organisations. In total, 3,500 buses are used by the organisations (see Table 9). This might also include buses used in the surrounding areas. For comparison, the total number of buses registered in the city areas is 7,500, including buses used for occasional services or scheduled long distance transport (remote bus).

Table 9: Number of public buses and total number of registered buses by city
Public buses several years 2019-2021; Buses: 2020

	Public Transport organizations	Registered in city area
	Public buses	Buses total
Berlin	1,500	2,400
Hamburg	1,000	2,200
Munich	400	1,600
Cologne	400	1,000
Stuttgart	300	400
Total:	**3,500**	**7,500**

Transport public buses: [BVG, 2021; Hamburger Hochbahn, 2021; MVG, 2021; KVB, 2021; SSB, 2021], Registered vehicle stock: [KBA 2021]

The analysis evaluates the effect if these 3,500 buses are fully electrified by 2027 (see Table 10). By electrifying public buses, many people could have direct experience with zero-emission vehicles, which may have an indirect beneficial effect. This effect is not included in the calculation.

Table 10: Effects of the measure "Public transport buses" (M2.2)
by years and emission type, expressed as the difference compared to the reference scenario

Type	Unit	2025	2030	2035	2025-2030	2031-2035	2025-2035
CO_2	Mt	-0.04	-0.13	-0.10	-0.7	-0.5	-1.2
NO_X	kt	-0.13	-0.30	-0.23	-1.7	-1.3	-3.0
PM	t	-1.70	-3.24	-2.19	-21	-13	-34

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4.3 Urban logistics in 5 biggest cities

Measure M2.3 "Urban logistics in 5 biggest cities":
From 2025: 50%, from 2030: 100% of the vehicles used in urban logistics are ZEV.

Urban logistics vary among cities and depend on the geographic situation in relation to other cities, the road system, and the local economy. The usage of vehicles (mileage) and efficiency (fuel consumption) depend on the individual usage and vary from the national average. In the framework of this analysis a geographic and detailed usage analysis is not possible.

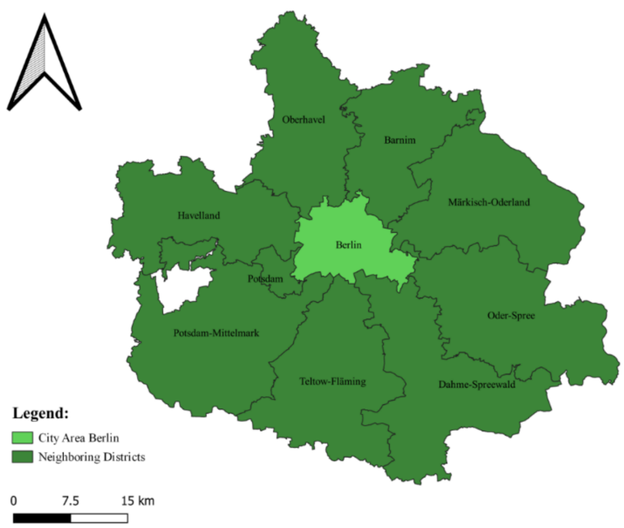
A first attempt to estimate the number of affected vehicles on the basis of a detailed analysis of the urban logistics situation in the city of Wiesbaden, carried out in another Prognos study [Prognos 2020], was rejected. Deducing the number of vehicles taking part in traffic from the daily mileage of vehicles in the city area yielded a too great uncertainty. Traffic differs strongly between cities.

The estimation of the vehicles affected by this measure relies on the registrations of vehicles by region. The inventory data of commercial vehicles of the city and the "touching" regions around the city was aggregated [KBA, 2021]. An example of the definition of the touching regions is shown for Berlin in Figure 12. Maps for the other cities are included in the annex (see Annex). All vehicles registered in the city area and 25% of the vehicles in the touching registration zones were assumed to be affected by the measure. The corresponding number of vehicles for the year 2020 are shown in Table 11. The development over time for each vehicle category was adopted from the national reference scenario.

In fact, many vehicles, which are registered in distant regions and other countries, enter the city area and would also be affected by the measure. On the other hand, the measure will also induce leakage effects: Distribution centres outside the city area will be reached by long-distance trucks, and distribution from there will be performed by a much smaller number of ZEV. Given that the long-distance transport is responsible for the highest share of energy consumption, the CO_2-emissions will be less affected.

The calculation differentiated between light commercial vehicles (LCV, trucks < 3.5 t gvm), medium commercial vehicles (MCV, trucks >3.5 t but <12 t gvm), and heavy commercial vehicles (HCV, trucks >12 t gvm and tractor trailers). The number of vehicles registered in the city areas and the touching regions is shown in Table 11. The number of affected vehicles by the measure for each vehicle category is shown in Table 12.

Figure 12: Berlin central and touching regions of vehicle registration



Map basis: GeoBasis-DE / BKG 2020; Own editing by Prognos

Table 11: Vehicle registrations of commercial vehicles in five cities and touching regions
2020, registrations per city and touching regions, in 1,000 vehicles

	LCV	MCV	HCV
Berlin	91	10	10
Hamburg	54	5.5	6.5
Munich	35	3.3	2.7
Cologne	27	3.1	3.4
Stuttgart	14	1.6	1.9
5 cities	221	24	25
touching regions of the 5 cities	279	35	42
5 cities + 25% touching regions	291	32	35
Total (on the national level)	2,744	304	447

The measure assumes that the share of the vehicles being affected by the measure that are ZEV develops linear from 50% in 2025 to 100% from 2030 onwards. The resulting number of affected vehicles is shown in Table 12.

Table 12: Number of vehicles affected by measure by vehicle category
in 1,000 vehicles

	2025	2030	2035
Light commercial vehicles	299	299	306
Medium commercial vehicles	30	25	23
Heavy commercial vehicles	36	36	36

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Table 13 shows the emission reductions versus the reference scenario caused by measure M2.3 “urban logistics”.

Table 13: Effects of the measure “Urban logistics in 5 biggest cities” (M2.3)
by years and emission type, expressed as the difference compared to the reference scenario

Type	Unit	2025	2030	2035	2025-2030	2031-2035	2025-2035
CO_2	Mt	-1.8	-2.8	-2.1	-14	-12	-26
NO_X	kt	-3.3	-4.5	-3.7	-24	-20	-44
PM	t	-83	-134	-107	-667	-591	-1,258

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4.4 Zero Emission Zones in 5 biggest cities

Measure M2.4 "Zero emission zones in 5 biggest cities": Zero Emission Zones are introduced from 2025 and gradually enlarged to the whole city area until 2030. These will apply in 2025 to

- 10% of cars and LCV
- 15% of buses
- 5% of MCV and HCV
  entering the city area.

from 2030 to all vehicles entering the city area, with linear increase between 2025 and 2030.

The effect of introducing zero emission zones depends strongly on the local conditions, the size of the zone, and the interaction with other transport modes. In the framework of this study a detailed analysis of the local conditions was not possible. For an estimate of the effect of zero-emission zones in five major cities, firstly, the number of affected vehicles was estimated, and, secondly, emission change was analysed, as if these vehicles would be used like the national average vehicle in terms of fuel consumption and mileage per year.

The vehicle categories that were examined for their impact were passenger cars, buses, light commercial vehicles (LCV), medium commercial vehicles (MCV), and heavy commercial vehicles (HCV). The estimation of the number of affected vehicles was performed similar to the measure "Urban logistics" (M2.3). The basis was also the number of vehicles registered in the city area and the touching regions (see Table 14, for Commercial vehicles see Table 11). In addition, information on the in-commuters in the five cities was used.

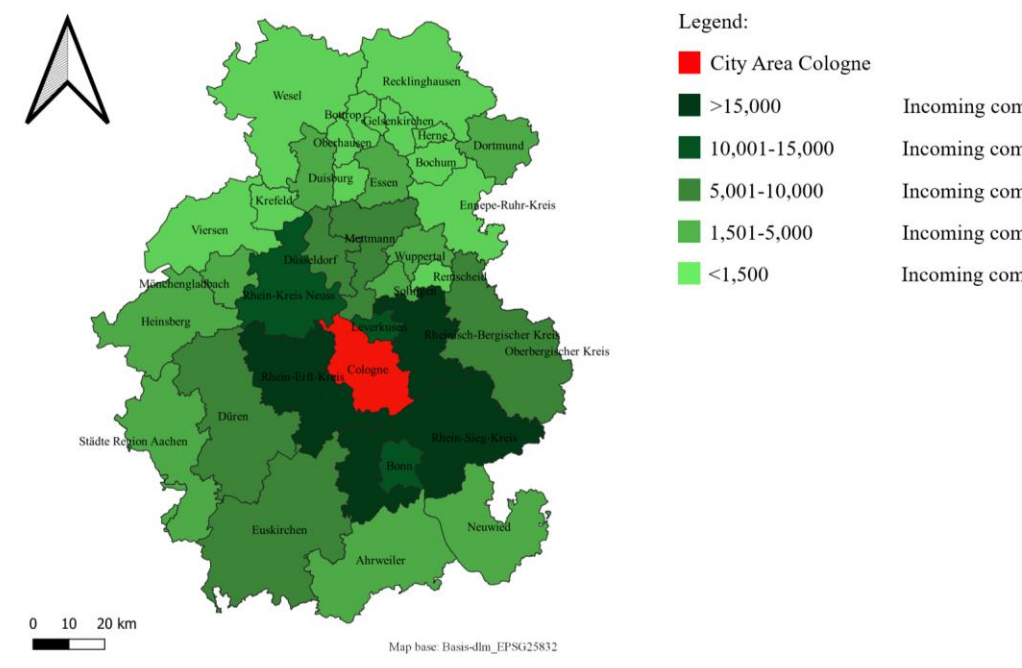
Table 14: Vehicle registrations of cars and buses in five cities and touching regions and in-commuters
2020, in 1,000

	Cars	Buses	In-commuters (all means of transport)
Berlin	1,221	2.4	333
Hamburg	804	2.2	356
Munich	740	1.6	411
Cologne	491	1.0	283
Stuttgart	307	0.4	256
5 cities	**3,564**	**7.5**	**1,640**
5 cities touching regions	5,003	6.1	
5 cities + 25% touching regions	**4,815**	**9.0**	
Total (on the national level	47,716	81	

Sources: [KBA, 2021], [BA, 2021]

In 2019, a total of 1.6 million people were commuting to the five cities, by all means of transport (see Table 14). In the national average, 67.7% commute by car [Destatis, 2016]. An estimated 1.1 million cars of commuters would be influenced by zero emission zones in the five cities. Figure 13 illustrates for the city of Cologne the number of commuters from the surrounding areas. This shows that not only touching regions, but also further distant regions are interdependent with the city area. In addition to the registered cars in the cities (3.6 million) and the commuters, this study conservatively assumes an additional 25% of the registered cars of the touching areas (1.3 million) to be affected by the zero emission zones.

Figure 13: Incoming commuter traffic in Cologne
2020



Source: [BA, 2021]

The share of vehicles entering the city area, which are being affected by the growing zero emission zones, is applied to derive the number of vehicles affected by the measure and, thus, being changed to zero emission (see Table 15). The decline in the number of affected passenger cars is due to the decline in the number of passenger cars on a federal level in the reference scenario.

Table 15: Number of vehicles affected by measure by vehicle category
2025, 2030, 2035, in 1,000 vehicles

Affected vehicles	2025	2030	2035
Passenger cars	595	5,837	5,682
Buses	1.4	9.5	9.8
Light commercial vehicles	15	299	306
Medium commercial vehicles	0.8	25	23
Heavy commercial vehicles	0.9	36	36

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Table 16 shows the emission reductions caused by measure M2.4 “zero emission zones” compared with that of the reference scenario.

Table 16: Effects of the measures for “zero emission zones” (M2.4)
by years and emission type, expressed as the difference compared to the reference scenario

Type	Unit	2025	2030	2035	2025-2030	2031-2035	2025-2035
CO_2	Mt	-1.5	-14.2	-10.5	-48	-60	-108
NO_X	kt	-2.6	-17.1	-10.6	-65	-65	-130
PM	t	-31	-240	-176	-869	-1,007	-1,876

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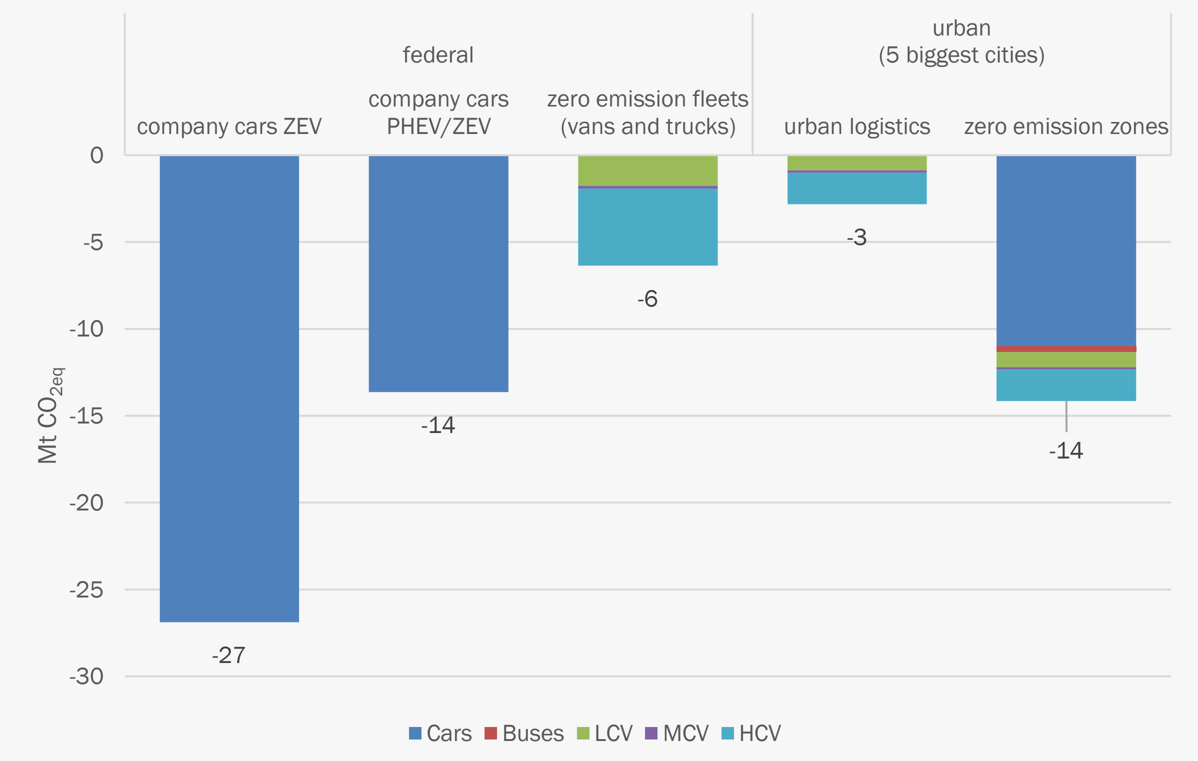
5 Comparison of the Measures by Emission Reductions

Figure 14 shows the effects on CO_2- emissions in the year 2030 by vehicle category for five of the analysed measures.

Figure 14: CO_2 -Emission reductions by measure and vehicle category
2030, in Mt CO_{2eq}



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The effects of the individual measures on the same vehicle category overlap and cannot be summed. The emission reductions of the measures “company cars ZEV” with an estimated impact of 27 Mt CO_2 is in the order of magnitude of the target gap of 30 Mt CO_2. The measures “company cars ZEV” and “vans and trucks” on the federal level affect different vehicle categories and can, therefore, be summed. Together they would have a major reduction effect on the GHG-Emission in the transport sector. The variant company cars “PHEV/ZEV” (-14 Mt CO_2) has a much weaker effect than “company cars ZEV”, as Plug-in-hybrids still have emissions and are to a large extend used in charging mode. Also, the certainty of the emission reduction is much lower, as the share of PHEV and the usage of the cars are difficult to anticipate. The measure “vans and trucks” also leads to a relevant reduction in CO_2-emissions (-6.4 Mt CO_2). The fact that it only applies to vehicles registered in Germany may lead to leakage effects and provide an advantage to vehicles registered in other countries. Heavy trucks in the long distant distribution account for the highest share of emissions of these vehicle categories. Technologically electrification of these vehicles is more difficult due to their high mass.

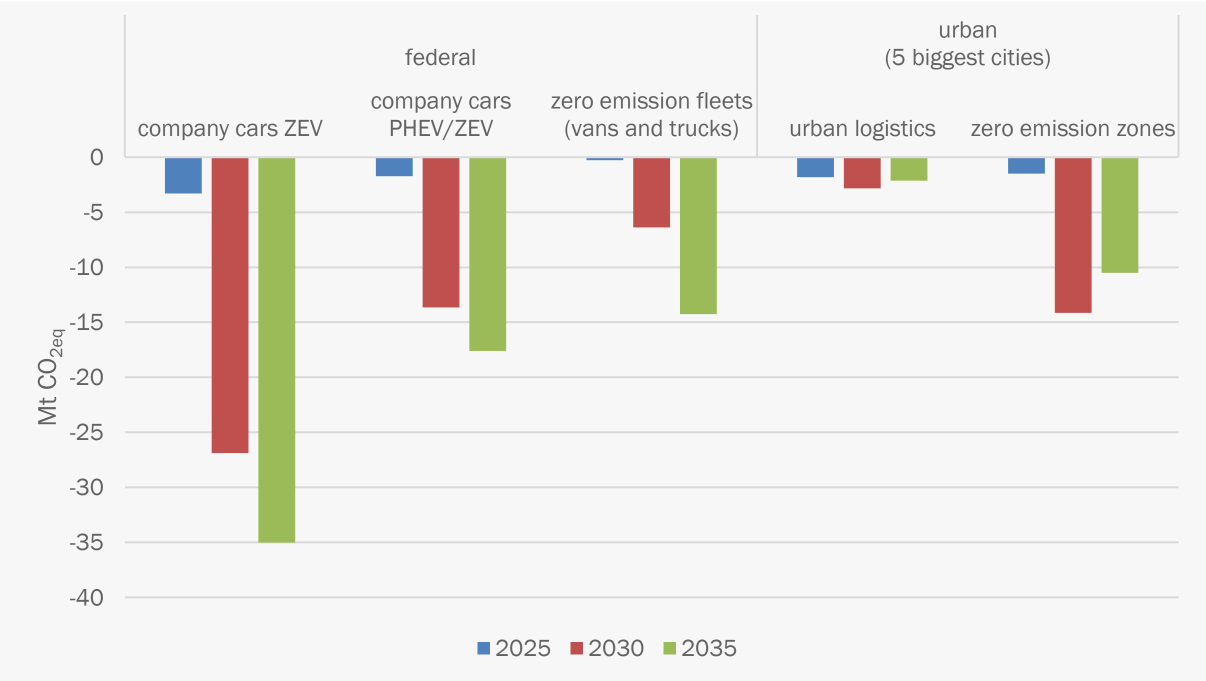
The measure “urban logistics in five biggest cities” also leads to measurable CO_2-emission reductions (- 2.8 Mt CO_2). The result of the calculation has a relatively high uncertainty, as the effect strongly depends on the local distribution infrastructure. Distribution centres outside of the cities will probably reduce the effect on long distant transport. On the other hand, more vehicles wanting to enter the cities may be affected but are registered outside of the city area. The measure “zero emission zones in five biggest cities” has the highest single effect on the urban level (-14.2 Mt CO_2).

The calculations of measures on the urban level have a relatively high uncertainty. Detailed analysis of the individual local situations is necessary to achieve a better certainty on the emission effects of these measures.

The development of the CO_2-emission reductions of the individual measures is shown in Figure 15 for the years 2025, 2030 and 2035. The effect of the measure increases due to a growing number of vehicles being affected by the ZEV measure over time. At the same time the emissions in the reference scenario decreases. In turn, this decreases the measure’s effect in terms of the difference compared to the reference scenario.

Figure 15: CO_2 -Emission reduction by measure

by years; in Mt CO_2; expressed as the difference compared to the reference scenario



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The effects on NO_x-emissions are shown in Figure 16 by vehicle category and in Figure 17 over time for five of the analysed measures. The reduction effects by 2030 reach from -5 kt NOx (“urban logistics”) to -29 kt NOx (“company cars ZEV”). This compares to a total of 150 kt NOx in the road transport of the reference scenario in the year 2030. Commercial vehicles, which are driven mainly by diesel engines have a higher share of these emissions in comparison to their share of CO_2-emissions. Measures on these vehicles have, thus, a comparably higher influence on the NOx-emissions. The effect on the NOx-emissions of the measure "company cars PHEV/ZEV" in comparison to "company cars ZEV" is closer than for CO_2-emissions, as PHEV are mainly driven by petrol and the use of diesel engines is reduced in the same way for both measures. The effects on PM-emissions are shown in Figure 19 by vehicle category and in in Figure 20 over time for five of the analysed measures. Main source of PM-emissions is LCV. Thus, the measure "vans and trucks" has the highest effect (-285 t PM). This compares to a total of 2,150 tonnes PM in 2030 in the reference scenario.

Figure 16: NO_X -Emission reductions by measure and vehicle category
2030, in kt NO_X

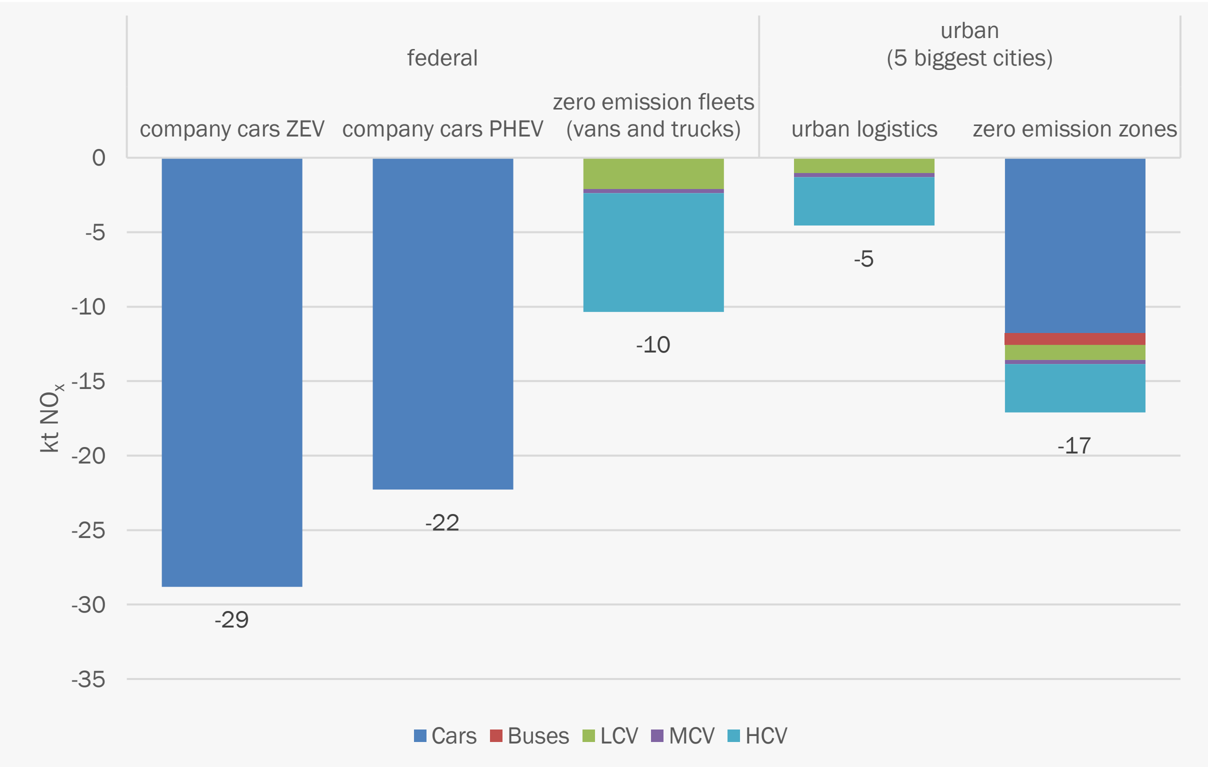

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Figure 17: NO_X -Emission reduction by measure

2025, 2030, 2035; in kt NO_X

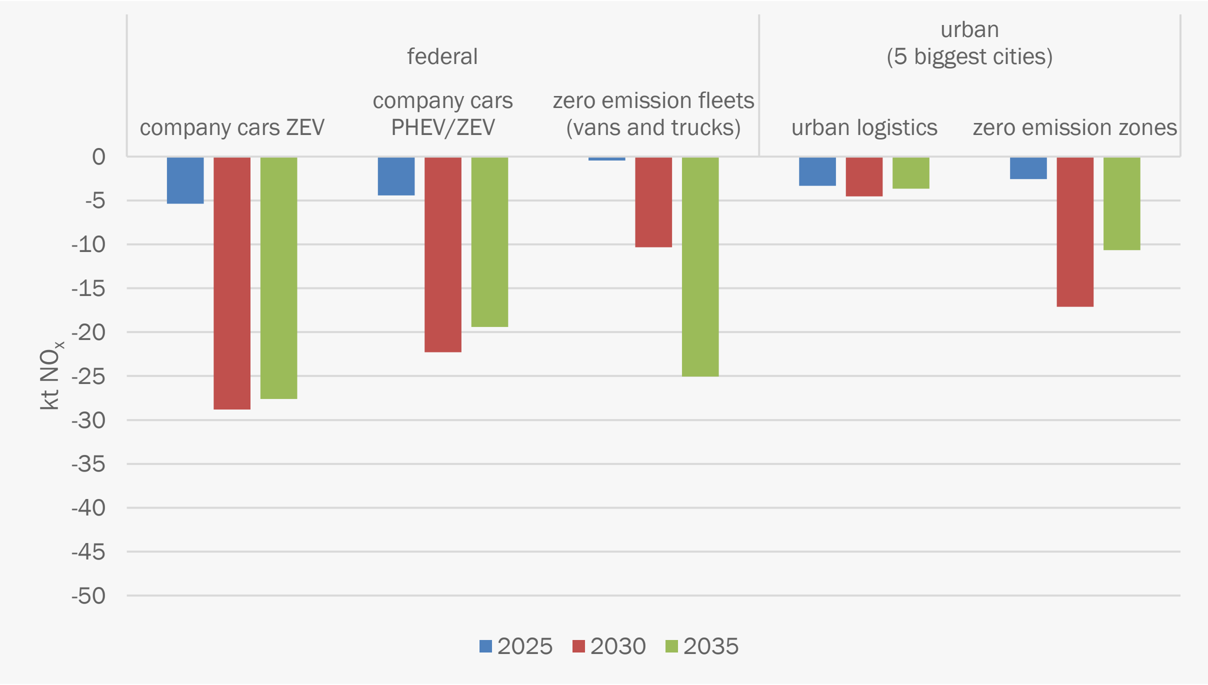

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Figure 18: Particulate matter emission reductions by measure and vehicle category

2030, in in t PM

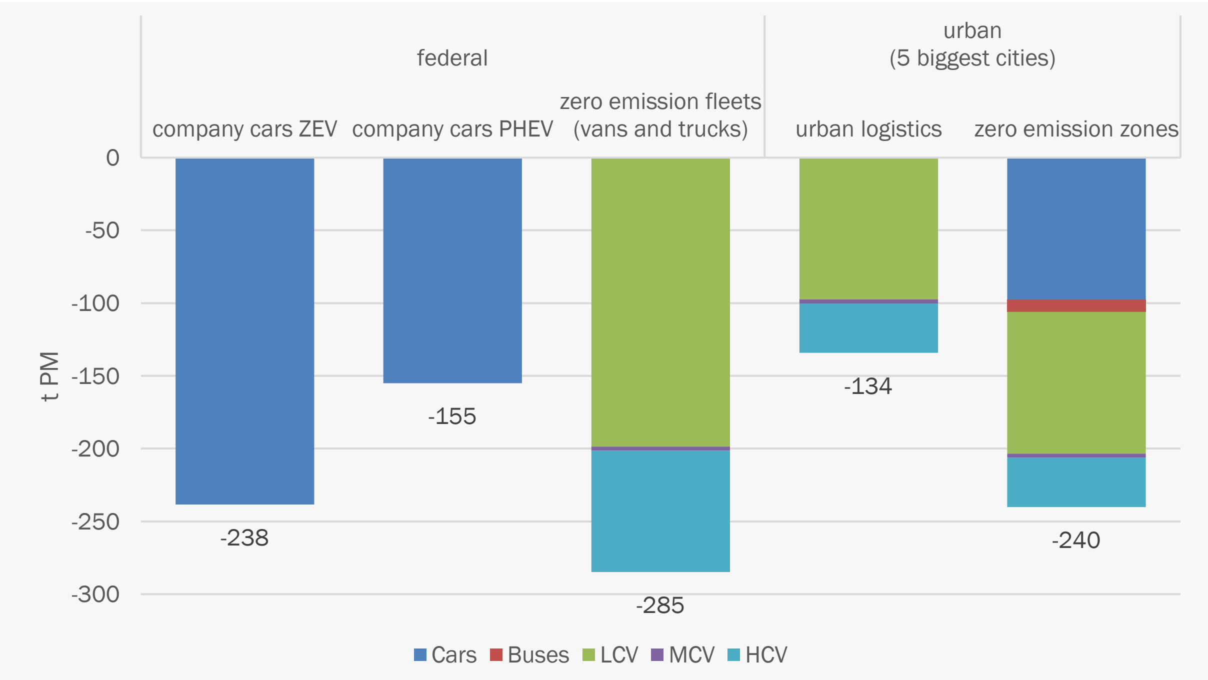

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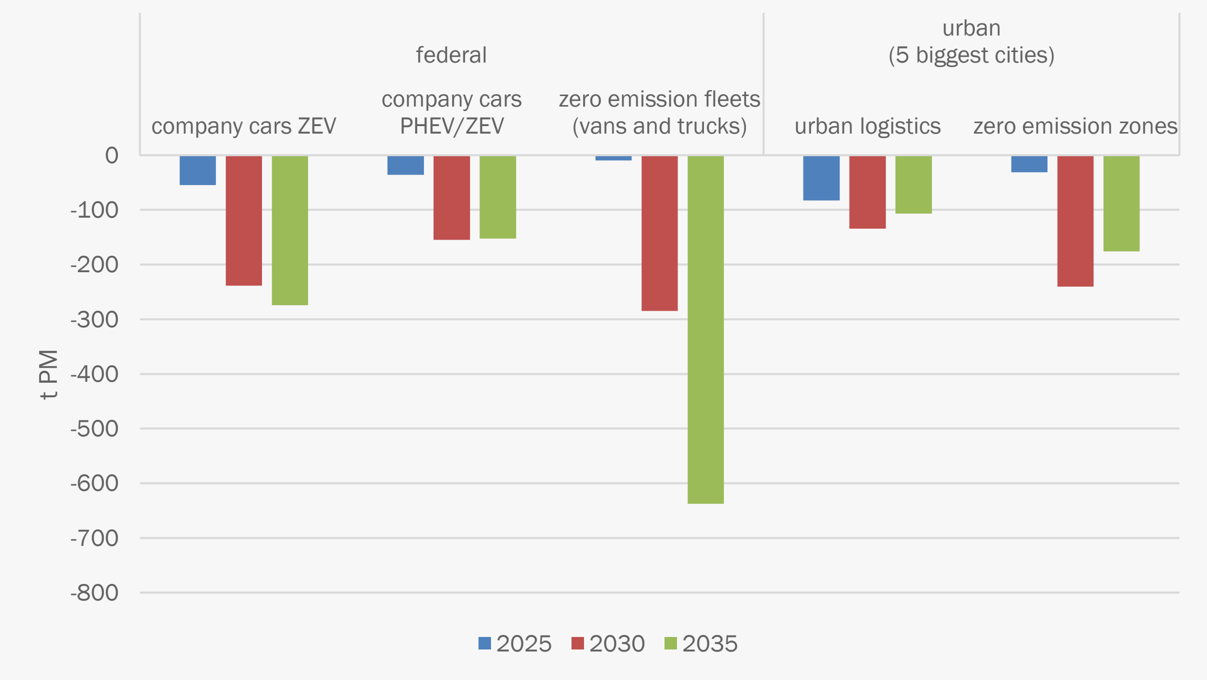
Figure 19: Particulate matter emission reduction for each measure
2025, 2030, 2035; in t PM



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Annex A: Emission Tables, Reference Scenario

Table 17: CO_2-Emissions in the reference scenario, by vehicle type
2025, 2030, 2035, 2025-2030, 2031-2035, 2025-2035, in Mt CO_2

Type	2025	2030	2035	2025-2030	2031-2035	2025-2035
Passenger Cars	104	87	64	574	365	939
Light commercial Vehicles	11	8	5	56	31	87
Medium commercial vehicles	2	2	1	12	6	18
Heavy commercial vehicles	26	22	17	143	96	239
Buses	2	2	2	13	9	22
All	**146**	**120**	**89**	**798**	**507**	**1,305**

Table 18: NO_X-Emissions in the reference scenario, by vehicle type
2025, 2030, 2035, 2025-2030, 2031-2035, 2025-2035, in kt NO_X

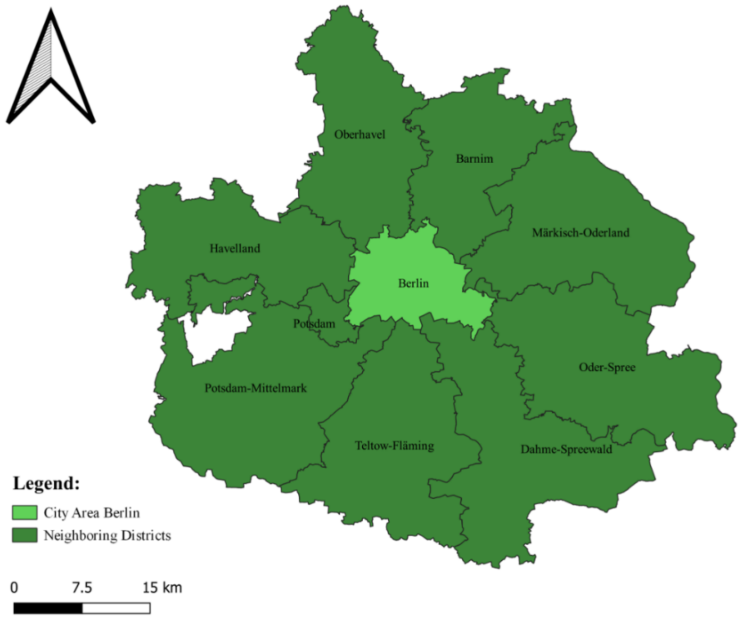
Type	2025	2030	2035	2025-2030	2031-2035	2025-2035
Passenger Cars	169	93	50	776	331	1,107
Light commercial vehicles	25	9	4	98	31	129
Medium commercial vehicles	4	3	2	20	12	32
Heavy commercial vehicles	42	39	35	243	184	428
Buses	7	5	4	35	20	55
All	**246**	**148**	**96**	**1,173**	**579**	**1,752**

Table 19: PM-Emissions in the reference scenario, by vehicle type
2025, 2030, 2035, 2025-2030, 2031-2035, 2025-2035, in t PM

Type	2025	2030	2035	2025-2030	2031-2035	2025-2035
Passenger Cars	1,719	769	501	7,353	3,013	10,365
Light commercial vehicles	1,056	868	675	5,816	3,786	9,602
Medium commercial vehicles	47	28	21	223	119	342
Heavy commercial vehicles	502	406	344	2,732	1,849	4,581
Buses	94	50	35	428	205	633
All	**3,419**	**2,122**	**1,575**	**16,552**	**8,972**	**25,524**

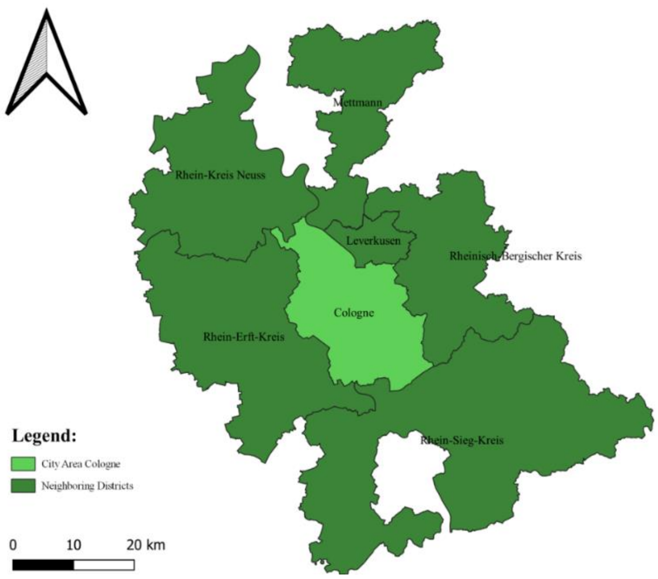
Annex B: Maps of Cities and touching Regions

Figure 20: Berlin and neighbouring districts



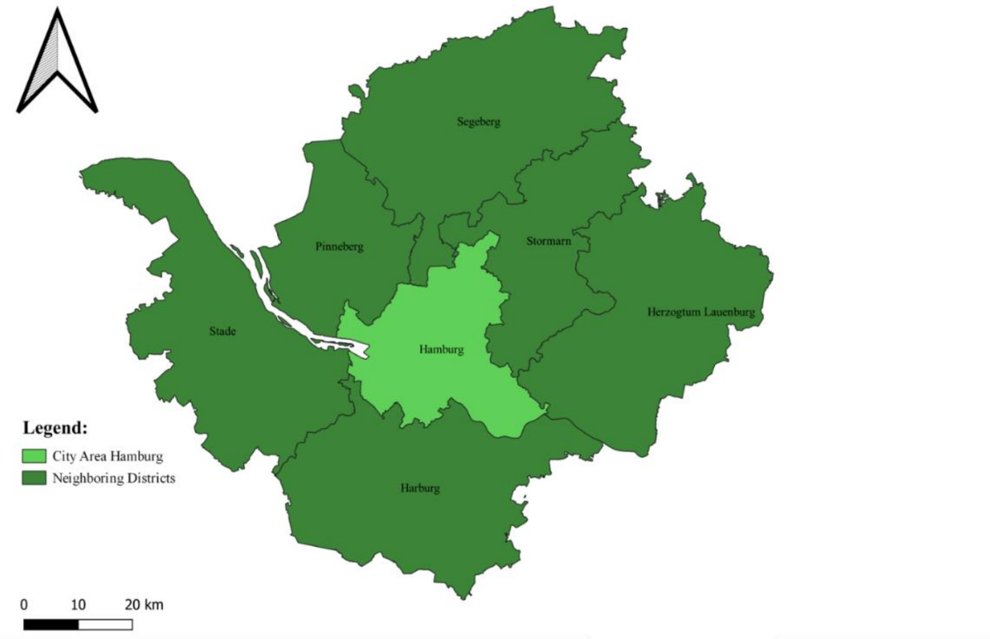
Map basis: GeoBasis-DE / BKG 2020; Own editing by Prognos

Figure 21: Cologne and neighbouring districts



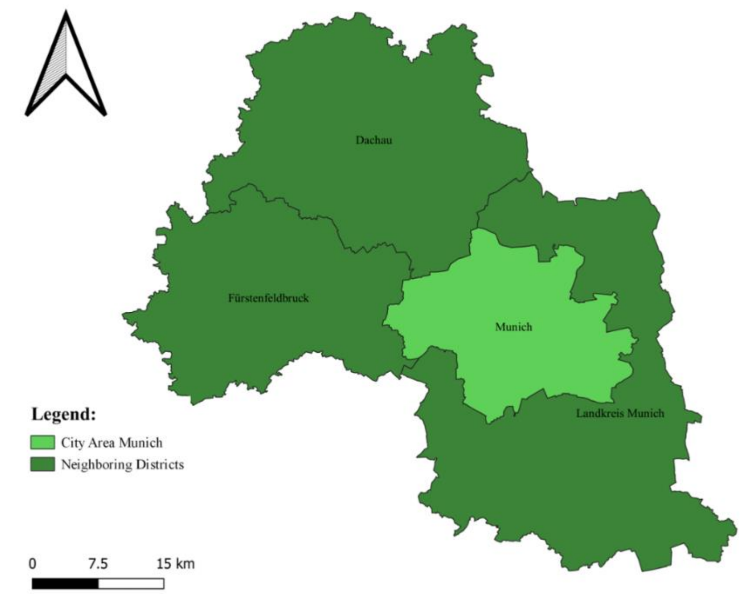
Map basis: GeoBasis-DE / BKG 2020; Own editing by Prognos

Figure 22: Hamburg and neighbouring districts



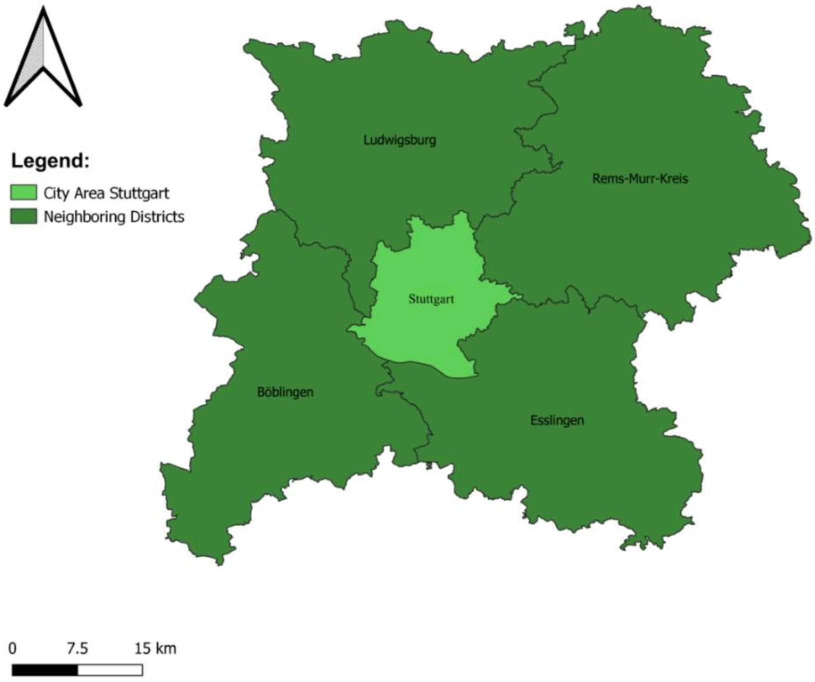
Map basis: GeoBasis-DE / BKG 2020; Own editing by Prognos

Figure 23: Munich and neighbouring districts



Map basis: GeoBasis-DE / BKG 2020; Own editing by Prognos

Figure 24: Stuttgart and neighbouring districts



Map basis: GeoBasis-DE / BKG 2020; Own editing by Prognos

Glossary

BEV	Battery Electric Vehicle
CO_2	Carbon Dioxide
CO_2eq	CO_2-equivalents: measure to quantify greenhouse gas emissions of different gases, mass of CO_2 having a comparable effect on the climate.
FCV	Fuel Cell Vehicle
Gas Drive	Drives run by: liquified pressured gas (LPG), compressed natural gas (CNG) or liquified natural gas (LNG) without hydrogen (H_2)
gvm	Gross vehicle mass
HCV	Heavy commercial vehicles >12t gvm and truck trailers
kt	Kilotonnes, 1,000 t
LCV	Light commercial vehicles <3.5 t gvm, including vans, that are not registered as passenger cars
MCV	Medium commercial vehicles > 3.5t <= 12 t gvm
Mt	Megatonnes, 1,000,000 t
ZEV	Zero emission vehicles: drive without local emissions: FCV, BEV
NO_X	Nitrogen oxide
PM	Particulate matter of size below 10 μm, i.e. equivalent to PM_{10}

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Key Measures to reduce Road Transport Emissions in Germany

Focus on E-Mobility and emission reduction effects

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