



# Charge, Set, Go!

Electrifying Urban Transport in Germany and Poland

STUDY



# Imprint

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Electrifying Urban Transport in Germany and Poland  
**Study**

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The study was prepared as part of the Int-E-Grid Polish-German project implemented by Forum Energii together with the Electric Vehicles Promotion Foundation and Agora Verkehrswende. Details on the project can be found at [www.int-e-grid.eu](http://www.int-e-grid.eu). The project is supported by the European Climate Initiative (EUKI). The overarching goal of EUKI is to foster climate cooperation within the European Union to reduce greenhouse gas emissions. EUKI is an instrument to finance projects by the German Environment Ministry (Bundesministerium für Umwelt, Naturschutz und nukleare Sicherheit, BMUB). EUKI is supported by the German International Cooperation Society (Deutsche Gesellschaft für Internationale Zusammenarbeit, GIZ). The opinions contained in this publication are solely those of the authors.

Supported by:



Federal Ministry  
for the Environment, Nature Conservation  
and Nuclear Safety



European  
Climate Initiative  
EUKI

based on a decision of the German Bundestag

Version 1.0, December 2021

**71-2021-EN**

**Please quote as:**

Agora Verkehrswende (2021): *Charge, Set, Go!*  
*Electrifying Urban Transport in Germany and Poland.*

# Preface

Dear readers,

when more than 40 countries signed the Katowice Partnership for E-Mobility at the 24th session of the Conference of the Parties (COP 24) in Katowice in 2018, it set a milestone for a global approach for the electrification of mobility and the decarbonisation of the transport sector. For Poland and Germany, as the sixth-largest and largest passenger car markets in Europe by sales, it was yet another confirmation of a lived reality. Dedicated friendship and strong long lasting economic cooperation are characteristic for the relationship of both countries and the motto of the framework, Driving Change Together, reflects their joint ambition for the electrification of the transport sector.

In this very sense, both countries set out to expanding their cooperation in the field of electromobility through the Int-E-Grid project, funded under the European Climate Initiative, to building a comprehensive Polish-German Platform on Electromobility, explore and share experiences and to develop policy recommendations for both local and national authorities. A cooperation which makes a lot of sense and can built on a lot of trust and friendship, essential to fulfil the ambition of the Katowice Partnership. And a cooperation which is in line with EU's approach to achieving the climate neutrality aimed for in the European Green Deal by 2050.

Only in July 2021, the European Commission published the long-awaited so-called Fit-for-55 package of legislative proposals on climate policy – referring to the target of a 55 percent reduction in greenhouse gas emissions in the EU by 2030 compared to the base year 1990. This target value of 55% is a core element of the EU's strategy of becoming climate neutral by 2050, and is now stipulated in the EU Climate Protection Act. The goal is significantly more ambitious than the previously applicable value of 40% and increases the urgency for transformation towards zero-emission mobility.

The effectiveness of this effort depends above all on the ability to put together a coherent overall package from the many different instruments and measures – at European and national levels as well as enable the mobility shift where population density is highest – in the cities.

Decarbonizing road transport, mainly through the electrification of the urban vehicle fleet including individual and public transport is already part of the national and local strategies to reduce air pollution and mitigate climate change. Yet urban mobility cannot be reshaped without continuous collaboration and exchange on best practices, good solutions and feasible approaches across borders, especially within the European Union.

Therefore, this study investigates the status quo of policies, influencing and framing the electrification of urban mobility and provides recommendations for municipalities in Poland and Germany on how to effectively support the electrification of urban mobility. It thus supports the discussions of the Polish-German Platform on Electromobility, where both countries jointly work toward their shared ambition of Driving the necessary Change together.

Charge, Set, Go!

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Charge, Set, Go!

# Executive summary

Electric vehicles have shown an upward trend in Germany and Poland in recent years. Registration rates among electric passenger cars reached their highest levels in both countries in 2020. This development has been supported by a mix of policies at the local, national, and European Union levels. Despite this growth, combustion engine vehicles make up the majority of new sales in both countries. Efforts by policy makers seek to further decarbonise the transportation sector by promoting continued electrification in order to reach established climate change goals.

This study provides information on the status of vehicle electrification in Germany and Poland with a specific focus on urban regions up to 2020. This includes examination of electric vehicle uptake, charging infrastructure deployment, model availability, and cost assessments as well as key policies at the European, national, and local levels affecting electric vehicle uptake in both countries. It provides key recommendations on how to further spur the electric vehicle market, particularly in urban settings in both countries, as a key measure to decarbonize transport. Based on the analysis, the following findings can be highlighted:

- **The electric vehicle market is developing in Germany and Poland with variations existing amongst regions and user groups.** Although combustion engine vehicles are still the dominant vehicle type amongst cars, vans, and buses, the analysis shows that new registrations of electric vehicles, particularly amongst passenger cars in Germany and buses in Poland, are on the rise. Cities play an important role in the electrification of vehicle fleets as they typically see the highest new electric vehicle registration by total numbers. In 2020, nearly half of all new electric passenger car registrations in Germany came from urban regions and in Poland the share was even higher with nearly 60%. The remaining shares could be accounted to suburban and rural regions. By user groups, the majority of new electric passenger cars in Poland were registered by companies in comparison to Germany where the distribution was balanced between companies and private individuals registering a new electric car.
- **Electric vehicle policy frameworks at the European Union, national, and local levels play a major role in electrifying urban vehicle fleets.** While local-level policies are crucial for city-wide electric vehicle uptake, national and European Union (EU) level policies also play a significant role in setting the relevant policy frameworks. Particularly tighter carbon dioxide (CO<sub>2</sub>) emission targets for new passenger cars from 2020 set by EU regulations have pushed car manufacturers to increase electric vehicle supply in the EU. In mid-2020, the European Union released the Fit for 55 package which seeks to significantly reduce European carbon emissions, including the transport sector, by strengthening CO<sub>2</sub> standards or altering minimum tax rates on fossil fuels. National policies and strategies in Germany and Poland have also pushed for increased electrification including purchase and tax incentives, charging infrastructure deployment, and local level benefits for drivers of an electric vehicle. In response to the COVID-19 outbreak in early 2020, both Germany and Poland have introduced recovery packages, providing additional funding while also benefitting the electrification of their national vehicle fleets. The Polish National Recovery Plan is still pending as of December 2021. City-specific actions in place, include preferential access to bus lanes, preferential parking and charging use, establishment of low-emission zones, or awareness-building campaigns.
- **Cost, charging infrastructure deployment, model availability and awareness are crucial in electric vehicle adoption.** The analysis and interviews with local stakeholders show that costs, charging infrastructure deployment, model availability, and awareness are the most important factors impacting electric vehicle uptake in urban regions. While the assessment of vehicle costs shows that it is mostly purchase incentives which make selected electric vehicle models cost competitive or cheaper to comparable petrol and diesel cars, this is not the case for Poland if looking at one-time purchase incentives in 2020 and 2021. Public charging infrastructure availability in terms of public charging points per million inhabitants is higher in Germany than in Poland in 2020. This is also reflected at the city levels. However, both Germany and Poland saw fewer than 20 cars per public charging point, putting them ahead of other European nations in this regard. Additionally, while Germany sees more available electric vehicle

models on the market than Poland, a high model choice remains crucial to both countries to broaden up the market for a larger consumer group. Lastly, raising awareness on the benefits of electric vehicles, how they function, and the current policies that affect them is important to bridge uncertainties amongst consumers and increase rates of electrification.

- **Leading electric vehicle cities can set an example for other urban regions looking to increase vehicle electrification.** Berlin, Stuttgart, Warsaw, and Krakow are among the leading electric vehicle cities in their respective countries by new electric passenger car registrations in 2020, accounting for 17%, 13%, 1.9%, and 2.3% of total new passenger car registrations. Among these cities, user groups varied in terms of uptake, but companies held the majority in electric vehicle registrations in Warsaw and Krakow, while Berlin saw the highest private individual shares. Stuttgart, being a major automobile manufacturing region, had the highest share amongst short-term rentals, car manufacturers, and dealerships.

Specific policies implemented in these cities show the ability of local actors and governments to increase electric vehicle rates. For example, Berlin has adopted a programme targeted at local businesses and taxi companies purchasing a new vehicle. This includes a purchase incentive which can be added to the national grant, financial support for charging infrastructure, and consulting. Additionally, Berlin introduced specific guidelines to developing the city's charging infrastructure grid which involves a user-friendly approach focusing charge points around major roads and traffic links. The city implemented a low emission zone in 2010 that was strengthened in 2019 to ban diesel models under the Euro 6 standard along certain routes. Berlin is also a member of the C40 initiative which enables knowledge sharing as well as signing declarations such as the Clean Bus Declaration.

Stuttgart allows free parking in the city for drivers of an electric vehicle since 2012. In addition, the city has created a special transportation action plan with over 100 measures to increase sustainable transport and reduce air and noise pollution. One goal of the plan is to establish over 1,000 public charging points by the end of 2021. Stuttgart also has established a low

emission zone in 2008 and since 2019 has strengthened it to only allow admission of diesel vehicles with at least the Euro 5 standard or better. Lastly, Stuttgart had a special parking license system that since 2012 had allowed free parking at public parking spots for fully electric vehicles, however, this was replaced by a federal programme in 2015.

Warsaw, via the Act on Electromobility and Alternative Fuels, allows electric vehicles bus lane access to over 250 lanes throughout the city. On top of that, the city offers the Eco-Card programme which allows electric vehicles to park and charge their cars outside of operational hours at car parks throughout the city, with no additional charge. Municipal fleet electrification is an active part of the city's electrification goals and the bus operating company MZA, for example, has recently purchased 130 new electric buses. Warsaw, like Berlin, is a member of the C40 city initiative and through this group has also signed pledges, such as the Green and Healthy Streets Declaration, further promoting vehicle electrification. Finally, Warsaw will engage in the 2023 Green Capital of Europe competition which evaluates cities based on 12 indicators which include sustainable urban mobility, air quality, and levels of noise pollution.

Krakow actively engages in municipal fleet electrification and in 2010 the city surpassed the goal of 10% of municipal fleets by 2022. Krakow also offers park and ride systems that allow free charging while parked. The city employs the Smart City Polska initiative, which helps establish electromobility goals, plans to enhance the electric car sharing system, and fosters stakeholder collaboration. The mayor of Krakow also invited residents to take part in a consultation of the current electromobility projects in early 2021, encouraging local stakeholder participation. Lastly, like Warsaw, Krakow is participating in the 2023 Green Capital of Europe Competition. These examples show the wide-ranging actions cities can use to promote electromobility in their regions.

The study shows the variety of measures that have been adapted at the EU, national, and local levels to spur the electric vehicle market. Specifically for cities, the following key recommendations can be made to further enhance electric vehicle uptake:

- **Tackling misinformation and uncertainty around electric vehicles requires continued communication and collaboration efforts with stakeholders and consumers.** According to city experts, misperceptions exist in regards to electric vehicle range, costs of purchase and operation, and the policies surrounding their promotion and implementation. Increasing levels of electric vehicle usage requires continued efforts to spread accurate information effectively. Efforts in the cities of focus including Berlin, Stuttgart, Warsaw, and Krakow have centered on awareness campaigns, electromobility days, and electric car showcases which all can successfully provide information on functionality as well as raising interest in purchases. Information campaigns can additionally be utilised by online platforms such as city and national government websites to provide a reliable source on electric vehicles. Furthermore, stakeholder collaboration is an integral aspect of electromobility as lessons and recommendations can be useful and transposable amongst other cities and countries.
- **Introduction of new measures and strengthening of current local level policies could further help to spur the electric vehicle market in German and Polish cities.** These measures include but are not limited to increased charging and parking benefits, establishment of zero-emission zones, fostering electric adoption among shared fleets and on-demand services, introduction of local-level electric vehicle subsidies, and continued municipal fleet electrification.

Some form of parking benefits currently exist in Berlin, Stuttgart, Warsaw and Krakow. Stuttgart provides free parking for electric vehicles on public streets and in chargeable spaces, however, Berlin offers this service only when a vehicle is charging. In Polish cities, battery electric vehicles are exempt from parking fees in municipal paid parking zones and Krakow offers free parking for battery electric vehicles, however, free charging is less common. Offering free parking and charging options encourages electric vehicle

purchasing by making their usage more convenient while also reducing costs of operation. Introduction of zero-emission zones to cities in Germany and Poland could also help in encouraging electric vehicle use by allowing only battery electric and fuel cell electric vehicles with zero tailpipe CO<sub>2</sub> emissions to pass through major parts of urban regions. Low-emission zones currently exist in Berlin and Stuttgart, however, a zero-emission zone has yet to be established in either city. A zero-emission zone was introduced in Krakow in 2019, however, it was removed due to pressure from stakeholders.

Electrification of ride-hailing and on-demand services as well as shared fleets could provide electromobility options for those in urban regions who do not want to or are unable to afford their own car. The local public transport company in Berlin offers an electric on-demand ride-pooling service in the form of the Berlkönig programme as a complement to their public transport service. Services such as this could be introduced to other cities across Germany and Poland. Additionally, city governments could work with car-sharing and ride-hailing companies by collaborating on electrification goals, providing preferential parking and charging options, and giving priority lane access.

Local level electric vehicle subsidies could be introduced in addition to national purchase incentives to maximise cost reduction benefits. For example, Berlin offers a vehicle purchase subsidy through the aforementioned programme targeting commercial businesses, non-profits, and self-employed individuals, and taxi companies. This could be replicated in other cities and for other user groups such as private individuals yet the cities would need to secure the relevant funding of their budgets.

Lastly, electrification of municipal vehicle fleets should continue to occur. City municipal fleets make up a significant portion of vehicles used in urban regions and can help accelerate the transition to electric fleets by promoting the electric vehicle market, increasing levels of charging infrastructure developed, and promoting awareness and visibility.

- **Local charging infrastructure could be supported by streamlining permit processes and increasing financial support via grants or tax exemptions.** Charging infrastructure deployment is a critical part of vehicle fleet electrification and the demand for charge points will continue to rise as more electric vehicles are purchased. Some bureaucratic limitations hinder this development in cities, according to experts. Long application and construction waiting periods can leave users without accessible charging points and create uncertainty in their ability to reliably charge their cars. City governments could focus on streamlining processes and removing potential barriers for charging point construction. Further actions to encourage development of charging points could come in the form of payment grants or tax write-offs for electric vehicles. These instruments could provide financial support to private individuals, companies, or other institutions looking to install charge points and can be introduced at the national and local level.

# 1 | Introduction

The number of motor vehicles on Europe's roads continues to grow. Between 2015 and 2019, the number of passenger cars, commercial vehicles, and buses grew in Germany by 6%, from over 48 million to over 51 million, and at an even higher rate of 17% in Poland, from 24.3 million to 28.4 million.<sup>1</sup> Most of the vehicles in use, including new registrations, are still made up by internal combustion engine vehicles. In 2020, their share of new registrations in the car segment was 86% in Germany and 98% in Poland. New van registrations were also mostly non-electric vehicles in 2020, having a share of 97% in Germany and almost 100% in Poland. In addition, the Polish vehicle fleet is one of the oldest across Europe, whereas in Germany the fleet age is younger than the European Union (EU) average.<sup>2</sup> Therefore, the electrification of the vehicle fleet and the renewal of the existing fleet with electric vehicles – particularly battery electric vehicles with zero carbon dioxide (CO<sub>2</sub>) emissions at the tailpipe – plays an important role in decarbonizing the transport sector.

To better understand supporting and hindering factors in electric vehicle uptake, we first quantitatively assess the vehicle market in Germany and Poland. We look at vehicle stock data and new registrations, the latter covering national and local levels. As cities play an important role in electrifying vehicle fleets, we also analyse the electric vehicle market for those regions. Similar to the national levels, new vehicle registrations at the local level are dominated by the internal combustion engine. In 2020, new car registrations in urban regions being non-electric accounted for a share of 87% in Germany and 98% in Poland.

The focus of the paper is on passenger cars as the segment accounts for the highest number of vehicles on the road as well as by new registrations. In 2020 alone, new passenger car registrations in Germany and Poland had each a share of about 90% of total new car registrations whereas the share of vans was 8% or 12% and for buses 0.2% and 0.3% in Germany and Poland, respectively. In addition, passenger cars play an important role in urban settings as they are used for private purposes but also as part of fleets such as taxis, carsharing, or ride-hailing services. Although in less detail, we also assess the van

and bus segment. Vans play an important role in urban logistics as part of last mile deliveries and buses used in urban transport can help to reduce car dependency.

Despite its importance, the used electric vehicle market is not analysed in more detail as part of this paper as the market is at a nascent stage in both countries. Rather, the focus is on the quantitative assessment of new vehicle registrations.

The paper includes an in-depth analysis of policies to better understand electric vehicle uptake in the two markets, as well as supporting and hindering factors, to derive policy recommendations with the focus on cities. Although the focus is on urban settings, we also assess regulations and policies at the EU and national levels as the uptake is also largely affected by measures and frameworks implemented beyond city levels.

For the various sections, we state main findings before carrying out the relevant analyses' steps. The following summary highlights key similarities and differences between the German and Polish electric vehicle market, sorted by the different chapters (Table 1).

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1 ACEA (2021 a), p. 9.

2 ACEA (2021 a), p. 10-13.

Summary of key findings

Table 1

Topic	Key findings
<b>Electric vehicle market in Germany and Poland</b>	<ul style="list-style-type: none"> <li>• The vehicle markets in Germany and Poland are largely driven by the internal combustion engine</li> <li>• In 2020, the new electric passenger car market increased significantly, particularly in Germany</li> <li>• New electric cars are commonly registered by companies in Poland, whereas the share between private and company car registrations is balanced in Germany</li> <li>• Cities play an important role in electrifying vehicle fleets</li> </ul>
<b>Electric vehicle policy frameworks at European Union, national, and local levels</b>	<ul style="list-style-type: none"> <li>• The European Union has adopted a variety of legal frameworks to spur the electrification of national vehicle fleets</li> <li>• At national levels, Germany and Poland have adopted various laws and initiated different programmes to enhance electric vehicle adoption</li> <li>• Germany and Poland have implemented a broad set of policies at the national and local levels to spur electric passenger car adoption</li> </ul>
<b>Further factors influencing electric vehicle adoption</b>	<ul style="list-style-type: none"> <li>• Model availability of electric passenger cars and vans is significantly higher in Germany than in Poland</li> <li>• In the European context, Poland has a comparably high percentage of fast charging points while Germany scores, on average, lower in terms of fast charging on the highway network</li> <li>• Germany has a much higher public charging infrastructure deployment than Poland</li> <li>• Local stakeholders rate costs, model availability charging infrastructure deployment, and awareness as key in electric vehicle adoption</li> </ul>
<b>Best-practice city examples: Berlin, Stuttgart, Warsaw, and Krakow</b>	<ul style="list-style-type: none"> <li>• BERLIN: With 17% of new passenger cars registered as electric cars, their uptake was 4 percentage points above the German average in 2020; companies dominate in their registration numbers; public charging infrastructure is concentrated in the inner-city areas</li> <li>• STUTTGART: With 20% of new passenger cars registered as electric cars, their uptake was 7 percentage points above the German average in 2020; short-term rentals, manufacturers, and dealerships dominate in their registrations; public charging infrastructure is concentrated in several Stuttgart neighborhoods</li> <li>• WARSAW: With 1.9% of new passenger cars registered as electric cars, their uptake was the same as Poland in 2020; companies dominate in their registrations; public charging infrastructure is sparsely distributed</li> <li>• KRAKOW: With 2.4% of new passenger cars registered as electric cars, their uptake was slightly above the 1.9% Poland average in 2020; companies dominate in their registrations; public charging infrastructure is sparsely distributed</li> </ul>

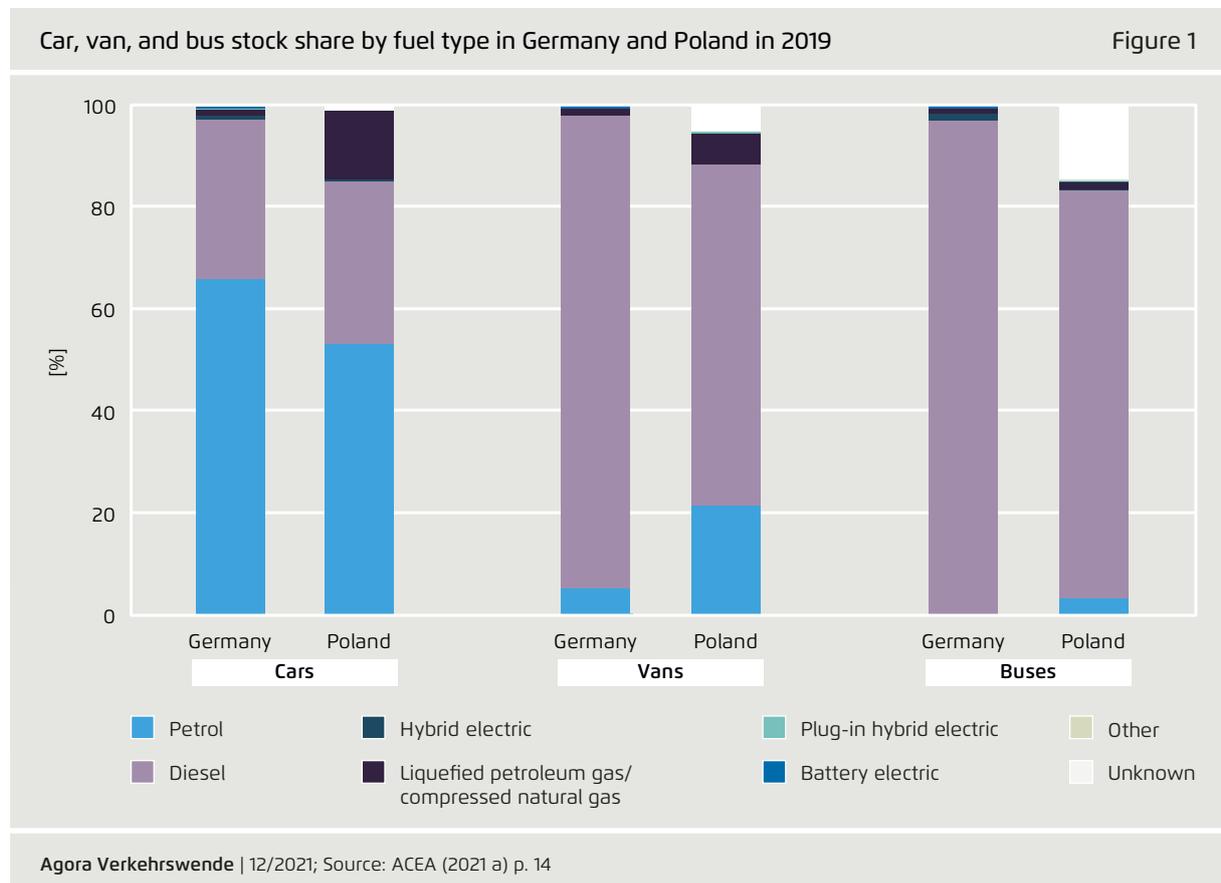
## 2 | Electric vehicle market in Germany and Poland

The electrification of the vehicle fleet plays an important role in decarbonising transport. To better understand the developments in both markets, we first analyse the uptake of electric vehicles before analysing policy frameworks and other factors which support or hinder their uptake. For the quantitative analysis of the passenger car, van, and bus market in this section, we use the most recent comparable data, referring to the years 2019 and 2020.

### The vehicle markets in Germany and Poland are largely driven by the internal combustion engine

Most vehicles on the roads in Germany and Poland – passenger cars, vans, and buses – are powered by petrol or diesel (Figure 1). For cars, 66% on the roads were petrol or diesel (Figure 1). For cars, 66% on the roads were petrol by the end of 2019, followed by diesel cars with a share

of 32%. Liquefied petroleum gas (LPG) and compressed natural gas (CNG) vehicles accounted for 1.2%, and hybrid electric vehicles (HEVs) for 0.9%. Battery electric vehicles (BEVs) and plug-in hybrid electric vehicles (PHEVs) had the lowest stock shares with 0.3% and 0.2%, respectively. In Poland, petrol cars made up 53% and diesel cars made up 32% of the total stock share. LPG powered vehicles held a share of 14%, almost 13 percentage points higher than in Germany. The battery electric and plug-in hybrid electric stock share was near 0% by the end of 2019. Vans on the road were mostly diesel vehicles in both countries, at over 90% in Germany and almost 70% in Poland. LPG powered vans accounted for 6% of the share in Poland, 5 percentage points higher than in Germany. Electric vans, typically BEVs, accounted for almost 1% on German roads and near 0% on Polish roads. The bus stock share was almost exclusively made up of diesel vehicles, at 97% in Germany and almost 80% in Poland. Electric buses, com-



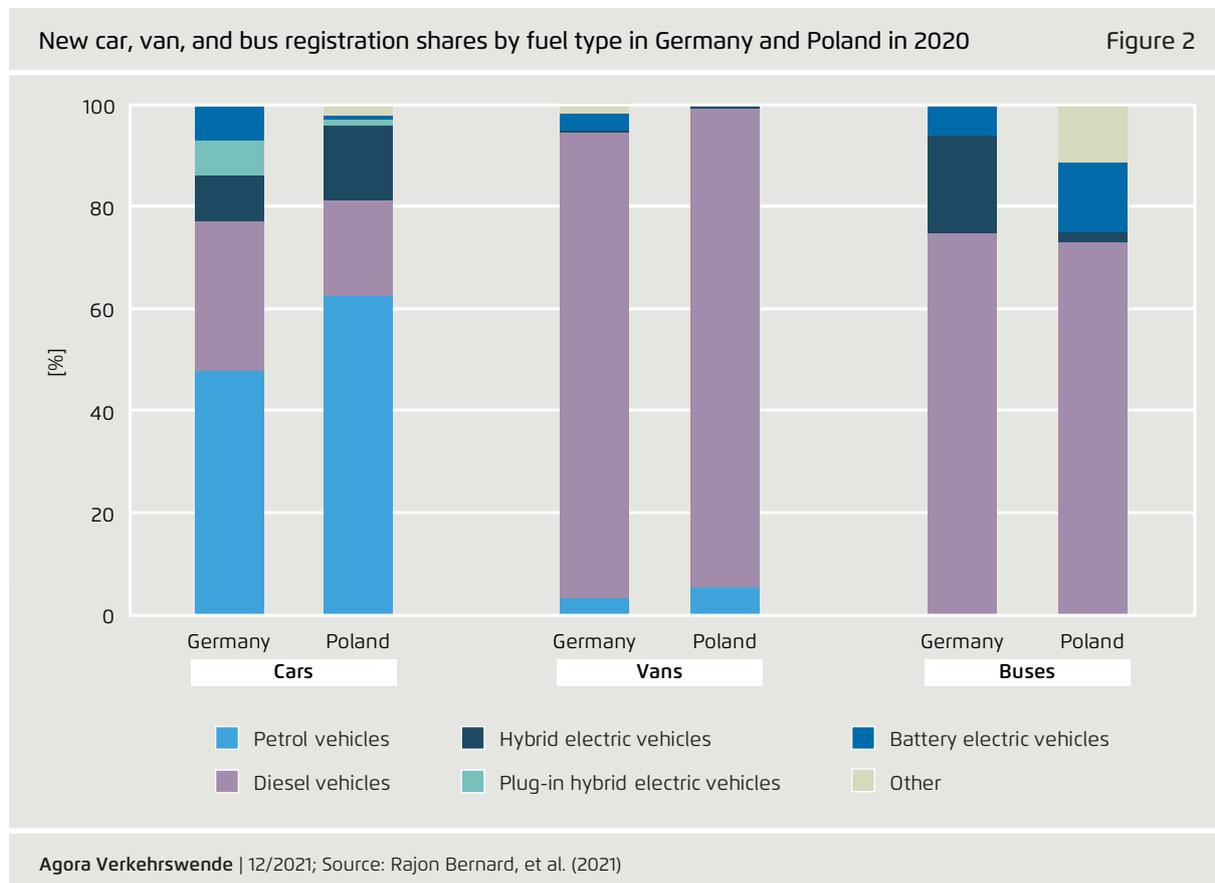
monly BEVs, accounted for 0.5% in Germany and 0.3% in Poland by the end of 2019. By the end of 2020, the BEV bus stock share stood at almost 1% in both countries.<sup>3</sup>

New vehicle registrations for cars, vans, and buses also show a dominance of combustion engine vehicles (Figure 2). For cars, Germany recorded new petrol car registrations at a rate of 48%, diesel vehicles at 29%, and HEVs at 9% in 2020. Only 14% of all new passenger car registrations were electric (7% BEVs and 7% PHEVs). In Poland, new petrol cars were registered at a rate of 62%, diesel cars at a rate of 19%, and HEVs at a rate of 15%. Electric vehicles accounted for a 2.0% share. Of these electric passenger cars, 0.9% were registered as BEVs and 1.1% were classified as PHEVs. For vans, the majority of new registrations were diesel vehicles in both countries, at 92% in Germany and 94% in Poland. Battery electric

vans recorded a share of over 3% in Germany and 0.4% in Poland. New bus procurements were also largely driven by new diesel vehicles, accounting for about three quarter of all new bus registrations in both countries. Battery electric buses accounted for 6% of new registrations in Germany and 14% in Poland.

Despite electric vehicles on the road being at a nascent stage in both countries, new registrations figures show that the market is picking up in some segments. Battery electric cars, vans, and buses made up 7%, 3%, and 6% of new registrations in Germany in 2020, respectively. In Poland, BEVs accounted for 14% of all new bus procurements, likely driven by the local production of electric buses. Conversely, in Poland in the car and van segment new BEV registrations shares were low, at 1% and 0.4%, respectively.

3 KBA (2021); Fundacja Promocji Pojazdów Elektrycznych (2021).



### In 2020, the new electric passenger car market increased significantly, particularly in Germany

Increasing the new registration share of electric vehicles is a key pillar to decarbonise transport, particularly in the car segment where most new vehicles are registered. Since 2010, the share of new electric car registrations have increased steadily (Figure 3).<sup>4</sup> For cars, registrations of new BEVs in Germany increased from below 0.1% in 2010, to 0.3% in 2016, to 2% in 2019, reaching almost 7% in 2020 (Figure 3, left). PHEVs in Germany saw similar rates of growth as BEVs since 2010. In total, over 290,000 new BEVs and PHEVs were registered in Germany in 2020. Poland saw less development in the shares of new electric car registrations than Germany (Figure 3, right). BEVs did not account for any share of newly registered cars until 2017, where they made up 0.1%. In 2018, the same share of new BEVs were registered, 0.1%, and this rose to 0.3% in 2019. Poland witnessed slightly

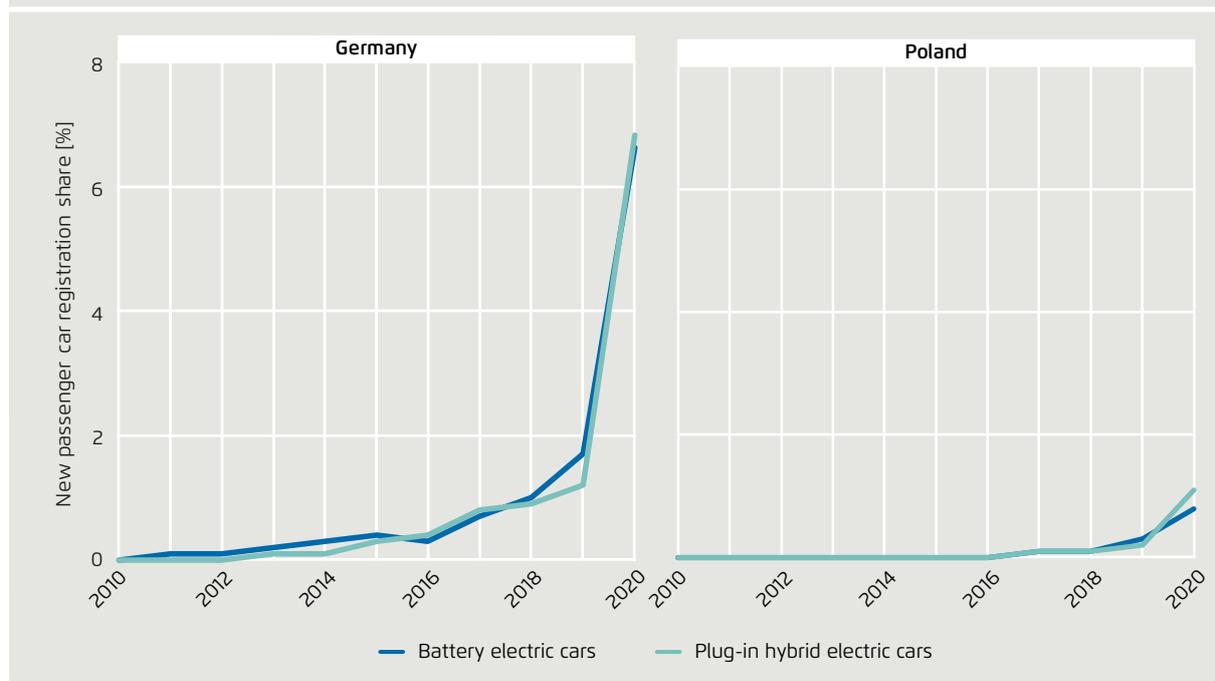
higher figures in 2020, when new BEV registrations totaled to almost 1%. The development was similar for PHEVs. By total numbers, BEVs and PHEVs accounted for over 5,000 new registrations in 2020, almost 60 times less than in Germany. The increase in 2020 can largely be traced back to tighter CO<sub>2</sub> emission performance standards, particularly for new passenger cars, set at EU levels from 2020 and, in the case of Germany, increased bonus amounts for purchasing an electric car as part of the recovery package by the national government in response to the COVID-19 outbreak.<sup>5</sup>

4 EAFO (2021 a) and Rajon Bernard, et al. (2021).

5 Wappelhorst, et al. (2021).

New electric passenger car registration shares (BEV and PHEV) in Germany (left) and Poland (right) between 2010 and 2020

Figure 3



Agora Verkehrswende | 12/2021; Source: EAFO 2021 a; Rajon Bernard, et al. (2021)

## New electric cars are commonly registered by companies in Poland whereas the share between private and company car registrations is balanced in Germany

To better understand the policy landscape and how it affects electric vehicle uptake, it is important to note that companies play an important role in new registrations. In Germany, of the over 290,000 electric cars newly registered in 2020, 49% were by companies used as company cars, long-term rentals, leased vehicles, taxis, and cars belonging to driving schools, public administrations, and diplomats. Private individuals registered 51% of new electric vehicles. In Poland, the share of company registrations of the approximately 5,000 new electric vehicles registered was significantly higher, at a rate of 76%. The remaining 24% were made by private individuals.<sup>6</sup>

6 Wappelhorst; Bieker (2021).

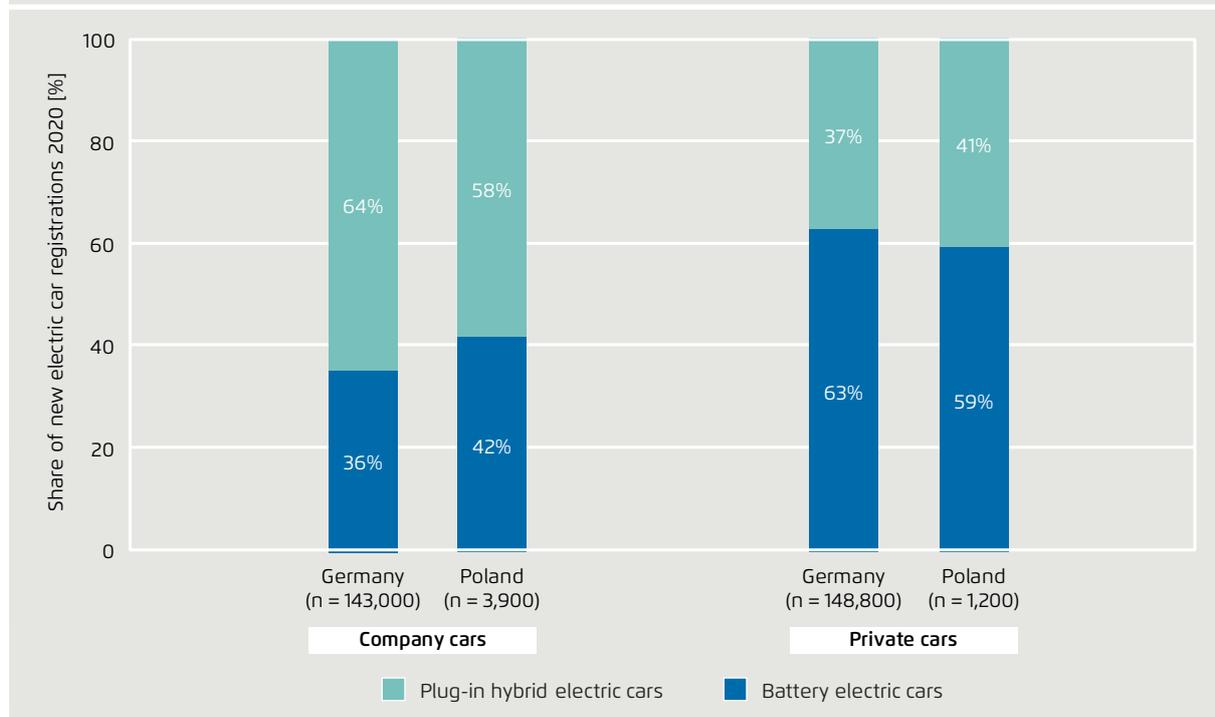
Differentiated by BEVs and PHEVs, companies mostly opted for a PHEV in 2020 (Figure 4). Their share was 64% in Germany and 58% in Poland. Conversely, private individuals mostly chose a BEV in 2020 if deciding for a new electric car. Their share was 63% in Germany and 59% in Poland.

## Cities play an important role in electrifying vehicle fleets

As at the national level, new vehicle registrations in urban regions are dominated by combustion engine vehicles. For cars in 2020, 87% of new registrations in Germany's urban regions were non-electric, including petrol, diesel, HEVs, and LPG and CNG powered cars. In Poland, their new registration share in urban regions was 98%. However, if only looking at new electric car registrations in 2020, many of them are registered in urban regions. In 2020, almost 50% of new electric car registrations, including BEVs and PHEVs, in Germany

Share of new electric passenger car registrations by company and private individuals in Germany and Poland in 2020

Figure 4



Agora Verkehrswende | 12/2021; Source: Wappelhorst, Bieker (2021)

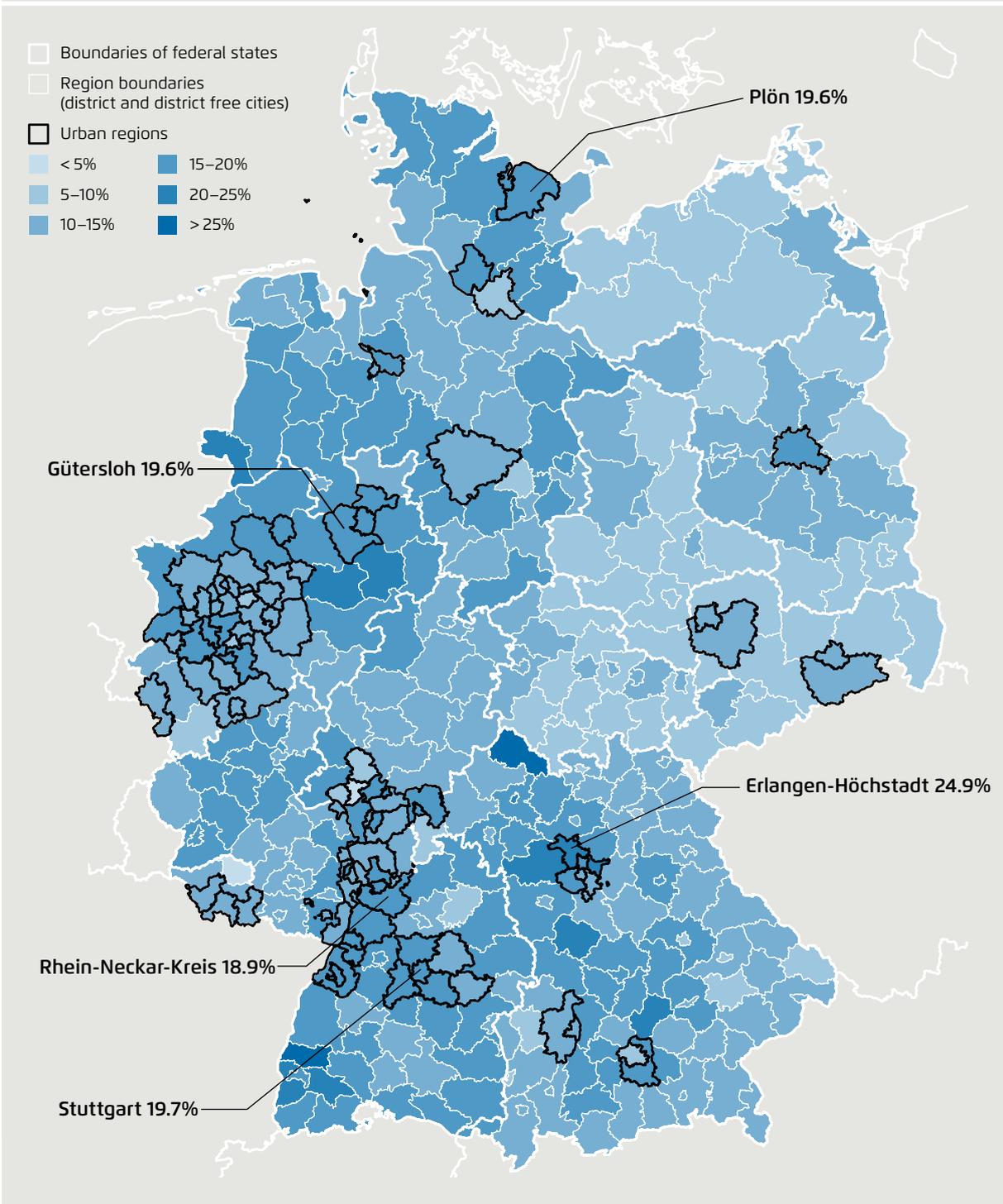
were made in the 95 urban regions, the remaining share was in the 306 regions outside city areas. In Poland, the share of new electric vehicles registered in the 14 urban regions was just over 60%.

Figure 5 shows the spatial distribution of new electric car registrations, including BEVs and PHEVs, across the 401 regions in Germany, highlighting the 95 urban regions in black. Of the urban regions in Germany, most electric cars were registered in the district of Erlangen-Höchstädt (metropolitan area of Nuremberg, Bavaria), the city of Stuttgart, Plön (metropolitan area of Kiel in the northern state of Schleswig-Holstein), Gütersloh (city in the western state of North-Rhine Westphalia), and the district of Rhein-Neckar (metropolitan area of Heidelberg in Baden-Wuerttemberg). Here, new electric car registration shares ranged between 19% and 25% in 2020. In the capital city of Berlin, new electric car registrations reached 17%, ranking 16th among the 95 urban regions.

In Poland, the top 5 urban regions with the highest share of new electric car registrations included Tyski in the metropolitan area of Katowice, the cities of Łódź, Kraków, and Poznań, as well as Bydgosko-Torunski in the metropolitan area of Bydgoszcz – Toruń (Figure 6). New registration shares of BEVs and PHEVs ranged between 2.1% and 2.5%. The capital city of Warsaw ranked 6th among the 14 urban regions (out of 73 regions in total) with 1.9% of new car registrations being electric in 2020.

Registration shares of new electric passenger cars in Germany by regions in 2020; urban regions are highlighted in black with the top 5 urban regions for electric vehicle uptake labeled

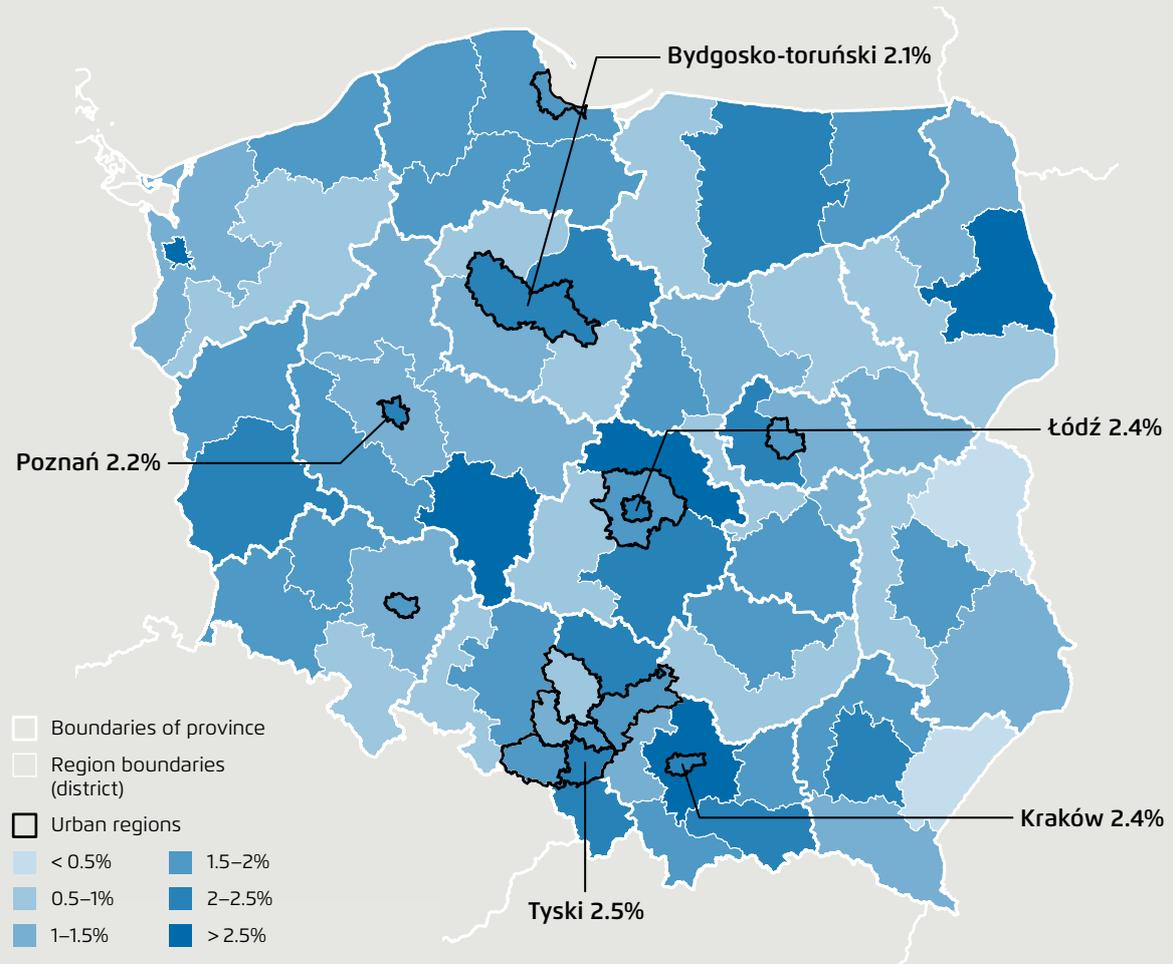
Figure 5



Agora Verkehrswende | 12/2021; Source: Rajon Bernard, et al. (2021)

Registration shares of new electric passenger cars in Poland by regions in 2020; urban regions are highlighted in black with the top 5 urban regions for electric vehicle uptake labeled

Figure 6





# 3 | Electric vehicle policy frameworks at European Union, national, and local levels

To best understand the development of the electric vehicle market in Germany and Poland as well as the supporting and hindering factors in electric vehicle uptake in urban regions, we qualitatively assess frameworks and policies which support cities in electrifying their vehicle fleets. We first highlight key EU level regulations and directives which help to address main barriers of model and charging infrastructure availability. This is followed by an assessment of key strategic legal frameworks at the national level in Germany and Poland which address the main barriers of electric vehicle adoption including cost, charging infrastructure deployment, and awareness. Lastly, we choose three cities each in Germany and Poland to further analyse national and local level policies.

## The European Union has adopted a variety of legal frameworks spur the electrification of national vehicle fleets

In the past, the EU has adopted a variety of binding regulations and directives concerning electric vehicles aimed at car manufacturers and national governments to meet greenhouse gas emission targets set by the EU. We highlight key regulations and directives to understand market dynamics of electric vehicle adoption and charging infrastructure deployment, which can partially be traced back to some of the EU legal frameworks described below.

Key binding legal framework addressing the supply side i.e., car manufacturers, is the **Regulation of the European Parliament and of the Council setting CO<sub>2</sub> emission performance standards for new passenger cars and for new light commercial vehicles**.<sup>7</sup> The current regulation adopted in 2019 sets EU fleet-wide average CO<sub>2</sub> emission targets from 2020, 2025, and 2030 and includes a mechanism to incentivise car manufacturers for the uptake of zero- and low-emission vehicles.

To enhance the adoption of zero- and low-emission vehicles as part of public procurements, the **Clean Vehicles Directive** sets procurement targets for cars, vans, trucks, and buses as part of purchase, lease, rent

or hire-purchase contracts, public service contracts for passenger road transport services, and services contracts for public road transport services or mail and parcel transport and delivery.<sup>8</sup>

There are also various legal frameworks targeted at charging infrastructure for electric vehicles concerning their access, interoperability, and other technical requirements to encourage deployment. The **Alternative Fuels Infrastructure Directive** adopted in 2014 requires EU Member States to develop national policy frameworks for the market development of alternative fuels and their infrastructure. The directive includes technical requirements for charging stations for electric vehicles, requiring that each Member State ensures that charging points are accessible to the public and widely available, and recommending a minimum number of charge points per electric vehicle. The **Energy Performance of Buildings Directive** requires buildings across the EU to be ready for electric vehicle charging infrastructure development. This means all new or renovated non-residential buildings must contain at least one charging point which includes installation of electric cable conduits. For parking spaces, recharging points must occur at a rate of one charging point per five parking spots. The directive also requires Member States to address any potential barriers that would prevent charging point installations in regards to property and tenancy legislations.<sup>9</sup>

In July 2021, the European Commission presented the Fit for 55 package with the goal of reducing EU wide greenhouse gas emissions by 55% before 2030. The package provides revisions to legislation affecting all European emissions, including from the transportation sector. Among others, the European Commission has proposed a revision of the current CO<sub>2</sub> emission performance standards for new passenger cars and for new light commercial vehicles. It proposes an average EU fleet-wide CO<sub>2</sub> emission target for cars and vans of 0 g CO<sub>2</sub>/km by 2035. If adopted, this would mean that by 2035 only the new registration of battery electric or fuel cell electric vehicles would be allowed by 2035. Based on the proposal, CO<sub>2</sub> standards would also be strengthened for new cars and

7 EUR-Lex (2019 a).

8 EUR-Lex (2019 b).

9 EUR-Lex (2018).

vans in the EU by 2030 compared to the year 2021. For passenger cars, the new target would go from the existing value of -37.5% to -55% and for new vans, from -31% to -50%. The Fit for 55 package also includes a proposal for revising the Alternative Fuels Infrastructure Directive. The revision would include turning the directive into a regulation which would be directly binding for all EU Member States and would not need to be transposed into national laws as the case for a directive. The proposal foresees binding minimum targets for the installed charging capacity per electric and per plug-in hybrid electric vehicle, and minimum densities for the deployment of public charging infrastructure for electric vehicles (both light-duty and heavy-duty) to be met by certain years. There is also a proposal to alter the way in which minimum tax rates on fossil fuels are set via the energy tax directive. Where equal minimum levels of taxation are laid down in relation to a given use (as is proposed for petrol and diesel in road transport), the levels of taxation actually levied also have to be equal. This would thus be the end of the favourable tax treatment of diesel fuel.<sup>10</sup>

As indicated, EU legal frameworks play an important role in spurring electric vehicle adoption at national levels, to the benefit of urban regions. The regulations and directives outlined above are some of the key measures to push car manufacturers and governments towards electrification of vehicles.

## At national levels, Germany and Poland have adopted various laws and initiated different programmes to enhance electric vehicle adoption

As for the EU level, we also briefly highlight key legal frameworks and programmes adopted and implemented at national levels in Germany and Poland to understand current developments in electric vehicle adoption, supporting and hindering factors, and how these activities support city regions in electrifying their fleets. Since there have been many actions taken over more than ten years, the listed frameworks only provide a broad overview.

<sup>10</sup> Dornoff, et al. (2021).

For Germany, the following key frameworks and policies can be highlighted which work to enhance electric vehicle adoption, also in urban settings:

- The **Electric Mobility Act**, adopted by the German government in 2015, provides cities and municipalities with the legal framework to promote electric mobility through certain privileges. This includes parking privileges for electric vehicles on public roads, such as access to roads that are dedicated to special purposes, like bus lanes, permitting exemptions on access restrictions, driving bans for combustion engine vehicles, or partial or full exemption of electric vehicles from fees for public parking. Electric vehicles applicable to this law include cars and vans and must have an electric range of at least 40 km or must emit a maximum of 50 g CO<sub>2</sub>/km i.e., affecting BEVs, fuel cell electric vehicles (FCEVs), and PHEVs.<sup>11</sup> The law also defines the labeling of these electric vehicles via an e-license plate, which allows municipalities to grant benefits for drivers of an electric vehicle.<sup>12</sup>
- To enhance charging infrastructure deployment, the German government published the **Charging Infrastructure Master Plan** in 2019. The plan lays out the necessary measures to create a comprehensive charging infrastructure network for the up to 10 million electric vehicle users estimated by 2030.<sup>13</sup> To support home charging in multi-dwelling buildings, Germany passed the **Building Electromobility Infrastructure Act** in 2021 which requires new residential and non-residential buildings to be equipped with protective electric cable tubes to allow faster construction of charging stations when needed. For residential buildings with more than five parking spaces, every parking space must come equipped with the necessary protective tubes. Non-residential buildings must equip every fifth parking space.<sup>14</sup> Bundled charging point locations are also now possible to provide a neighborhood approach. In April 2021, Germany also approved the **Law for the Provision of Comprehensive Fast Charging Infrastructure for Pure Battery Electric Vehicles**, creating the political foundation

<sup>11</sup> BMWi (2020 a).

<sup>12</sup> emobil region stuttgart (2021).

<sup>13</sup> BMWi (2020 b).

<sup>14</sup> BMWi (2021).

to expand fast charging points with at least 150 kW charging capacities throughout Germany. This aims to develop 1,000 additional fast charging hubs by 2023, receiving funding of €2 billion.<sup>15</sup> The German government has also released the **StandortTOOL**, a comprehensive charging infrastructure assessment website that aims to determine future needs of charging stations based on the time horizon, number of electric vehicles, development strategies, and capacities of private charging stations. This tool is intended to assist municipalities and policy makers in planning the charging infrastructure development process.<sup>16</sup>

- The German government has also funded the transition to electric vehicles over the past decade through multiple programmes and incentive schemes which also target cities and municipalities. In 2020, Germany released a **COVID-19 recovery package** which aims to spur electric vehicle uptake via additional funding for charging infrastructure and extended electric vehicle purchase benefits. Charging investments from this package total to €2.5 billion.<sup>17</sup>

Poland has also adopted various laws and initiated different programmes to enhance electric vehicle uptake in national and urban settings. Key frameworks include the following:

- The **Strategy for Responsible Development** was the initial approach put forth by Poland's council of ministers in 2017 to create a medium and long-term national electromobility plan. It created the conditions to foster electromobility development by giving support to cities for development of low-emission public-transportation and through purchasing of electric buses. The strategy also introduced regulations to increase usage of electric vehicles, namely through the establishment of the Electromobility Development Plan.<sup>18</sup> The **Electromobility Development Plan** was adopted in 2017 and encourages electric vehicle uptake through financial incentives and electric infrastructure development, and outlines the specific benefits and economic growth potential that comes

with increased levels of electromobility.<sup>19</sup> The **Electromobility Development Program** is governed by a steering committee, which is responsible for overseeing the implementation of the program, making key decisions, establishing goals, and providing necessary resources.

- In terms of charging infrastructure deployment, the **National Framework for Alternative Fuels and Infrastructure Development Policy** was passed by the Polish government in 2017, to adhere to the EU directive of alternative fuels infrastructure. The primary goal was to install 6,400 charging points with 400 fast charging points by 2020. To fund these endeavors, the **Law on Biocomponents and Liquid Biofuels** was amended in 2018 to include the low-emission transport fund.<sup>20</sup> Electric infrastructure for public transportation (electric buses) is financially supported in Poland mainly through the **Infrastructure and Environment Operational Program** as well as through EU funding. Money from this program aims to reduce carbon emissions of all transport sectors with alternative fueled vehicles being prioritized. Direct EU funding (e.g., from Connecting Europe Facility mechanism) has also been used by companies building fast charging network in Poland along TEN-T routes. Due to the Law on Electromobility, new Polish public and multi-family buildings must be equipped with charging capacities of a minimum of 3.7 kW where the municipal population is above 100,000 and where there are more than 60,000 electric vehicles registered.
- Derived from the EU directive of alternative fuels infrastructure development, the **Law on Electromobility and Alternative Fuels** defines the national framework for charging infrastructure.<sup>21</sup> It allows for exemptions on excise taxes for electric vehicles as well as tax incentives for electric company cars. It has also created specific goals for municipal electric fleets and charging infrastructure. The minimum number of charging outlets is based on the number of inhabitants, taking into account the total number of registered motor

15 BMVI (2021).

16 StandortTool (2021).

17 BMF (2021).

18 Kowalska-Pyzalska, et al. (2020).

19 Ministerstwo Klimatu i Środowiska (2021).

20 In 2020, the low-emission fund was terminated. Financial resources and commitments were transferred to National Fund for Environmental Protection and Water Management.

21 IEA (2020).

vehicles and number of registered vehicles per 1,000 inhabitants, mandating a specific number of charging outlets by March 31<sup>st</sup>, 2021. It states that by the end of 2020, cities with:

- over 1 million inhabitants must have at least 1,000 public charging stations;
- over 300,000 inhabitants must have at least 210 public charging stations;
- over 150,000 inhabitants must have at least 100 public charging stations, and
- over 100,000 inhabitants must have at least 60 public charging stations.

In November 2020, an important and long-awaited revision of the Electromobility Act was initiated. New provisions implementing the Clean Vehicles Directive and amended provisions for Clean Transportation Zones were proposed. By the end of September 2021, the legislative proposal has not been forwarded to Parliament for adoption.

- The **Sustainable Transport Development Strategy until 2030**, adopted in 2019, aims to increase accessibility, efficiency, and innovation in the transportation sector. The policy specifically seeks to reduce the environmental impact of transportation through the promotion and financing of alternative fuels and forms of mobility. Deriving from this plan, the Polish Ministry of Infrastructure has encouraged Polish cities to go further by developing their own sustainable urban mobility plans (SUMP).<sup>22</sup> These long-term plans engage stakeholders and encourage public cooperation and participation.
- Poland has put forward a **COVID-19 recovery strategy**, namely the National Recovery Plan (KPO) adopted in July 2021 which funds low emission transportation and buses. This package aims to help the economy recover after the impacts of the global pandemic in which economic activity, including purchases of electric vehicles, were hindered. The funds total to over €1.1 billion for the support of low and zero-emission transportation production and fuel storage centers, as well as €1.1 billion for low and zero-emission bus purchases.<sup>23</sup>

Overall, both countries have adopted a set of legal frameworks and strategies and have secured national funding as part of different programmes and initiatives to spur the electrification of the vehicle fleet and to help and support cities and municipalities in these efforts.

## Germany and Poland have implemented a broad set of policies at national and local levels to spur electric passenger car adoption

Both national and local policy actions play an important role in electric vehicle uptake. In this section, we describe key national policies of Germany and Poland as well as key local policies and initiatives found in the German cities of Berlin, Stuttgart, and Leipzig, and the Polish cities of Warsaw, Krakow, and Poznan. These cities were selected as they are large cities with high electric vehicle uptake, providing good examples for other urban regions. To better understand why the electric vehicle uptake has been high in these cities, we analyse electric vehicle goals, electric vehicle purchase and operation incentives, charging infrastructure deployment, fleet integration, strategic local actions, and information and educational initiatives. We also evaluate national level policies in this context as they also benefit urban regions. We reflect 2020 policies to understand electric vehicle uptake for the year based on our analysis seen in the previous section. Additionally, we add 2021 policies if it contributes to the discussion. Our focus is on policies encouraging electric vehicle adoption rather than those disincentivising non-electric vehicles.

### Electric vehicle purchase and operation

The first set of policies evaluates those aimed at purchase and operation, addressing the barrier of cost. These policies range from purchase benefits at car purchase to benefits on parking or charging an electric vehicle.

**BEV and PHEV purchase benefits.** Benefits to reduce the costs at the point of purchase are largely implemented at national levels. Germany and Poland have both adopted national incentive schemes for the purchase of new cars and vans. At local levels, of the six selected cities analysed, Berlin is the only city that has implemented a local support scheme for new van purchases.

22 Oleśków-Szlapka, et al. (2020), p.6.

23 IEA (2021).

The German national government introduced an environmental bonus in 2016 which provides payments for purchase of electric vehicles.<sup>11</sup> The governmental share was doubled in 2020 as part of the COVID-19 stimulus package. BEV purchasers receive €9,000 and PHEV purchasers receive €6,750, including the share by car manufacturers, with a price cap at €40,000. For cars and vans up to €65,000 there is a bonus for BEVs of €8,000 and for PHEVs of €5,626. To be eligible, vehicles can emit no more than 50 g of CO<sub>2</sub>/km and have an electric range of at least 50 km until the end of 2021 which will thereafter be increased to 60 km. From January 2025, the electric range requirement will be raised to 80 km.<sup>24</sup> Since 2018, the German government also supports the purchase of battery-electric and hybrid electric buses used in public transport.<sup>25</sup>

The Polish national purchase subsidies came in the form of three small-scale pilot programmes started in June 2020. The "Green Car" programme for private persons provided grants to purchasers of electric cars of PLN 18,750 (€4,100) or up to 15% of the purchase costs. Eligible vehicles included any BEV or FCEV passenger car up to 3.5 tonnes for private use. The "E-Van" for small and medium companies provided grants for electric and hydrogen vans up to 3.5 tonnes, inclusive of chargers. The "Koliber" programme for taxi owners provided grants for electric and hydrogen passenger vehicles and chargers. Due to the lack of an information campaign, limited time for applications, and low purchase price limits, these pilot programmes concluded with very limited success, and only 7% of total budget was utilized.<sup>26</sup> As of July 2021, the Polish government launched a new support scheme. The first programme (already operational) "My Electric Vehicle" is for private persons.<sup>27</sup> It now includes a much broader spectrum of eligible electric vehicles (purchase price limits have been lifted up to PLN 225,000 (€49,200) comparing to PLN 125,000 (€27,400) in the pilot phase), and covers the period in which the "Green Car" program was not funded. This support scheme, however, does not support hybrid vehicles. The next support scheme for companies and public institutions is to be started later

in 2021 and will provide support for long-term rents and leasing.<sup>28</sup>

At local levels, Berlin launched the "business-related electromobility" or WELMO funding program in 2018, which aims to assist commercial businesses, non-profits, and self-employed individuals to purchase electric vehicles. The funding assistance is maximum of €5,000 and can be used in combination with the national bonus outlined above. Vans up to 3.5 tons receive the full benefit, and vans between 3.5 tonnes and 12 tonnes receive 25% of the purchase price up to €15,000.<sup>29</sup> Additionally, in July 2021, the program was expanded to include taxi drivers so long as a taxi license is presented, with support for passenger cars up to 3.5 tonnes reaching €15,000 per vehicle.<sup>30</sup>

**Electric vehicle registration tax benefits.** Both Germany and Poland do not impose registration taxes when registering a new vehicle for the first time. Poland also offers preferential rates on excise taxes for electric vehicles. Generally, excise tax is 3.1% when the engine capacity is up to 2,000 cm<sup>3</sup> and at a rate of 18% when it is over 2,000 cm<sup>3</sup>. In Poland, excise taxes on zero emission cars are waived, based on the Law on Electromobility, which includes BEVs and FCEVs. Some hybrid vehicles with ICE engines of less than 2 liters, including PHEVs, HEVs and mild hybrid electric vehicles (MHEVs) have been covered with 50% reduction of excise tax.<sup>26</sup>

**Electric vehicle ownership tax benefits.** Only Germany imposes regularly payable taxes for owning a vehicle. The vehicle ownership tax exemption, developed in 2012, allows BEVs and FCEVs to be purchased with a vehicle ownership tax exemption lasting for 10 years. After the 10 years, the tax is reduced by 50%. With the passage of the COVID-19 stimulus package, the tax exemption was extended until the end of 2030. The Polish government does not impose ownership taxes on any vehicle type.

**Electric vehicle benefits for companies (employers and employees).** Both Germany and Poland have adopted electric vehicle benefits for companies at national levels. In Germany, for example, employees privately using an

24 Bundesregierung (2021).

25 Bundesanzeiger (2018).

26 Wappelhorst; Pniewska (2020).

27 KPMG (2021).

28 gov.pl (2021 a).

29 SenWiEnBe (2020).

30 Investitionsbank Berlin (2021).

electric company vehicle benefit from tax breaks on private income tax. While company non-electric vehicles are taxed at an additional rate of 1% per month based on the vehicles gross price, the national government established a preferential treatment for electric vehicles in 2018. From 2020, BEVs and FCEVs pay a reduced 0.25% monthly tax rate for vehicles up to a gross vehicle price of €60,000 and 0.5% above this threshold. PHEVs up to 50 g CO<sub>2</sub>/km and a minimum electric range of 40 km pay a monthly 0.5% rate. These rates will remain in effect until 2030.<sup>31</sup> In Poland, the Law on Electromobility designates that electric company cars receive a longer depreciation write-off benefit and also receive a higher maximum car value deduction amount of PLN 225,000 (€49,200).<sup>26</sup> In general, when company cars are used for both private and business purposes there is a 50% reduction in the Value Added Tax (VAT). The full deduction of the VAT is possible when company vehicles are used solely for business purposes.<sup>32</sup> Currently, there are no benefits/tax incentives for employees that use company electric cars privately.

**Electric vehicle parking benefits.** In Germany, the Electromobility Act grants cities and municipalities the ability to create preferential benefits for electric vehicles in terms of free parking and access benefits.<sup>11</sup> Several cities have produced their own parking benefit systems. For example, Stuttgart introduced a permit system in 2012 for electric vehicles and has continued parking benefits with the introduction of e-number plates, allowing free parking without time limitation in public streets and chargeable parking spaces whereas in Berlin this privilege is only granted while charging. Leipzig plans to enable free parking for electric vehicles in the future but, as of September 2021, it is not apparent when this will take place.<sup>33</sup> At the national level in Poland, BEVs are exempted from parking fees in municipal paid parking zones.

**Electric vehicle charging benefits.** As of September 2021, electric vehicle charging benefits are not widely utilized in German cities. Leipzig allowed free charging up to a maximum of 4 hours in designated zones, however, this benefit was cancelled as of March 2021.<sup>34</sup> In Poland, free public charging is available to BEV users at park and ride

parks located across Warsaw, Krakow, and Poznan.<sup>35</sup> Krakow currently possesses four car parks with eight charging stations. Warsaw offers six park and ride parks with eleven charging stations city wide.<sup>36</sup> Poznan has three park and ride car parks as of 2020 with a total of six spaces offering electric vehicle charging.<sup>37</sup>

#### **Electric vehicle infrastructure use and access benefits.**

Berlin established a low-emission zone (LEZ) in 2010 which sets a minimum access standard of diesel Euro 4. The public administration has begun the consultation process to create a zero-emission zone (ZEZ), with the intention to only allow zero-emission vehicles to drive within the city area in future years.<sup>38</sup> Stuttgart and Leipzig also established an LEZ where only vehicles with a green emission sticker may enter.<sup>39</sup> However, those LEZs are not limited to electric vehicles. In Poland, the Electromobility Law also allows for an electric vehicle access benefit mandating that BEVs have access to all city bus lanes, although cities can enact requirements on minimum occupancy to limit this access. The law also designates that in cities with more than 100,000 inhabitants, a clean transportation zone can be established by the city council. There is currently a proposed amendment to this act, making the provisions much more simplified and flexible for local governments. The current provisions for clean transportations zones are commonly seen as too restrictive considering the present state of e-mobility development. As a result, no single clean transportation zone is operational in Poland. Krakow was the first city to establish an inner-city ZEZ in Poland in 2019 allowing only electric vehicles to drive there, however, due to protests from business owners and local community, it was terminated after a couple of months.<sup>26</sup>

#### **Electric vehicle charging infrastructure**

Another key barrier in electric vehicle adoption is charging infrastructure deployment. In the following, we list key measures adapted at national and local levels in Germany and Poland to address public and private home and workplace charging.

31 EAFO (2021 b).

32 PSPA (2020).

33 Region Leipzig (2021).

34 MDR (2021).

35 Poland Today (2020).

36 ZDM (2021).

37 POZnan (2021 a).

38 Eltis (2021).

39 City of Leipzig (2021) and Urban Access Regulations (2021 a).

**Public charger promotions for electric vehicles.** The German Charging Infrastructure Master Plan from 2019 suggests investments of over €3 billion into charging infrastructure for vehicles and trucks that are emission free. The Charging Infrastructure Master Plan also incorporates a smart grid, giving operators early access to information to make charging networks as efficient as possible.<sup>40</sup> Moreover, the plan suggests investing €50 million into private charging options. The COVID-19 stimulus package provides an additional €2.5 billion towards the expansion of charging stations as well as funding research and development. Between 2017 and 2020, Germany invested €300 million into electric public charging infrastructure through the government programme for electric mobility, with €200 million going to rapid charging stations and €100 million going to normal charging stations.<sup>17</sup> While the programmes funding focused on efforts up to 2020, more initiatives have been launched in 2021 to further extend the public charging infrastructure network. The Polish Covid-19 recovery initiative from 2020 totals to over €58 billion and funds several areas of the Polish economy with some contributions towards low-emission transportation. This plan increases financing of low- or zero-emission buses up to €1.1 billion and increases funding for low emission transport for the agricultural sector.<sup>41</sup> In spring 2021, the government has announced a wide-scale supporting scheme for charging infrastructure with a total budget of PLN 800 million (€175 million) for both fast and normal chargers. However, the programme is still not operational as public-aid related consultations with the European Commission are ongoing. All national programmes are also of benefit for local authorities.

At city levels, Berlin also supports the deployment of charging stations in public locations of commercial entities. Similarly, Stuttgart benefits from their respective federal programme (called Charge@BW), which also provides funding for the installation of public and private charging stations.

**Private home and workplace charger promotions for electric vehicles.** The German government funds the installation of private charging stations with a €400 million investment. Funding is approved for private individuals, apartment associations, housing companies,

and property developers. The grant is approved at a rate of €900 per installed charging point and is transferred after the project's completion.<sup>15</sup> The "on-site charging infrastructure program," passed by the German Federal Ministry of Transport and Digital Infrastructure in 2021, provides €300 million to small- and medium-sized companies to invest in charging infrastructure. This assists with the purchase of normal power charging units providing 80% of the price up to €4,000 per unit.<sup>42</sup> Fast charging units are also covered up to 80% and up to €16,000 per unit. In Poland, under the eVan incentive programme, support for electric charging stations was provided to businesses that purchased a zero-emission van. This aid came in the form of 50% off eligible costs up to a maximum of PLN 5,000 (€1,100) for a charger giving up to 22 kW of power. The Koliber programme allowed small- and medium-sized business who bought an electric taxi 20% of the costs of a charging station up to a maximum of PLN 25,000 (€5,500). The power maximum for this program also maxed out at 22 kW.<sup>26</sup>

Of the cities in focus, Stuttgart, Berlin, and Leipzig all benefit from some sort of local private and workplace charger promotion. Private installation (and also public, see above) is supported in Stuttgart via the Charge@BW initiative which was extended in May 2021. It provides support for the installation of private charging infrastructure via a grant of €2,500 per charging point as long as the station is powered via renewable energy.<sup>43</sup> The programme finances a maximum of 500 charging points per applicant. Leipzig receives private charger promotion support through state funding. The Saxony photovoltaic funding, launched in December 2020, provided a grant of €400 for private charging infrastructure stations with grants only awarded if funding reaches at least €2,500. As of May 2021, the funding for this programme was exhausted.<sup>44</sup> Berlin promotes workplace chargers through the WELMO programme, which was extended in January 2021. The funding is up to 50% of total costs with a maximum of €2,500 per normal charging point. Fast charging points also receive up to 50% costs with a maximum of €30,000 per charging point.<sup>45</sup> Private and workplace charger promotions are not utilized in the Polish cities of focus as of September 2021.

40 BMVI (2019).

41 gov.pl (2021 b).

42 E-mobil BW (2021).

43 L-Bank (2021).

44 Zolar (2019).

45 IBB Business Team (2021).

### Strategies, fleet integration, and public awareness

Aside from purchase benefits and charging infrastructure deployment, there are many ways national and local governments can influence electric vehicle uptake. This includes establishing electrification goals, integrating electric vehicles into fleets, and raising public awareness on the benefits of electrification.

**Electric vehicle goals.** At national levels, the goal of establishing 7 million to 10 million electric vehicles by 2030 was adopted through the German Climate Action Programme in 2019.<sup>46</sup> One of the main goals of the Polish national government is to reduce air pollution throughout Polish cities, which in 2020 ranked among the worst in the EU.<sup>47</sup> The previously adopted policy frameworks display the many initiatives from Poland, which attempt to align the country with the requirements of the EU on air quality and emissions reductions. One of the goals is to establish 1 million electric vehicles on the road in Poland by 2025. However, due to delays, the progress was projected to reach 600,000 vehicles by the end of 2030 by the Strategy for Sustainable Transport Development. By 2020, the government aimed to have 50,000 electric vehicles on the road as a part of the National Framework for Alternative Fuels Infrastructure Development Policy.

**Strategic actions.** Strategic local actions provide support for electric vehicle uptake via focused initiatives on a localized scale. Berlin is a part of the Smart City initiative which aims to bring together businesses and stakeholders to provide solutions to modern challenges in fields such as electromobility and transportation.<sup>48</sup> From 2014 to 2020, Leipzig took part in the climate protection programme which encompasses several broad sustainability goals and aims to reduce emissions by promoting electromobility. Krakow utilizes the Smart City Polska initiative which aims to develop the city to face future challenges by promoting electromobility with flexible city governance. Warsaw and Krakow will both take part in the European Green capital competition for 2023. This involves efforts from both cities to reduce carbon emissions and improve air quality with levels of electromobility factoring into the competition.<sup>49</sup> Poznan has recently adopted the “Electromobility development strat-

egy for the city of Poznan until 2035” resolution. This strategy seeks to improve the development of sustainable transport as well as promote increased electromobility. Specific goals of the plan involve increased development of electric infrastructure and refueling stations for alternative fuels, replacement of municipal combustion engine vehicles with electric, and promotion of alternative methods of transport.<sup>50</sup> Poznan will also join the other Polish cities in implementation of the Sustainable Urban Mobility Plan (SUMP). The city aimed to have the document and plan published by the end of 2020.

### Municipal electric vehicle fleet integration programmes.

Incorporation of electric vehicles into public municipalities is an important step in achieving electromobility goals. At national levels, the German government set a goal in 2019 of achieving 20% electric vehicles in the public sector fleet by investing over €100 million to the purchase of municipal electric vehicles. Additionally, in 2020 governmental funding totaling over €90 million went to local authorities which will authorize the purchase of over 3,800 electric vehicles, 30 buses, and 400 commercial vehicles.<sup>51</sup> At local levels, Stuttgart has made progress on its municipal electric fleet by establishing a low-emission driving fund supporting the conversion of public internal combustion engine vehicles to low- or zero-emission vehicles.<sup>52</sup> Berlin has launched the E-Bus Berlin project which aims to further incorporate electric buses into the public transportation system. Since October 2020, over 100 electric buses are running and the project is forecasted to be fully electric and record zero emissions from local buses by the year 2030.<sup>53</sup> Additionally, Berlin has launched the project “Smart e-fleets” a partnership between several public and private institutions in Berlin, such as the public transportation company (BVG) and the Berliner Wasserbetriebe, to make their operations fully electric. The project is funded by the German Federal Ministry of Transport and Digital Infrastructure and has put over 300 electric vehicles on the road since its founding.<sup>54</sup>

The Polish Act on Electromobility and Alternative Fuels requires central and local governments to ensure that 30% of their fleets consist of electric vehicles. The obliga-

46 Deloitte (2021 a).

47 EEA (2020).

48 SenWiEnBe (2021).

49 EC (2021).

50 POZnan (2021 b).

51 Electrive (2020 b).

52 Region Stuttgart (2021).

53 Electrive (2020 c).

54 InfraLab Berlin (2020).

tion of introducing low- and zero-emission vehicles also applies to public services fleet and public transportation buses. The aim is to achieve specific goals by 2028 with the rollout occurring in incremental stages.<sup>55</sup> Considering this initiative, Polish cities have increasingly begun to incorporate electric vehicles into their public municipal fleets. Krakow has achieved already 10% of municipal fleet integration.<sup>55</sup> In addition, Krakow will add an additional 50 electric buses to its public transport system in 2021.<sup>56</sup> Poznan has also seen uptake in electric buses levels within the city. In 2020, MPK, the public transportation company of Poznan, ordered an additional 37 electric buses to accompany the already 21 electric buses, in use since 2019.<sup>57</sup> In Warsaw, 130 electric buses have been provided in 2020 and 2021.

**Electric vehicle sharing and hailing operations.** Electric vehicle sharing and hailing operations particularly implemented in urban settings are an option to bridge low-threshold access barriers to electric vehicles. In addition, they can help to reduce private car ownership. The electrification of the fleets can also help cut down on air pollution and greenhouse gas emissions. Electric vehicle carsharing systems are present in all six cities analysed. For example, in Berlin, WeShare operates an all-electric carsharing scheme using BEVs. Share Now operates an electric fleet in Stuttgart and teilAuto provides an electric vehicle option for riders in Leipzig. In Warsaw, InnogyGo offered an electric carsharing system, however, the company terminated the service in May 2021.<sup>58</sup> Traficar, another electric carsharing provider in Warsaw, offers two electric vehicle models in their fleet. 4mobility also has some electric vehicles operating in Warsaw, Poznan, and Krakow. Ride-hailing programmes, similar to carsharing, allow city inhabitants to travel without the need to purchase a vehicle. For example, in late 2020, Uber launched a pilot programme in Berlin seeking to deploy electric e-Golf cars for their operations.<sup>59</sup> The local public transport authority of Berlin, also operates the Berlkönig programme which offers electric vans as a ride-hailing service.<sup>60</sup> Clevershuttle, another ride-hailing service, operates in Leipzig offering rides

via electric vans.<sup>61</sup> FREE NOW, a taxi hailing service that operates in Berlin, Stuttgart, Leipzig, Warsaw, Krakow, and Poznan, has pledged to operate 50% of all rides via fully electric vehicles by 2025 and aims to have net zero operations by 2030.<sup>62</sup> Most of these services outlined above are provided as fully commercial, with no public support from local or central governments.<sup>63</sup>

**Electric vehicle information and education.** Spreading information and awareness to the public on electric vehicles is crucial to promote electric purchases and achieve electromobility goals. Cities across Germany and Poland have implemented various campaigns and measures to provide more information on the benefits of electric uptake. Examples of the various initiatives include the "e-THF" electromobility showroom at the Tempelhofer Feld in Berlin, a hands-on public display of the benefits of electric vehicles as well as a showcase for scientific research. Stuttgart has begun an awareness campaign "Stuttgart steigt um" which provides information on sustainable mobility and local transportation initiatives.<sup>64</sup> In 2017, Stuttgart began a pilot project of an electric driving school. Since 2017, Stuttgart has put on the "electromobility action day" which promotes useful information to the public on the benefits of electric vehicles and how they function. The event offers hands-on experience as well as presents electromobility plans.<sup>65</sup> Since 2014, Leipzig provides electromobility information to its residents via a yearly rally called "Lipsia-e-motion" to promote awareness of electric vehicles and to display new electric models. Warsaw provides information via the city website which details progress on electromobility development. Furthermore, since 2017, the city has put on the "Electric Vehicle Congress". This event brings together scientists and stakeholders to discuss new ideas and progress in the electromobility transition. Krakow and Poznan both provide information via the city websites. Krakow additionally held the "Electromobility in Practice" training event which gave participants additional information on how to overcome challenges to electric uptake.<sup>66</sup> Poznan held the "Road to Electromobility" event which showcases new

55 Magiczny Kraków (2020 a).

56 Magiczny Kraków (2021 a).

57 Solaris (2020).

58 green-news.pl (2021).

59 Electrive (2020 a).

60 BVG (2018).

61 Clevershuttle (2021).

62 Realwire (2021).

63 4mobility (2021).

64 Stuttgart steigt um (2021).

65 Cities for mobility (2018).

66 Krakula (2020).

electric models and technology to the public, attracting over 130,000 participants.<sup>67</sup>

Table 2 summarizes policy measures and their implementation in the six German and Polish cities selected here for in-depth local policy analysis. Some of the policies are typically adopted at national levels, such as tax benefits for the purchase and operation of an electric vehicle, shown in dark green. Other measures have been imple-

mented at local levels, displayed in lighter green. Some actions are based on national level legal frameworks or programmes but implemented at local levels as well such as parking benefits for electric vehicles or public charger promotion programmes. Those actions are highlighted in the table in dashed green colors. Of the policies analysed, most have also been adopted in the six leading electric vehicle cities selected in terms of 2020 new electric vehicle registrations in their respective countries.

67 mtp (2019).

**Analysis of selected national and local level policies with focus on six selected German and Polish cities**

**Table 2**

City Share and total new electric (battery electric and plug-in hybrid electric) car and van registrations in 2020	EV purchase and operation							EV charging infrastructure deployment		EV strategies, fleet integrations, and public awareness raising					
	BEV purchase benefits	PHEV purchase benefits	Electric vehicle registration tax benefits	Electric vehicle ownership tax benefits	Electric vehicle benefits for companies (employers and employees)	Electric vehicle parking benefits	Electric vehicle charging benefits	Electric vehicle road infrastructure use and access benefits	Public charger promotions for electric vehicles	Private home and workplace charger promotions for electric vehicles	Electric vehicle goals	Strategic actions	Municipal electric vehicle fleet integration programmes	Electric vehicle sharing and hailing operations	Electric vehicle information and education
<b>Berlin</b> Cars: 17%, ~11,000 total Vans: 2%, ~250 total	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
<b>Stuttgart</b> Cars: 20%, ~9,000 total Vans: 4%, ~70 total	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
<b>Leipzig</b> Cars: 12%, ~1,700 total Vans: 1%, ~20 total	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
<b>Warsaw</b> Cars: 2%, ~2,000 total Vans: 1%, ~20 total	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
<b>Krakow</b> Cars: 2%, ~600 total Vans: 2%, ~50 total	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
<b>Poznan</b> Cars: 2%, ~600 total Vans: 2%, ~60 total	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■

■ National EV promotion action     
 ■ Local EV promotion action     
 ■ National and local EV promotion action

Agora Verkehrswende | 12/21; Source: ICCT

## 4 | Further factors influencing electric vehicle adoption

Understanding beneficial and hindering boundary conditions can help policy makers address the main barriers to electric vehicle uptake. Common barriers include high costs, low electric vehicle model availability, sparse charging infrastructure deployment, and other specific local-level barriers. These subjects are analysed in more detail in the following section. A qualitative literature assessment was paired with local stakeholder interviews from the cities of focus to make up the base of the analysis.

### **One-time purchase incentives make electric cars cost competitive or less expensive in Germany compared to petrol and diesel cars, while in Poland they bear higher costs**

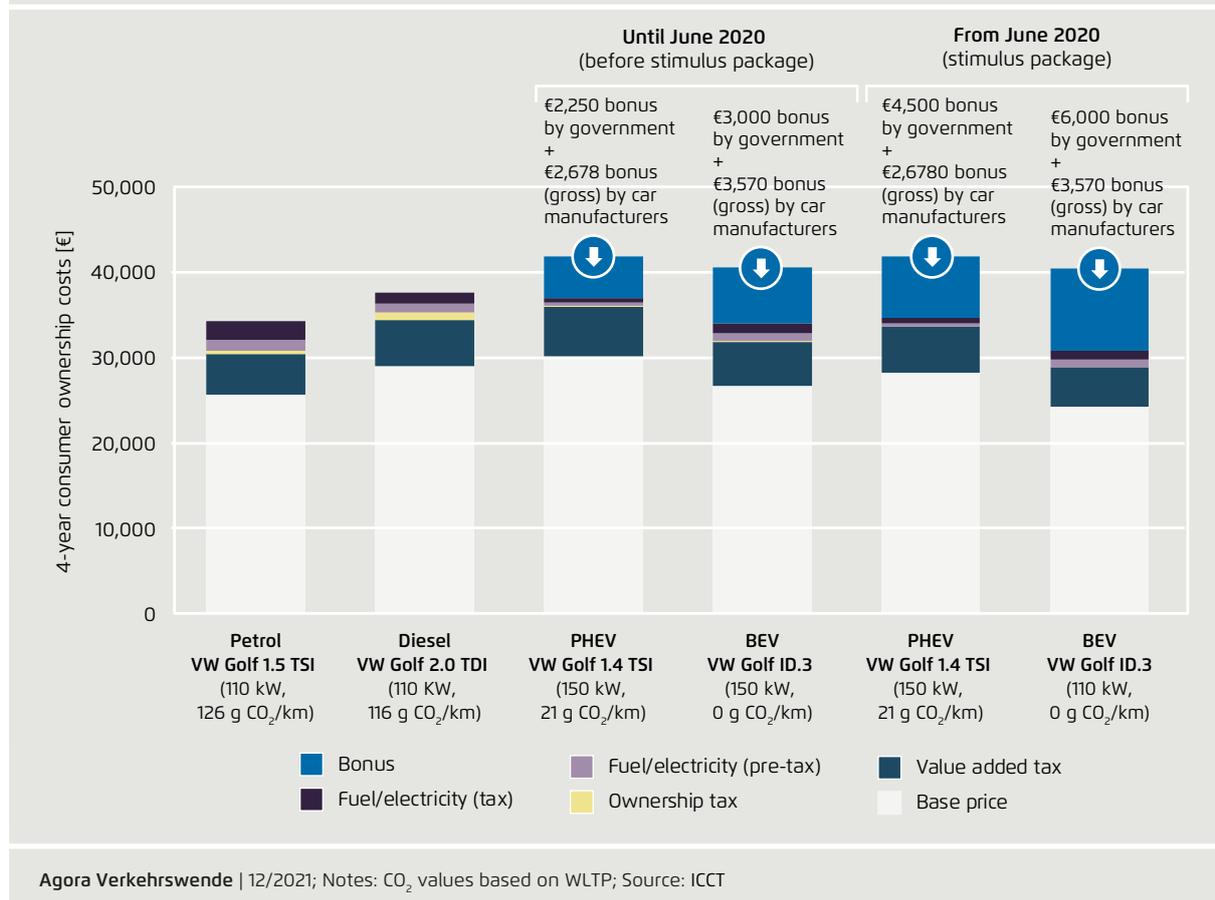
To evaluate the effects of taxes, tax breaks, and one-time purchase incentives on the total cost of ownership for newly purchased cars and vans we choose comparable petrol, diesel, PHEV, and BEV versions of the Volkswagen Golf, the best-selling passenger car model in the EU. The costs are shown over a period of 4 years, discounted at 6% for annual cost components, and assume private holders. In the absence of registration tax, the cost comparison includes the one-time costs of car purchase (base price, VAT, excise duty, registration fee), ownership taxes, and fuel costs, differentiated by pre-tax and taxed price. Information on fuel consumption is based on the Worldwide harmonized Light vehicles Test Procedure (WLTP). Fuel prices reflect average values for 2020, and electricity prices for household consumers with a consumption between 5,000 kWh and 15,000 kWh were applied, based on average prices in Germany and Poland in 2020. We also assume that private holders charge their electric car only at home. For all vehicle types, we consider vehicles to be driven 13,000 km per year due to lack of specific data by fuel type for Poland. Results reflect purchase and tax benefits for the year 2020 to compare with electric vehicle uptake in that year and potential supporting or hindering factors. In the case of bonus payments, the base prices are adopted accordingly and do not reflect the initial purchase price at the car dealers.

Figure 7 shows the results for a German consumer purchasing a new passenger car in 2020, before and after the introduction of the COVID-19 stimulus package, which resulted in increased governmental bonus amounts for BEVs and FCEVs. Prior to its introduction in the first half of 2020, the BEV Volkswagen Golf ID.3 was cost-competitive with the petrol Volkswagen Golf and less expensive than a diesel variant over a 4-year holding period. The PHEV Volkswagen Golf was only cost-competitive with the diesel version of the Volkswagen Golf. After the introduction of the COVID-19 stimulus package in June 2020 with increased governmental bonus amounts, the PHEV bears the same costs as a comparable petrol version of the Volkswagen Golf over 4-years. The BEV Volkswagen is about €3,500 less expensive than the petrol version in 4-years. Despite waivers on ownership tax for BEVs in Germany, the effect is marginal. It is primarily the purchase incentive that brings down the costs of BEVs and PHEVs.

The same comparison for Poland derives different results. In most of 2020, the reference year for the analysis, the bonus payment would not have applied to the BEV Volkswagen Golf since the base price would have exceeded the price cap for receiving the incentive at car purchase (Figure 8, left). Consequently, the BEV and PHEV versions of the Volkswagen Golf are significantly higher in costs over 4-years than the comparable petrol and diesel versions. The waivers on excise tax for BEVs have a marginal effect on the 4-year ownership costs and lower consumptions costs for fuel compared to electricity use cannot bring down the cost significantly. Over a 4-year holding period, the BEV Volkswagen Golf ID.3 bears higher costs of about €12,000. Despite a lower base price, the PHEV Volkswagen Golf is also higher in costs by about €7,500 in 4 years. With the new subsidy scheme introduced in mid-2021, granting a one-time subsidy of €4,100, but raising the price cap from €27,400 to €49,200, the BEV would become cost competitive with the comparable PHEV version but would be still more expensive than the petrol or diesel version (Figure 8, right).

4-year consumer ownership costs for comparable passenger cars in Germany by fuel type before and after the introduction of the COVID-19 stimulus package in June 2020

Figure 7



### Model availability of electric passenger cars and vans is significantly higher in Germany than in Poland

Adequate numbers of electric vehicle models on the market can help spur electric vehicle demand, lower purchase costs, and create competition amongst vehicle manufacturers. Development of new electric vehicle models are often driven by higher vehicle standards and national support policies. Here we display the number of electric vehicle models for battery electric vehicles, plug-in hybrid electric vehicles, and battery electric van models for Germany and Poland. As a proxy, we use the number of different models registered and count in only those which had more than 20 new registrations per month.

Figure 9 shows monthly battery electric model availability in Germany and Poland in 2020. Germany had higher amounts of battery electric vehicle models registered at the end of 2020 compared to the beginning of the year. Model availability through the year ranged from under 25 to over 40 battery electric options to choose from. In May 2020, Germany saw the lowest levels of new model registrations, however, by December, the total available models reached over 40. The partial dip in May can in part be attributed to the onset of the COVID-19 pandemic which resulted in lower levels of global economic activity. However, after May, overall model availability increased gradually and peaked at the end of the year. In Poland, battery electric vehicle model registrations did not follow such a clear trend throughout the year. Overall, the model availability ranged from under 5 models to over 10 models in 2020. Like Germany, the lowest point of new electric

4-year consumer ownership costs for comparable passenger cars in Poland by fuel type in 2020 (left) and 2021 (right)

Figure 8



Agora Verkehrswende | 12/2021; Notes: CO<sub>2</sub> values based on WLTP; Source: ICCT

vehicle model registration occurred near April and May, likely due to the pandemic. However, in September new model registrations peaked at 10 models, with the end of the year seeing slightly lower rates of availability.

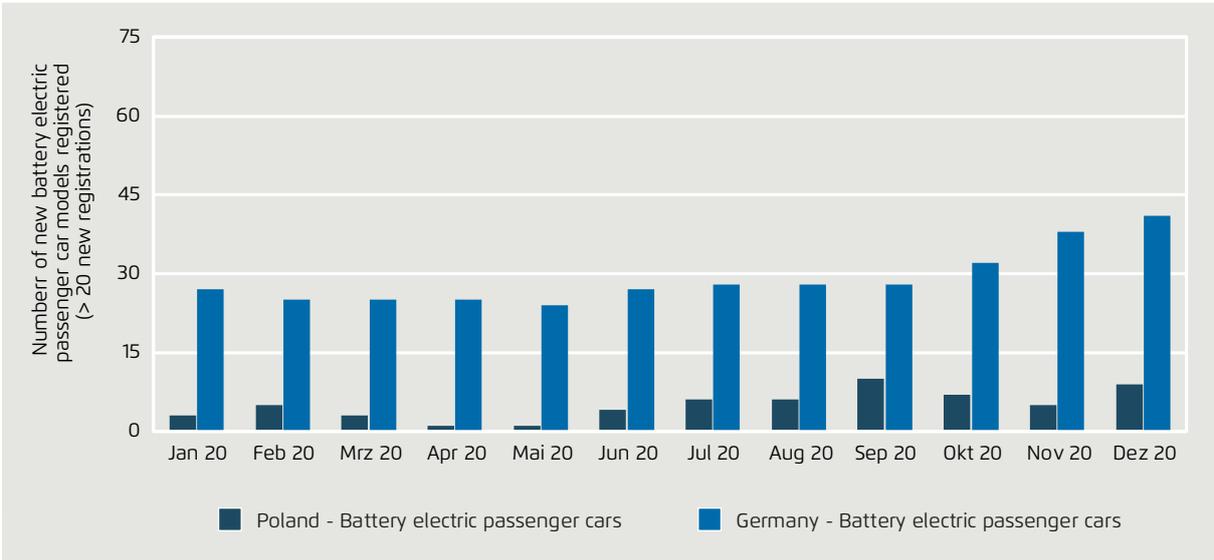
PHEVs saw significantly more available models in Germany compared to BEVs (Figure 10). During 2020, the range of vehicles went from just below 40 available models to over 60 by the end of the year. This trend followed that of the battery electric vehicles, with the highest month occurring in December and the lowest in April and May. Despite higher amounts of PHEV models available, this did not necessarily lead to higher uptakes in PHEVs compared to BEVs. New BEV registrations were above PHEVs in Germany by the end of 2020. Poland,

unlike Germany, had higher available models of BEVs, with PHEVs ranging from 2 to 6 models in 2020. Despite the relatively lower amount of available PHEV models compared to BEVs, Poland had a higher PHEV uptake at the end of 2020.

Battery electric vans see lower levels of available models compared to both BEVs and PHEVs (Figure 11). During 2020, Germany had a range of 3 to 10 available BEV van models, seeing its lowest points in July and August and peaking in November. Poland saw only 1 electric van model that recorded greater than 20 registrations, which was observed in December 2020.

New battery electric vehicle model registrations in Germany and Poland in 2020

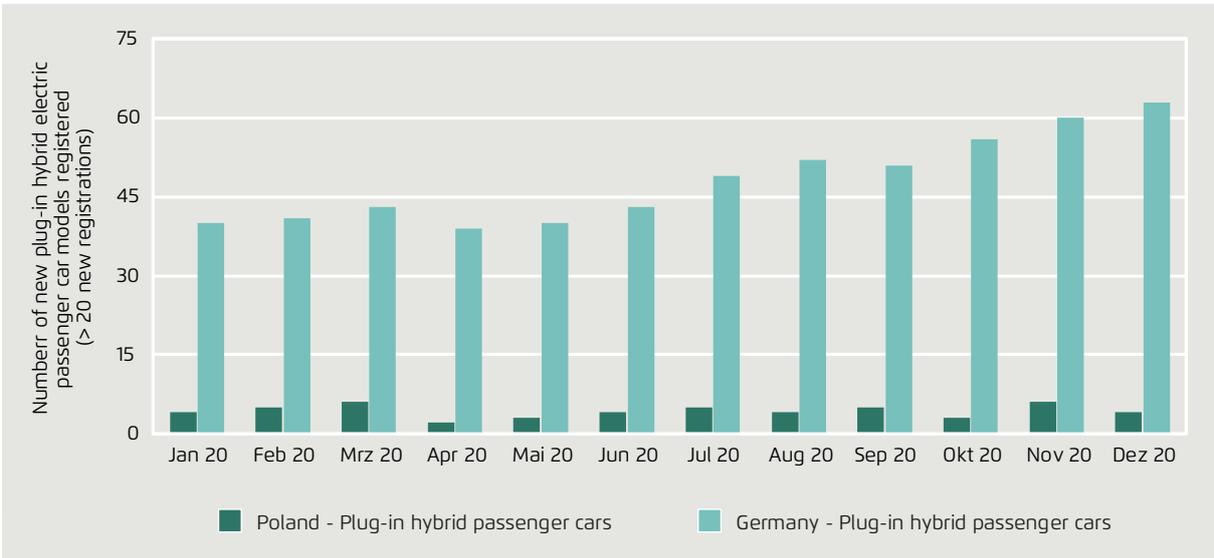
Figure 9



Agora Verkehrswende | 12/2021; Source: Rajon Bernard, et al. (2021)

New plug-in hybrid electric vehicle model registrations in Germany and Poland in 2020

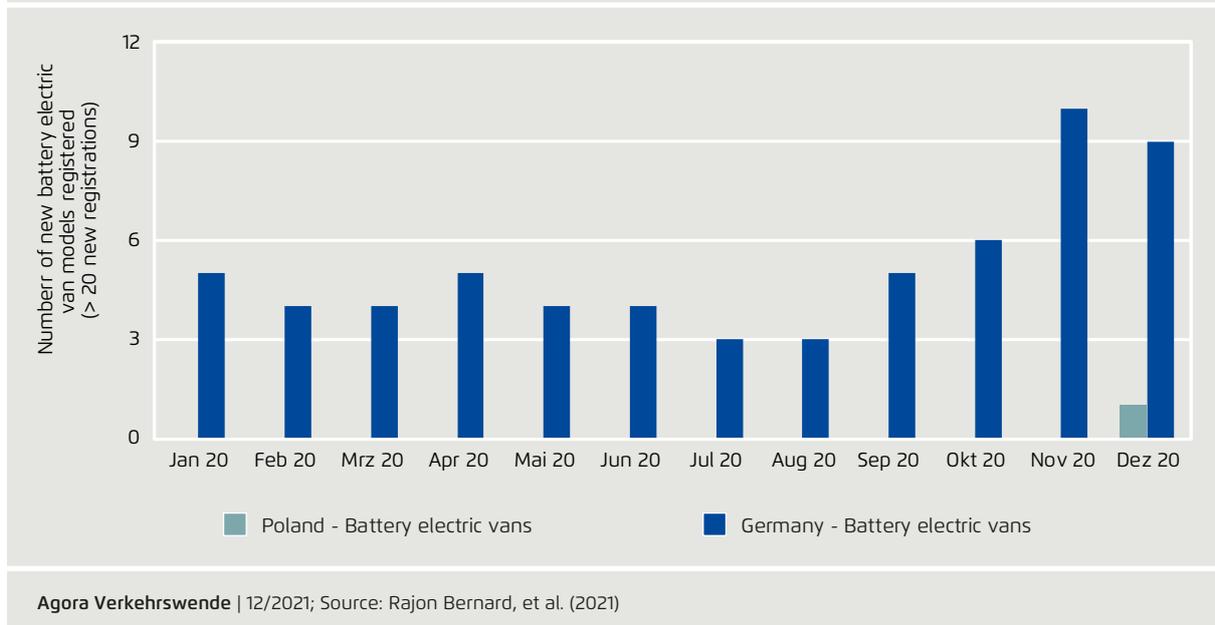
Figure 10



Agora Verkehrswende | 12/2021; Source: Rajon Bernard, et al. (2021)

New plug-in hybrid electric vehicle model registrations in Germany and Poland in 2020

Figure 11



Agora Verkehrswende | 12/2021; Source: Rajon Bernard, et al. (2021)

### In the European context, Poland has a comparably high percentage of fast charging points while Germany scores on average lower also in terms of fast charging on the highway network

Understanding public charging infrastructure deployment can assist in removing charging bottlenecks and improve consumer confidence with electric vehicles. Public charging deployment varies among cities and countries based on varying socio-economic factors and local policies in place. To best understand how Germany and Poland compare to other European nations, we display public charging infrastructure deployment for both countries and relate them to the European context using different metrics.

Normal- and high-power public charging points have developed significantly throughout Europe since 2010. This is in part due to the increased charging demand as well as increased funding coming from national governments. In 2010, only 3,200 normal public charging points were available across Europe, the majority located in Norway, and no high-powered charging points were publicly accessible. Compared to the numbers in 2020, with over 246,000 normal-power public charging points and over 37,600 high-power charging points, the growth trajectory was significant. Normal-power charging

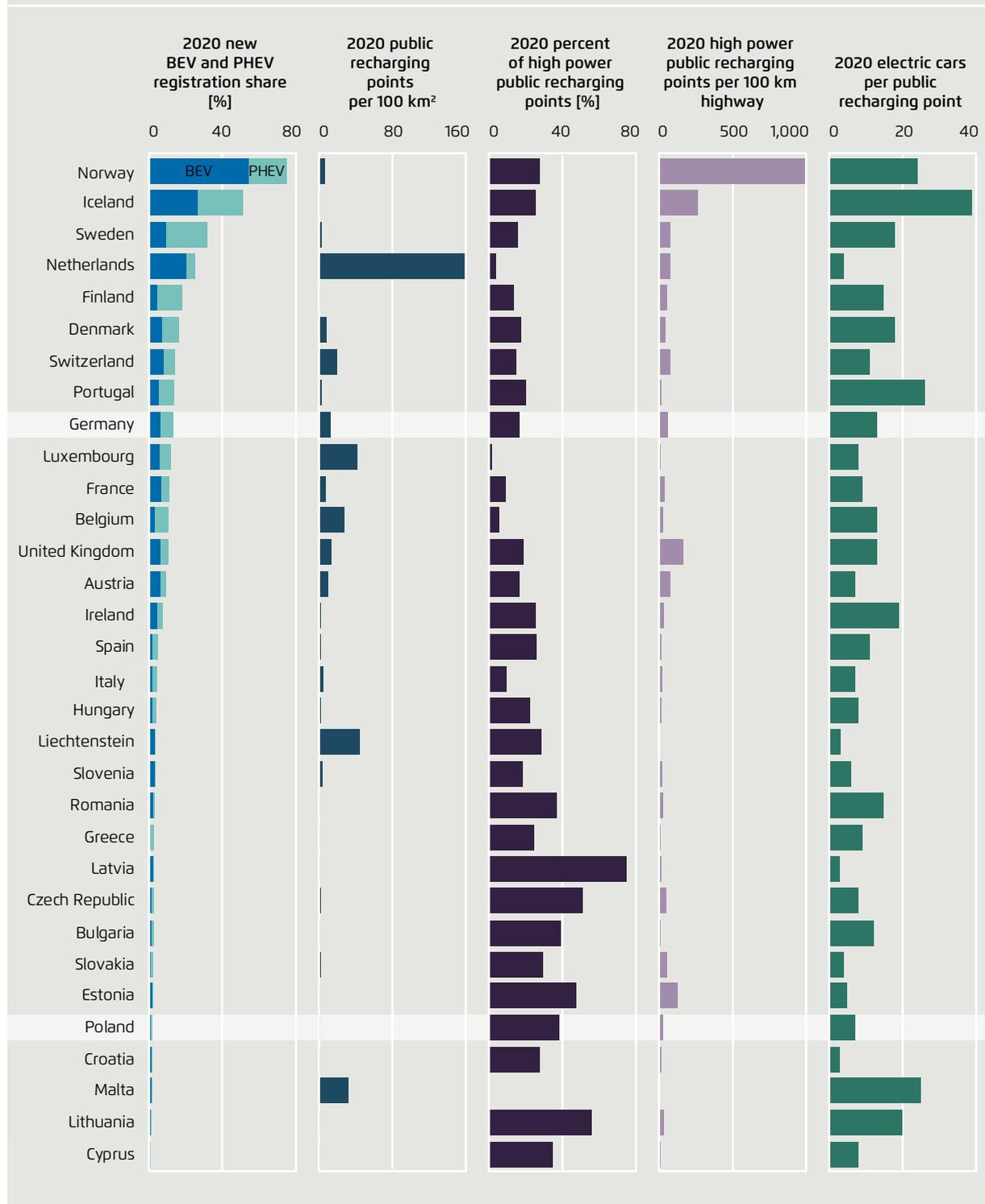
points still hold the majority compared to the high-power public options; however, these levels vary at the national and regional level.

The charging infrastructure development, as well as new BEV and PHEV registration shares across Europe for the year 2020, are displayed in Figure 12. Across the respective European countries, charging infrastructure varies in charging points per 100 km<sup>2</sup> of highways, as well as the percentage of public fast charging points and fast charging points per 100 km of highway. Countries with the highest public recharging points per 100 km<sup>2</sup> did not necessarily have the highest uptake in electric registration shares. For example, Norway had a nearly 80% new electric vehicle registration share in 2020 but had a lower public charging point per 100 km<sup>2</sup> compared to the Netherlands, Luxembourg, and Liechtenstein. Despite this, Norway saw high levels of public recharging points per 100 km of highway. Moreover, countries like Latvia, the Czech Republic, and Lithuania saw a high percentage of high-power public recharging points but still had lower electric registration shares than other European nations.

Additionally, electric vehicles per public charging point is an important element to the discussion. The European Commission has recommended 1 public charging

Public charging infrastructure deployment in Germany and Poland in 2020 based on different metrics compared to other European countries

Figure 12



Agora Verkehrswende | 12/2021; Source: EAFO 2021 c; Germany and Poland highlighted in light grey

point for every 10 electric vehicles. As it stands, many countries exceed this limit, including Iceland, Portugal, Malta, and Ireland. Yet, despite this, some of those who do exceed the recommended amount are still observing high rates of new registrations. Germany and Poland both saw under 20 electric cars per public charging points making them closer to the European Commission's recommendation in comparison to other nations.

### Germany has much higher public charging infrastructure deployment than Poland

Widespread public charging infrastructure deployment is necessary to provide adequate charging opportunities to electric vehicle users. Continued development of charging points will help support the transition away from combustion engine cars. This section illustrates the total public charging infrastructure per million inhabitants of Germany and Poland as a proxy for the density of the network. The data is overlaid across the 401 German and 73 Polish regions outlined in light grey with federal and national states and provinces outlined in dark grey.

For Germany, the scale ranges from less than 250 charging points per million population to over 1,600 (Figure 13). In general, Germany displays higher public charging infrastructure deployment outside urban regions. The top 5 urban regions in Germany include Landau in der Pfalz (about 1,400 charging points per million population), Stuttgart, Essen, Munich, and Baden-Baden, all situated in the southern or western parts of Germany.

In Poland, the public charging infrastructure network is less dense (Figure 14). The scale goes from less than 25 per million inhabitants to more than 200. Urban regions saw higher numbers of chargers per million inhabitants in Poland than outside urban regions. The top 5 urban regions in public charging infrastructure density in Poland include the city of Katowicki (almost 500 charging points per million inhabitants), Trójmiejski, Kraków, Poznan, and Gliwicki.

### Local stakeholders rate costs, model availability, charging infrastructure deployment, and awareness as key in electric vehicle adoption

Benefits and barriers to electromobility are highly affected by local economic and social circumstances. Electric vehicle uptake is influenced through policy but also by the specific regional conditions. Costs, model availability, charging infrastructure deployment, and awareness, all play a large role. It is necessary to understand how these conditions affect electric vehicle uptake in urban regions, and we explored these conditions by interviewing ten experts from the cities of Berlin, Warsaw, Krakow, and Stuttgart. The following results reflect key opinions and statements by the local stakeholders in terms of supporting and hindering factors in terms of electric vehicle adoption.

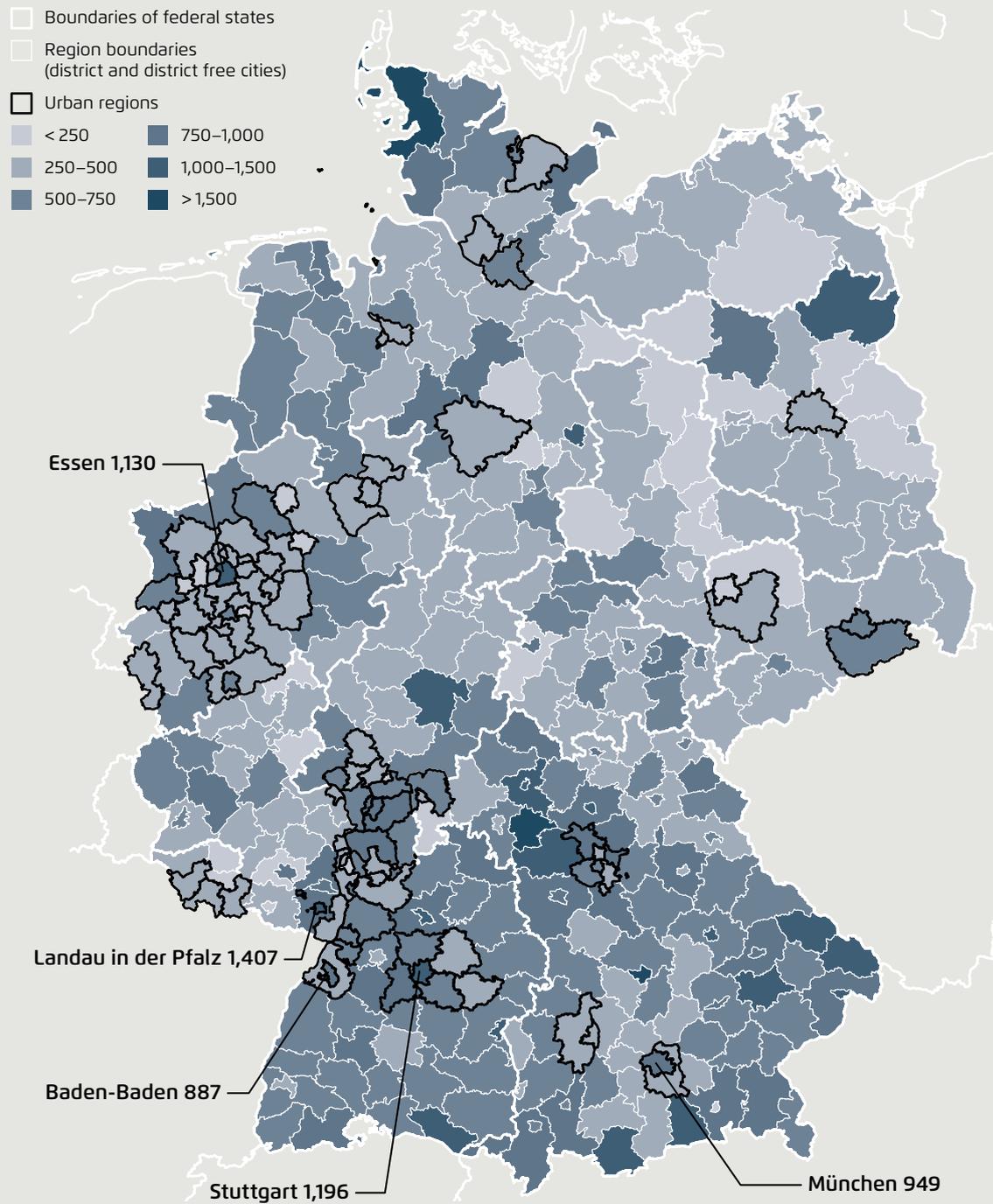
**Costs.** Many consumers believe that purchase and operation cost gaps remain a barrier to electric vehicle uptake in Germany. Increased awareness on true cost gaps could be achieved to overcome this perceived barrier. Other aspects of costs related to infrastructure development in Germany remain limiting. Stakeholders in Stuttgart and Berlin suggested that the costs of implementing charging infrastructure stations, especially in private homes, could prevent the needed acquisition of a widely accessible charging infrastructure network. As it stands, no further local policy instruments are envisioned for the city of Stuttgart or Berlin to reduce these infrastructure costs.

In Warsaw and Krakow, the cost gap between electric vehicles and non-electric vehicles does remain a barrier to electric uptake. In Poland, higher upfront investments burden consumers, however, this could be alleviated via a steady and strong national purchase incentive to reduce electric vehicle costs. Additionally, changing market dynamics and increased electric production capabilities could aid in driving down costs. For example, the construction of more electric production facilities within Europe could increase supply and reduce import tariffs, thereby lowering total purchase costs.

**Model availability.** Lack of sufficient numbers of affordable models across the German and Polish markets could reduce purchase rates of electric vehicles. City experts in Stuttgart, Berlin, and Warsaw suggest that more affordable models on the market could increase electric vehicle uptake in their regions. Some progress has been

Total public charging infrastructure per million inhabitants in German regions; urban regions are highlighted in black with the top 5 urban regions for charging infrastructure deployment density labeled

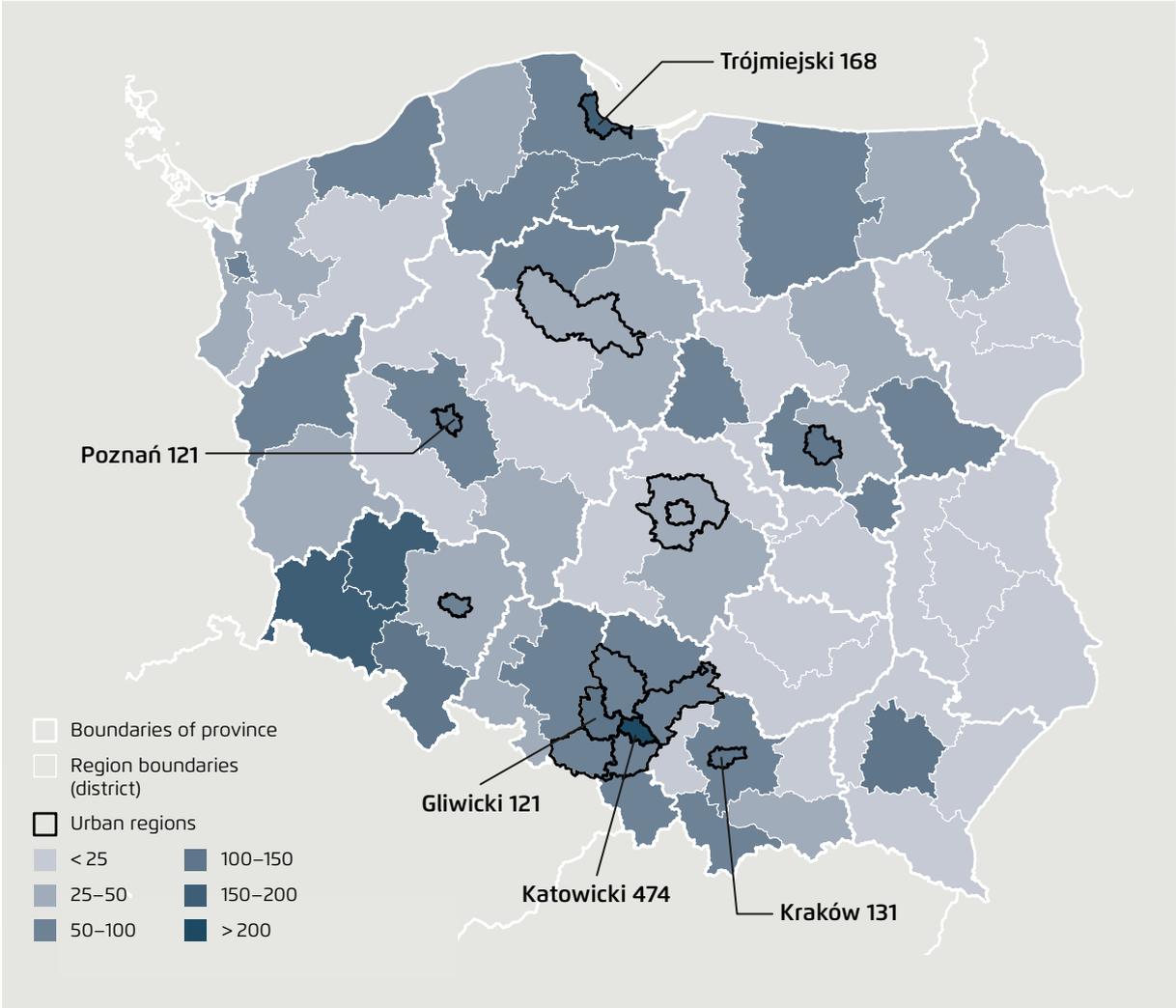
Figure 13



Agora Verkehrswende | 12/2021; Source: Rajon Bernard, et al. (2021)

Total public charging infrastructure per million inhabitants in Poland regions; urban regions are highlighted in black with the top 5 urban regions for charging infrastructure deployment density labeled

Figure 14



Agora Verkehrswende | 12/2021; Source: Rajon Bernard, et al. (2021)

made, for example, with the unveiling of the Volkswagen ID.3, however, higher model availability could potentially increase electric vehicle uptake. As many consumers buy second-hand cars and more affordable models, lack of affordable models might prevent electric development in Warsaw, despite a willingness to drive electric. A push to develop a Polish electric vehicle brand has been made by the national government, however, it is unclear if this could alleviate the availability limitations. Experts in Berlin are hopeful about the future of model availability due to increased legal pressure on car manufacturers to reduce emissions and adhere to environmental regulations.

**Charging infrastructure deployment.** As it currently stands, charging infrastructure remains a burden to electric uptake in Stuttgart and Berlin. Higher numbers of charging stations would be needed to keep up with increasing demand of electric vehicle users. City planners attempt to distribute charging infrastructure evenly across the city based on population distribution as well as jobs, with a focus on maximizing charging points in the city area. The German Building Electromobility Infrastructure Act and the Apartment Modernization Act allow for private individuals to install charging points within their own residence; however, this process can be cost intensive and complex. Experts in Berlin cited that long wait times for electric charging installation might be a hindering factor to infrastructure development. Stuttgart has additionally implemented a model of charging infrastructure deployment, like Berlin, where private companies can construct charging points on public property. While this approach increases the number of charging points, some legal issues regarding fair competition and antitrust laws are not clear. Additionally, experts imply that increased European wide standards for charging stations would be beneficial especially for cities, like Stuttgart, that are in driving distance to other nations. Lack of charging infrastructure in districts with a majority of multi-dwelling buildings is also likely a barrier to Warsaw and Krakow, especially in the outskirts of both cities. Public charging points (low power AC chargers) would need to be developed mainly on parking plots around multi-dwelling buildings to keep up with the rising demand of electric vehicles as purchase rates continue to rise. In Warsaw, public charging points exist mainly in park and ride and shopping center facilities across the city center, however, overnight public charg-

ing at parking plots should be made more accessible. The city council has plans to establish an additional 1,000 points to comply with the Act on Electromobility and Alternative Fuels.

**Awareness.** A lack of understanding of the benefits and regulations surrounding electric vehicles stands as a major barrier to electromobility in Berlin, Stuttgart, Krakow, and Warsaw. Confusion regarding requirements regarding national and local policies remain among consumers as well as some government administrators. Establishing clearer standards for city and local policy makers could assist in reacting to and implementing federal and national initiatives and laws. Experts in Stuttgart suggested that many local-level administrators were unclear about some of the nationwide initiatives and suggested that a universal approach provided by the national government to more local institutions could help reduce potential irritation. Experts in Berlin cited disinformation campaigns and unreliable news sources as factors that might prevent faster electric vehicle adoption. Consumer awareness and education around electric vehicles should also increase in Warsaw to promote electromobility. Warsaw is already a member of the C40 city leadership group, which commits the city to reducing greenhouse gas emissions as well as increasing adaptability to climate change impacts. This membership increases exchange with international cities on electromobility and has also led it to take actions as part of the C40 cities Green and Healthy Streets Declaration. This declaration commits the city council to increasing usage of electric buses as well as incorporating a zero-emission zone by 2030. City experts explain that while younger generations have a positive view of electric vehicles and their benefits to the environment, higher awareness of the rest of the population will benefit the city.

## 5 | Best-practice city examples: Berlin, Stuttgart, Warsaw, and Krakow

Established good practices in terms of local policies can set an example to for other cities on how to increase uptake in their respective regions. In this section, we highlight policies and actions that are implemented in four cities across Germany and Poland which have a leading share of electric vehicles. These cities include the German cities of Berlin and Stuttgart and the Polish cities of Warsaw and Krakow. We first examine the development of the electric vehicle markets in each city. This includes analyzing the growth of the total number and shares of electric vehicles for BEVs and PHEVs from 2019 to 2020. We also look at holding groups and the fuel types to better understand market trends for 2020. It is important to note that registration data will not always reflect the current usage of electric vehicles in the city in which they were registered. For example, cities can be seats of major leasing companies which will register a vehicle in one location only to transfer the vehicle to another city. Absolute public charging infrastructure maps for the four cities of focus are shown to give a sense of charging availability and its spatial distribution. Finally, we dive deeper into the local policies of the respective cities and describe how these might have positively impacted electric vehicle uptake.

**BERLIN: With 17% of new passenger cars registered being electric cars, their uptake was 4 percentage points above the German average in 2020; companies dominate in their registrations; public charging infrastructure is concentrated in the inner-city areas**

Berlin, the capital and largest city in Germany with over 3.6 million inhabitants, has seen continued growth in electric vehicle uptake. In 2020, the city saw a total of almost 11,000 electric passenger cars registered resulting in a share of 17%. Berlin saw a higher uptake in 2020 compared to the German average, which stood at 13%. However, differences still exist between user holding groups<sup>68</sup> and fuel types in terms of rates of vehicle uptake, for example, some groups show a preference for PHEVs over BEVs. To continue the electric vehicle growth, the city has enacted several unique policies

including the WELMO funding programme, as well as extending its charging infrastructure network.

The yearly development of BEVs and PHEVs is important to distinguish as BEVs emit lower levels of emissions through their lifecycle compared to PHEVs.<sup>69</sup> In Berlin, from the years 2019 to 2020, total new BEV registrations rose from about 4,000 to almost 5,000 and new PHEV registrations rose from almost 1,500 to 6,000 (Figure 14). The share of BEVs and PHEVs rose from almost 5% to 8% and from almost 2% to 9%, respectively, between 2019 and 2020. The largest growth was seen amongst PHEVs which in this period saw an increase by more than 7 percentage points. This shows that while both electric vehicle types are experiencing growth, there was a slight preference for PHEVs between 2019 and 2020.

In 2020, new electric passenger car registrations in Berlin saw a relatively high distribution among companies (Figure 16, right). The highest new registration shares of electric passenger cars belonged to company cars (here referred to as true fleets as it excludes short-term rentals and registrations by car manufacturers and dealerships) at 46%. New electric vehicle registrations were the second highest amongst private individuals which accounted for 33% of new electric passenger car registrations. The lowest share belonged to short term rentals, car manufacturers, and dealerships, with 21% of the share. If comparing with new registrations of all passenger cars in Berlin by holding groups, private registrations dominated with 40% of total new passenger car registrations in 2020 versus 33% if looking at new electric passenger car registrations.

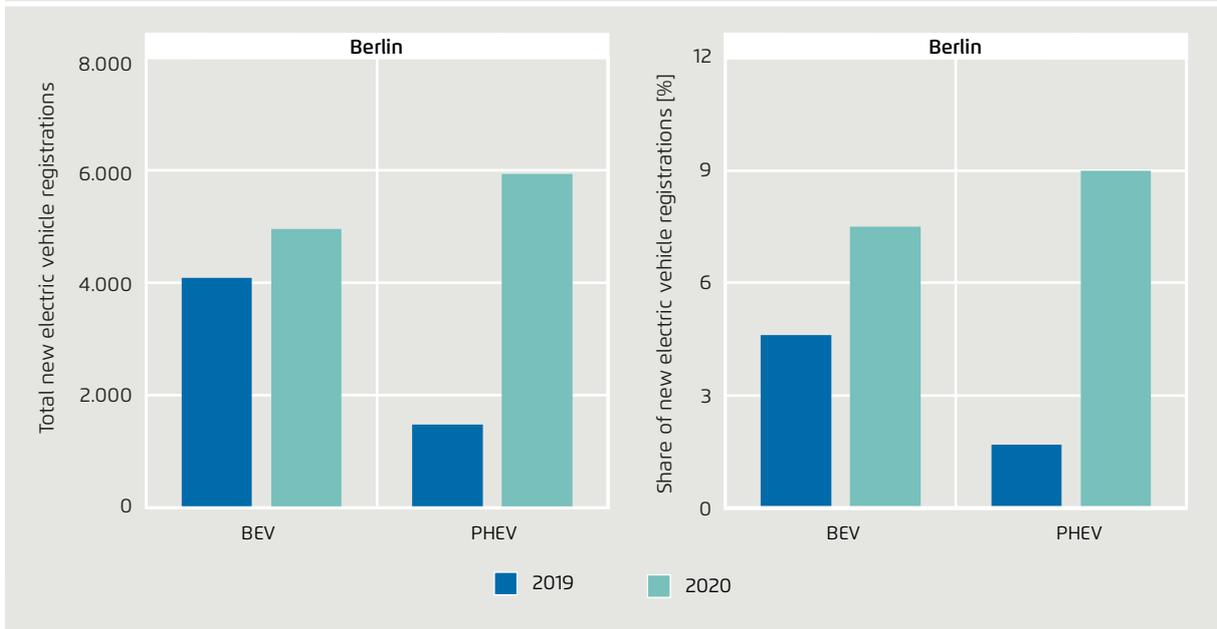
Figure 17 illustrates new passenger car registrations for Berlin in 2020 further differentiated by fuel type and the various user groups. Amongst private individuals, 13% of the newly registered passenger cars were electric vehicles, with a slight preference towards BEVs at 7% and PHEVs at 6%. Short term rentals, OEMs, and dealerships had slightly higher registration rates of electric vehicles at 16% with even uptake amongst BEVs and PHEVs. The share of newly registered electric passenger cars for true

68 User holding group denotes the specific demographics of the vehicle consumer group (i.e. private individuals, car dealerships, etc.)

69 Wappelhorst; Bieker (2021).

Total and share of new electric passenger car registrations in Berlin in 2019 and 2020

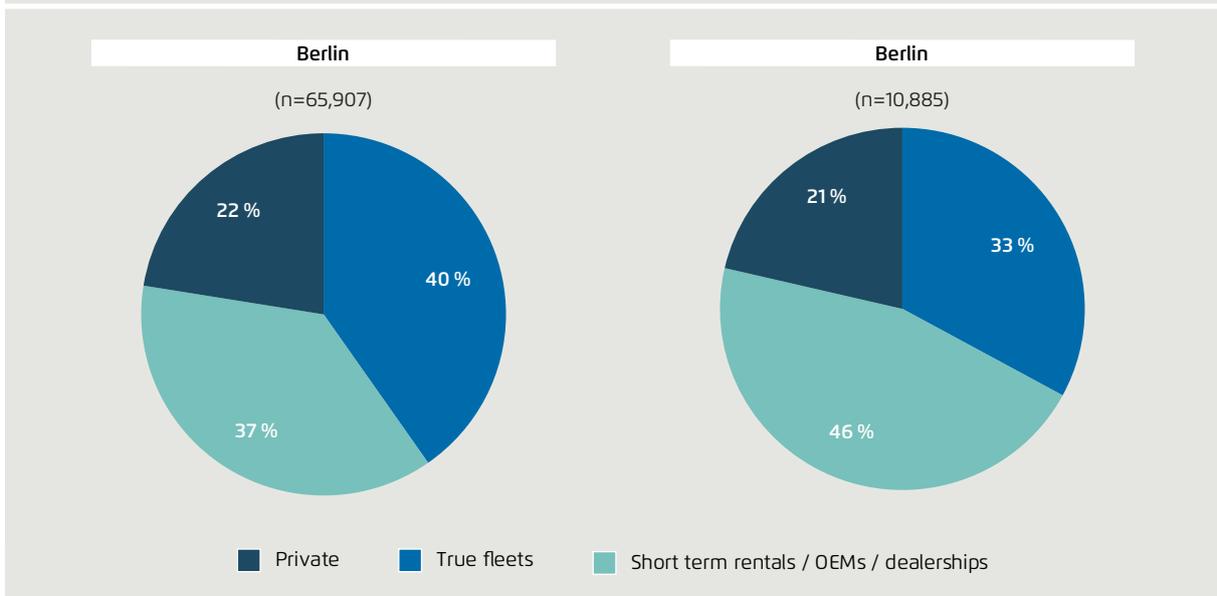
Figure 15



Agora Verkehrswende | 12/2021; Source: Rajon Bernard, et al. (2021)

New passenger car registration shares in Berlin in 2020 by holder group for the entire passenger car market (left) and electric passenger car registrations specifically

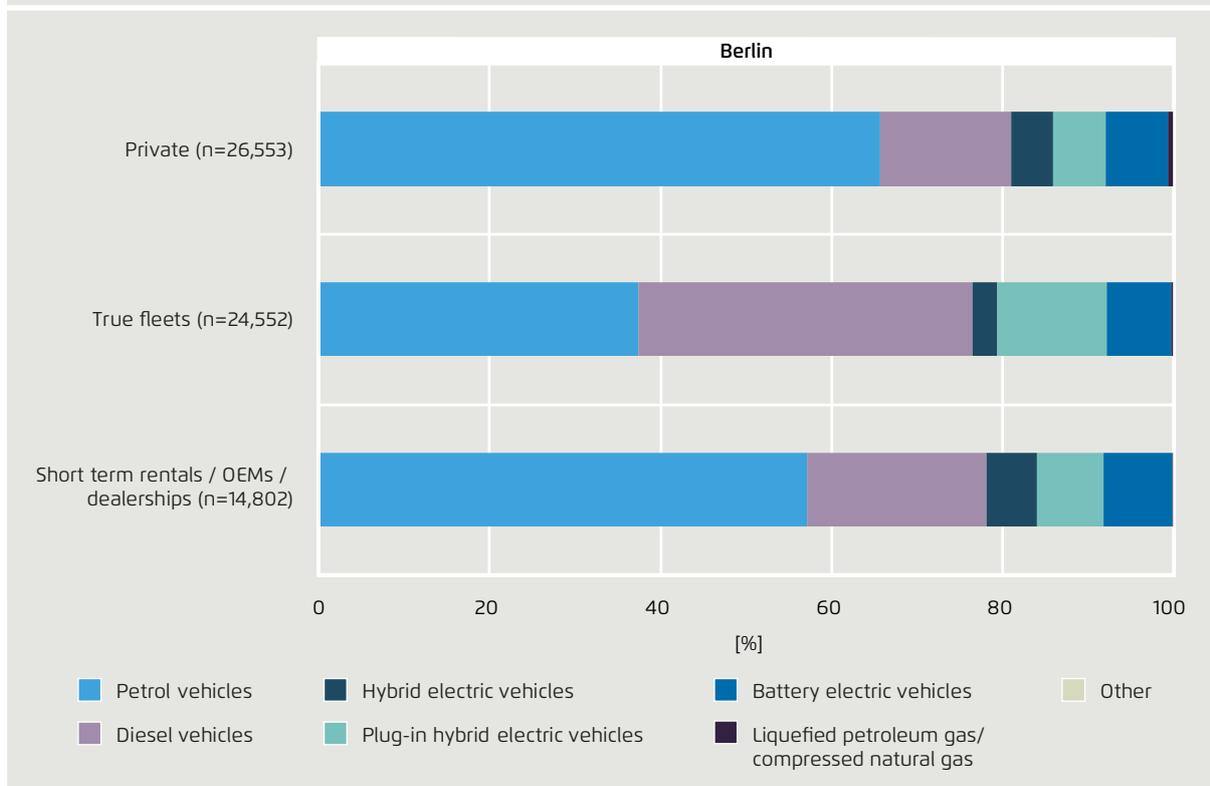
Figure 16



Agora Verkehrswende | 12/2021; Source: Dataforce

New passenger car registration shares in Berlin by holder group and fuel type in 2020

Figure 17



Agora Verkehrswende | 12/2021; Source: Dataforce

fleets<sup>70</sup> (in the following referred to as “company cars”) were highest at a total of 20%, with 13% of the registration shares made up from PHEVs. Overall, companies purchased new electric passenger cars at the highest percentage and private individuals had the lowest rates. However, a large proportion of new cars were still petrol cars and for company fleets (true fleets) also diesel cars.

In terms of public charging infrastructure to further spur the uptake of electric vehicles, Berlin had installed about 1,600 normal and about 100 fast charging stations by the end of 2020 throughout the city. Charging distribution for the city of Berlin by the end of 2020 was relatively widespread with a concentration in the inner city, reflecting neighborhoods with higher population

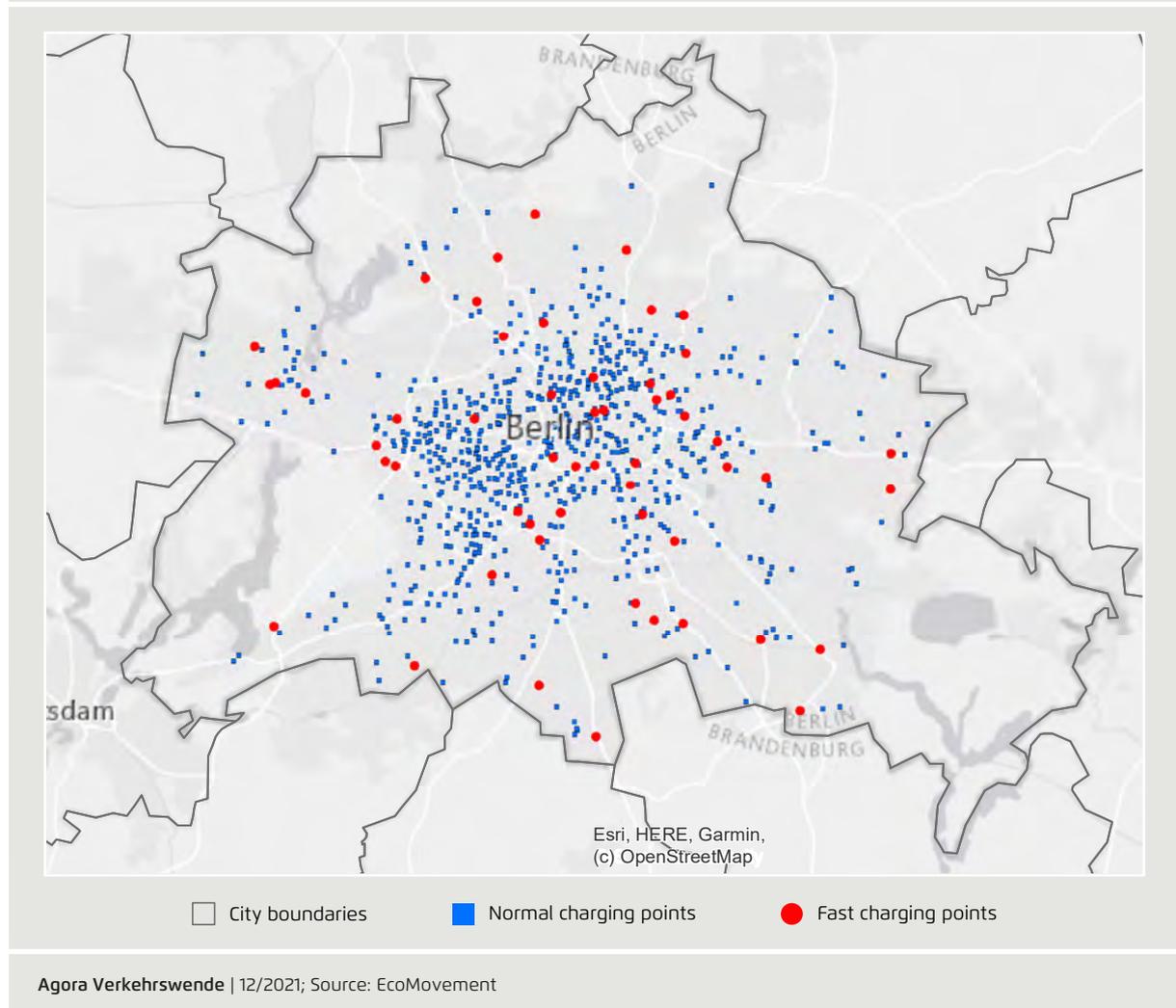
70 True fleet data includes company cars, long-term rentals, leased vehicles, taxis, and cars belonging to driving schools, public administrations, and diplomats. In the following, we refer to them as “company cars”.

concentrations. Further outside the city charging points were more disperse yet largely concentrated on main roads, as shown in Figure 18. In general, most of the charging points were normal, but fast charging points existed and were, in general, evenly spread throughout the various neighborhoods. Note that many charging points existed in the middle of the city where many businesses and companies operate.

The success of the increased electric vehicle registrations in Berlin can in part be attributed to several initiatives occurring within the city. For example, the WELMO programme, funding by the Senate Department for Economics, Energy, and Enterprises, grants small and medium-sized companies purchase incentives for electric vans. Funding to companies assists in electric vehicle uptake by not only promoting the electric market, but also encouraging corporations to install charging infrastructure to support electric vehicles. The programme has been highly successful according to the Berlin Senator for

Absolute charging infrastructure deployment in Berlin 2020

Figure 18



Economic Affairs and can be used in conjunction with the national environmental bonus.

On top of this development programme, Berlin has created specific guidelines to best develop the city's charging infrastructure network. This occurs through the German institute for Standardization, which has established four main guidelines for this development. These include that the design of charging points should be focused on traffic links and major roads and compatible with the electric network. Additionally, the German institute for Standardization aims to make the charging infrastructure as efficient and user-friendly as possible as to provide the most benefits to electric vehicle drivers.

The charging infrastructure also incorporates what is known as the "Berliner Model" which involves private landowners in the development of charging stations. The use of private land for public charging infrastructure rather than public land is an attempt to preserve public spaces in the city for other uses, as the Berlin Senate describes, much of the public land is already reserved for passenger cars in the form of parking spaces or petrol stations.<sup>71</sup>

Berlin has also implemented an LEZ in the city, limiting which vehicles may travel in the zone. The restrictions are in force 24 hours a day, 7 days a week, and was

71 SenUKV (2021).

established by the city to reduce levels of harmful air pollutants. While the zone still allows some combustion engine vehicles to pass through, having an established LEZ can make the transition to a zero-emission zone easier, which would largely benefit electric vehicle drivers. The city zone enforces the minimum standard of a diesel Euro 4 and has since July 2019 included route bans beneath diesel Euro 6 models.<sup>72</sup> To further improve local air quality by also stimulating electric vehicles, Berlin is planning a ZEZ in “medium-term”.

Lastly, Berlin is a member of the C40 city initiative. This membership involves special knowledge sharing on sustainable initiatives and includes participation in declarations towards clean mobility. In 2020, Berlin signed the Clean Bus Declaration which aims to increase levels of low or zero emission buses in the city and invites the cooperation between electric bus manufacturers and city governments. Berlin also signed the green and healthy streets declaration, which aims to transform city policies to reduce the number of combustion engine vehicles on the road while simultaneously promoting zero emission vehicles. This involves reporting progress on goals every two years.

**STUTTGART: With 20% of new passenger cars registered being electric cars, their uptake was 7 percentage points above the German average in 2020; short-term rentals, manufacturers, and dealerships dominate in their registrations; public charging infrastructure is concentrated in several Stuttgart neighborhoods**

The city of Stuttgart is a major auto manufacturing city and the capital of the southwestern German state, Baden-Wuerttemberg. The total population of the city area stood at over 634,000 inhabitants in 2019 and had above German average rates of new electric passenger car registrations at 20% in 2020. The total electric passenger car registrations stood at over 9,000 in 2020. Differences exist among electric vehicle registrations rates with a stronger growth of PHEVs from 2019 to 2020. Electric vehicle user groups also were slightly less balanced with short-term rentals, OEMs, and dealerships accounting for 50% of new electric vehicle registrations in 2020. Many initiatives have been enacted by Stuttgart to increase the rate of electric vehicle uptake, such as

the city's sustainable mobility plan and incorporation of electric vehicles into the municipal fleets.

The development of the electric passenger car market in Stuttgart from 2019 to 2020 saw a higher growth of PHEVs compared to BEVs. From 2019 to 2020, total new BEV registrations rose from about 1,000 to over 3,000 and total PHEVs rose from almost 1,400 to over 6,000 (Figure 19, left). This led to a share percentage rise from 2% to 6% for BEVs and 2% to 13% for PHEVs (Figure 19, right).

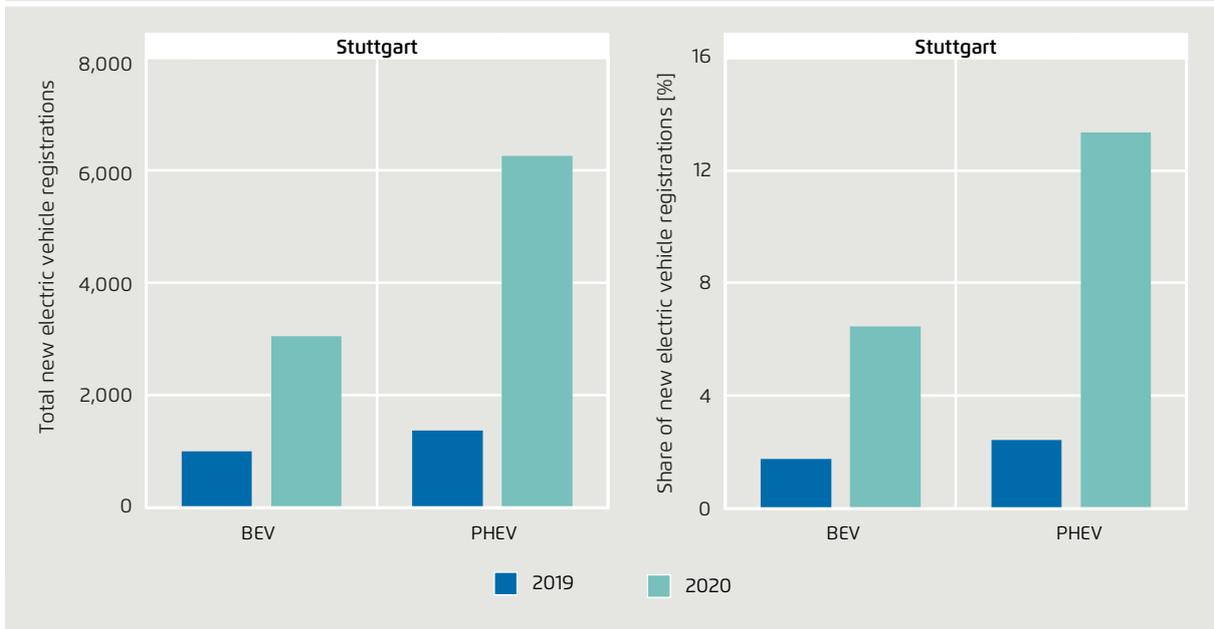
The large increase in PHEVs in Stuttgart can partially be attributed to the difference in registration rates among the various holder groups. Short term rentals, OEMs, and dealerships accounted for 50% of all newly registered electric passenger cars in 2020 (Figure 20, right). Company car (true fleet) registrations were the second highest holder group, accounting for 30% of new electric passenger car registrations, and private individuals accounted for 20%. The distribution among different holder groups was similar for all new passenger car registrations in Stuttgart in 2020 (Figure 20, left).

Looking further into the passenger car holder group and fuel type data, we see that private individuals in Stuttgart were the only group to purchase BEVs at a higher rate of 9% versus 8% for PHEVs (Figure 21). Companies (true fleets) held the second highest shares of BEV registrations at 6% and short-term rentals, OEMs, and dealership had the lowest shares at 5%. Both accounted for higher shares of new PHEV registrations in 2020 of 14% and 16%, respectively. Also in Stuttgart, new car registrations are dominated by petrol and diesel cars.

72 Urban Access Regulations (2021 b).

Total and share of new electric passenger car registrations in Stuttgart in 2019 and 2020

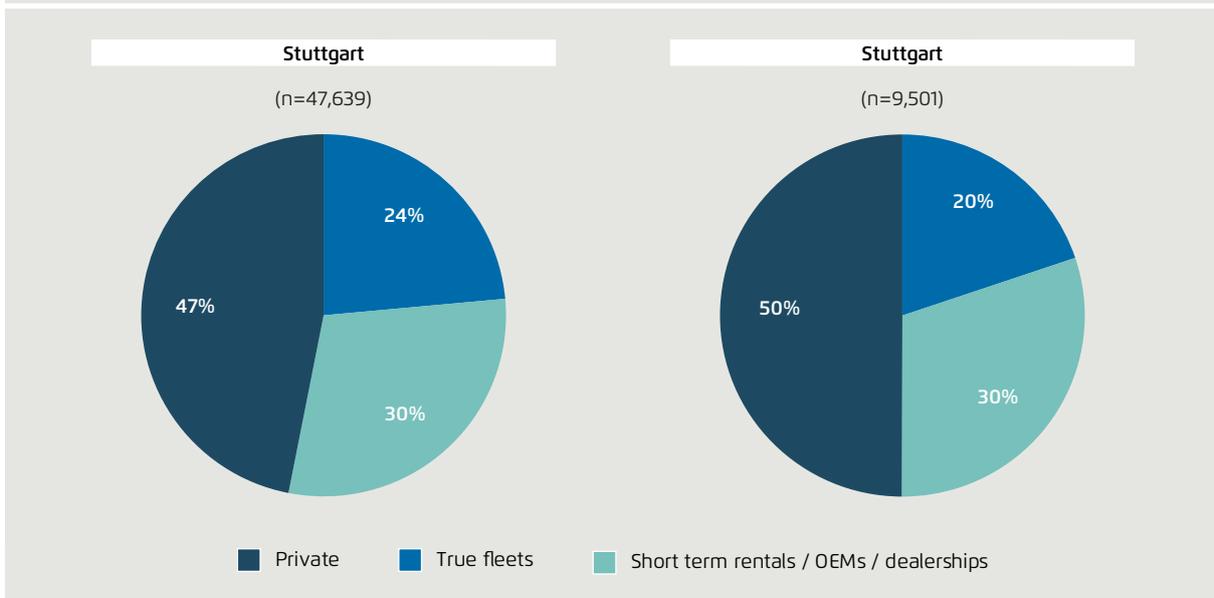
Figure 19



Agora Verkehrswende | 12/2021; Source: Rajon Bernard, et al. (2021)

New passenger car registration shares in Stuttgart in 2020 by holder group for the entire passenger car market (left) and electric passenger car registrations specifically

Figure 20



Agora Verkehrswende | 12/2021; Source: Dataforce

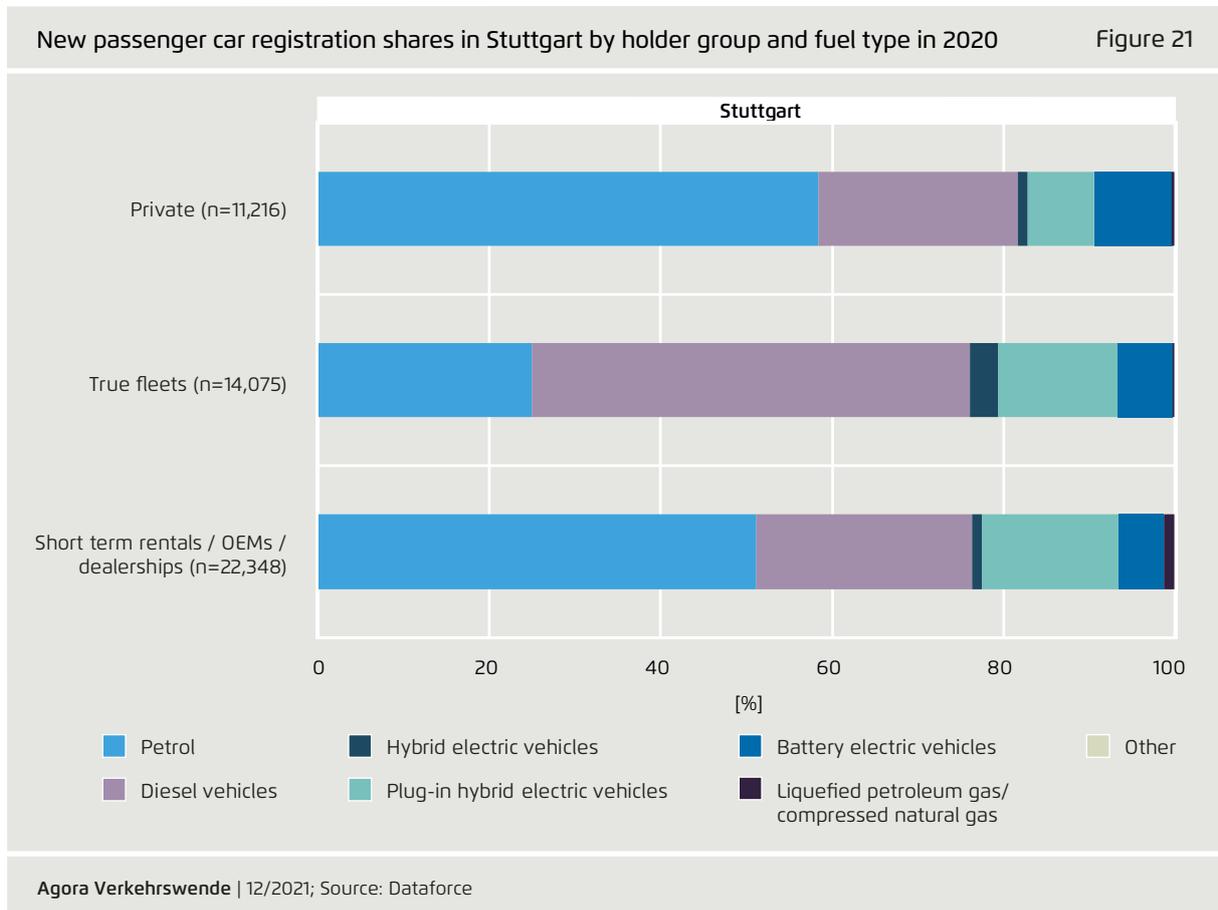


Figure 22 displays the absolute charging infrastructure deployment for the city of Stuttgart. By the end of 2020, there were about 700 normal and over 60 fast charging points available in the city. Most charging points occurred in the city center with some clusters along main roads in the north, east, and south of the city. Generally, neighborhoods outside the city center saw slightly lower concentrations of charging points, however, this can potentially be attributed to a higher presence of single homes where home charging is likely more available. Also, most public charging infrastructure contained normal rather than fast charging points.

Stuttgart has established several local policies concerning electromobility. The city government has created a special transportation action plan that contains over 100 measures with the main goals of reducing air and noise pollution as well as increasing the overall sustainability of the region. Specifically, it calls for an increase in public charging points to satisfy the growing demand of

electric vehicles, with over 1,000 public charging points planned to be completed by the end of 2021.<sup>73</sup> They also wish to increase the level of privately funded charging points across the city that are publicly accessible. The city's electricity provider offers regular updates on new charging infrastructure deployment and provides live information on which charging stations are available for use.<sup>74</sup> The special action plan also incorporates the conversion of the city municipal fleets to low- or zero-emission vehicles in order to ensure adherence to the sustainable mobility plan. As of March 2021, the city owns and operates 11 HEVs, 72 BEVs, and 19 e-scooters.<sup>75</sup>

<sup>73</sup> Landeshauptstadt Stuttgart (2021 a).

<sup>74</sup> Stadtwerke Stuttgart (2021).

<sup>75</sup> Landeshauptstadt Stuttgart (2021 b).

In 2021, the city plans to add an additional 46 electric vans and cars to the fleet.

In 2008, Stuttgart established an LEZ encompassing the entire city. Since 2019, the minimum standard to drive through is emission class Euro 5 or better for diesel vehicles. In 2020, the city introduced a second, so-called "small LEZ" zone in the city center and select districts outside the city center. The "small LEZ" is embedded in the city-wide LEZ and is a zonal traffic ban on diesel vehicles of emission class Euro 5 and worse, i.e. diesel vehicles of emission class Euro 6 are not affected. To help

maintain compliance, drivers, including commuters and visitors, must display a green sticker or be fined €80.<sup>76</sup>

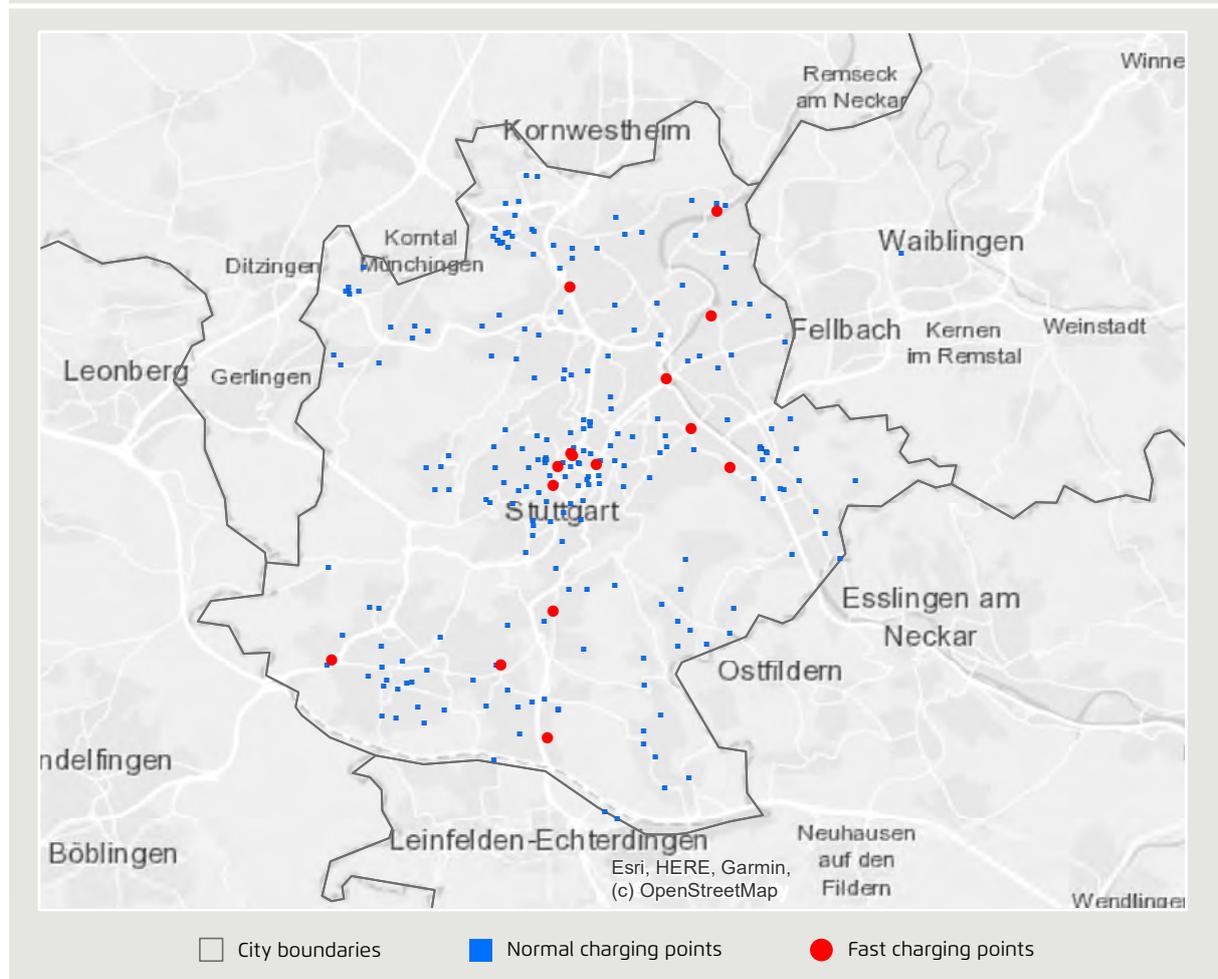
In 2012, Stuttgart introduced the "Sonderparkausweise," a special parking license system which allowed fully electric vehicles to park at public parking spots without paying fees. This was replaced by the federal e-license plate programme in 2015, which allows free electric vehicle parking in the city.<sup>77</sup>

76 Landeshauptstadt Stuttgart (2021 c).

77 Stuttgarter Nachrichten (2015).

Absolute charging infrastructure deployment in Stuttgart 2020

Figure 22



Agora Verkehrswende | 12/2021; Source: EcoMovement

**WARSAW: With 1.9% of new passenger cars registered being electric cars, their uptake was the same as for Poland in 2020; companies dominate in their registrations; public charging infrastructure is sparsely distributed**

Warsaw is the capital and largest city in Poland with over 1.7 million inhabitants. Air pollution continues to be a challenge to the city, with high numbers of diesel and petrol combustion engine vehicles contributing to the smog. To fight this, the city government has implemented policies to increase electromobility and has seen a gradual increase in electric vehicle registrations. The city saw higher levels of new PHEV than BEV registrations from 2019 to 2020. In 2020, Warsaw registered almost 2,000 new electric passenger cars with a total electric registration share of 1.9%, equal to the national average. The overall electric user groups are largely made up of companies rather than private individuals, however, the city would like to change this via policy instruments such as the “Eco Card” programme. This programme promotes private individual use by allowing electric vehicles to park at park and ride parks outside of normal hours in order to utilize free charging overnight.<sup>78</sup>

Figure 23 shows total new electric vehicle registration development from 2019 to 2020 for BEVs and PHEVs. Total new BEV registrations grew from over 800 to almost 900 and PHEVs increased from almost 500 vehicles to over 1,000 (Figure 23, left). The share increased from 0.6% to 0.8% for new BEV registrations and 0.3% to 1.1% for PHEVs (Figure 23, right). Overall, Warsaw has seen a stronger growth of PHEVs from 2019 to 2020.

In Warsaw, new electric passenger car registrations in 2020 were largely made up by with a share of 58% (Figure 24, right). This was less than for all new passenger car registrations, where companies recorded 70% of the total (Figure 24, left). Short term rentals, OEMs, and dealerships made up 37% of new electric vehicle registrations in 2020 versus 21% for all new passenger car registrations. Only 5% of new electric passenger cars were registered by private individuals. However, private individual shares of new electric cars registrations do not deviate much from the overall trend for all new passenger car registrations, as private individuals made up 9% of new registrations there.

Among the holding groups in Warsaw, electric vehicle uptake is relatively balanced between BEVs and PHEVs, yet at low levels. True fleets and private individuals both had a 2% share of BEVs and PHEVs amongst the various registered vehicle fuel types. Short term rentals, OEMs, and dealerships had slightly higher levels of electric vehicle shares at 4% (Figure 25). The majority of new cars is still powered by petrol and diesel independent of the user group.

To support electric vehicle adoption, the extension of the public charging infrastructure network is crucial. By the end of 2020, charging points in Warsaw were sparsely distributed. Those installed across the city focused along major roads (Figure 26). In total, over 150 normal and almost 40 fast public charging points were available for electric vehicle drivers. Most charging points were concentrated in the city center, with some outlying districts seeing few charging points.

As Warsaw continues to grow in terms of electromobility, local-level policies help encourage continued electric vehicle and charging infrastructure expansion. Derived from the Act on Electromobility and Alternative Fuels, electric vehicles have special access to over 250 bus lanes throughout Warsaw, allowing electric vehicles to avoid traffic and travel more seamlessly to their destination. In order to help enforce this regulation, a sticker system was implemented but has been replaced by the green number plate system.<sup>79</sup> Legal penalties are applied to combustion engine vehicles not in compliance. No emission regulated zones currently exist in Warsaw; however, the city has pledged to make a portion of the city center a ZEZ by the year 2030. This implementation is planned in reaction to the proposed amendment to the Act on Electromobility.<sup>80</sup>

As mentioned, electric vehicles receive special parking benefits through the city’s “Eco-Card” programme. With an Eco-Card, users of electric vehicles can leave their cars at any of the nine car parks located throughout Warsaw, even outside of the opening hours. Moreover, all car parks located throughout Warsaw are equipped with charging stations which are available to use at no additional charge.<sup>78</sup> While the privilege of parking overnight is beneficial to electric vehicle owners, the limited

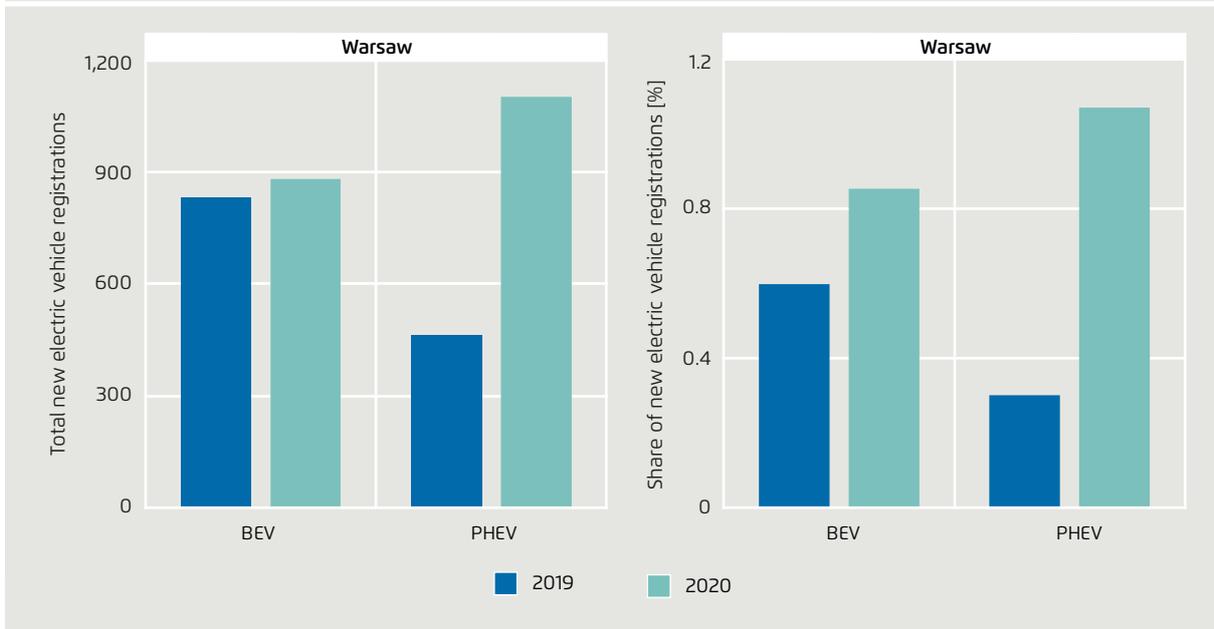
78 Warszawa 19115 (2021).

79 Moto.PL (2020).

80 Ministerstwo Klimatu i Środowiska (2020).

Total and share of new electric passenger car registrations in Warsaw in 2019 and 2020

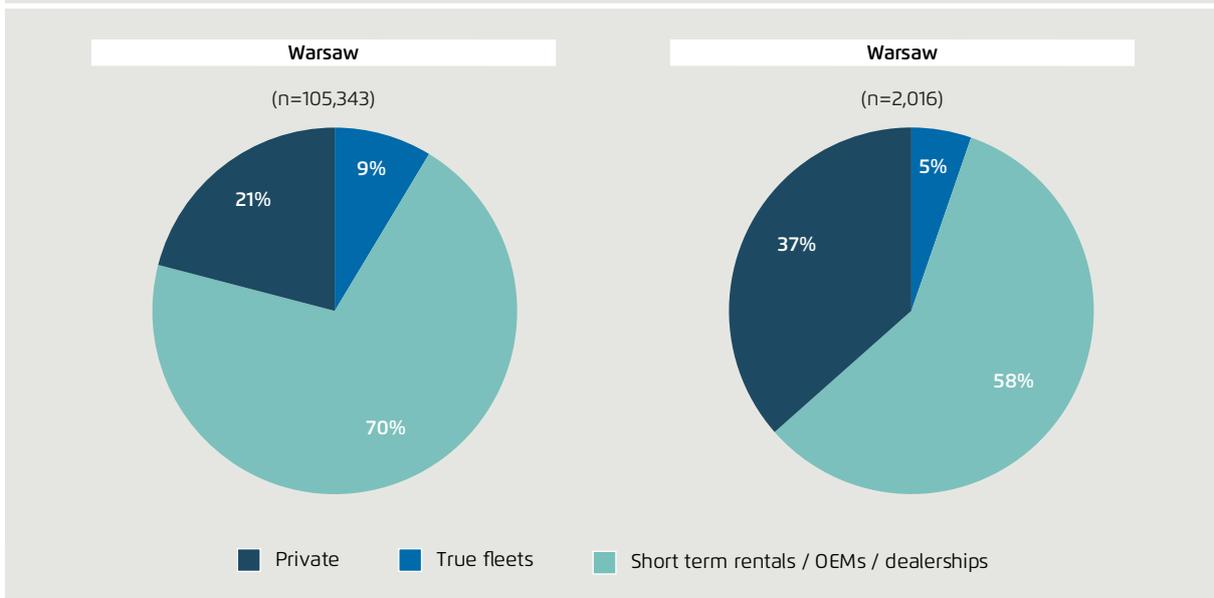
Figure 23



Agora Verkehrswende | 12/2021; Source: Rajon Bernard, et al. (2021)

New passenger car registration shares in Warsaw in 2020 by holder group for the entire passenger car market (left) and electric passenger car registrations specifically

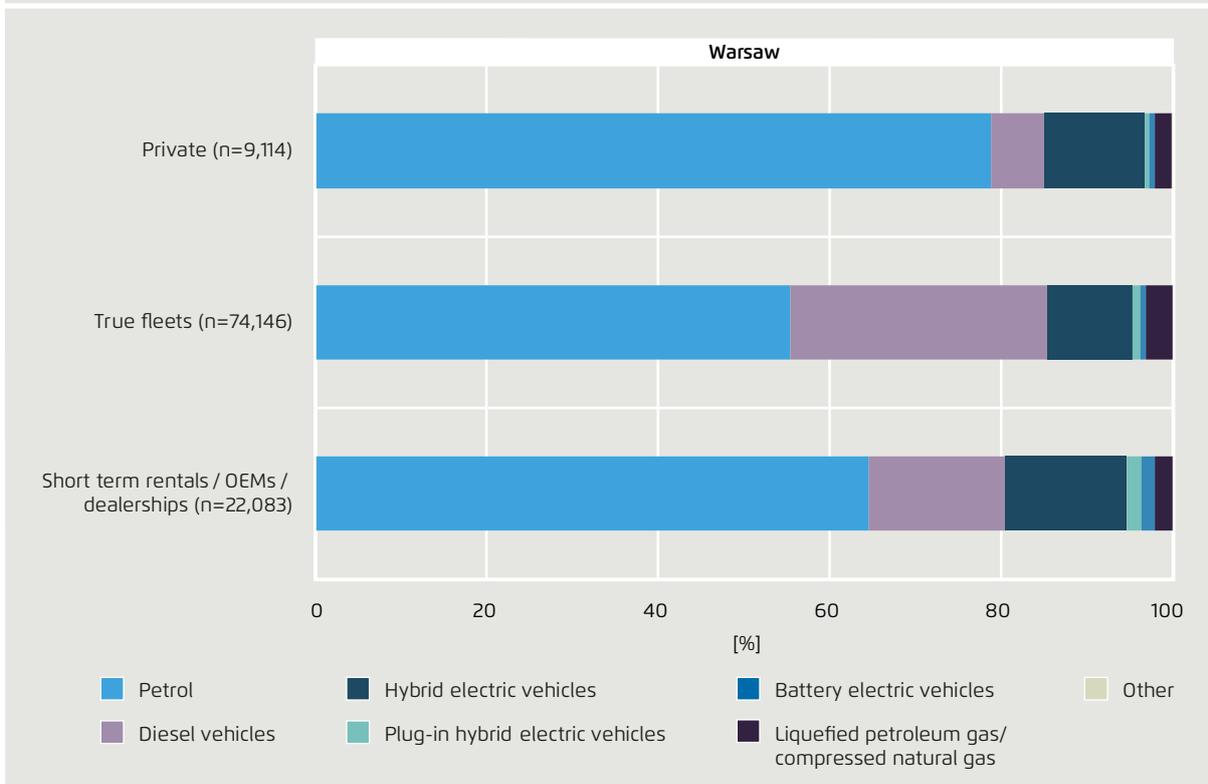
Figure 24



Agora Verkehrswende | 12/2021; Source: Dataforce

New passenger car registration shares in Warsaw by holder group and fuel type in 2020

Figure 25



Agora Verkehrswende | 12/2021; Source: Dataforce

availability of Eco-Cards can prevent some drivers from accessing the benefit. Removing the obligation of the Eco-Card can allow for easier access of public charging stations and higher electric vehicle uptake.

In Warsaw, there are efforts by the city to develop charging infrastructure for electric vehicles. Planning of the charger station placement has considered the opinions of residents to accommodate their needs and is focused on strategically placing stations near important locations around the city (cultural landmarks, sport venues, schools etc.). However, delays in building of charging points has occurred due to non-binding legal obligations of the upcoming version of the electromobility act which will remove responsibility of construction from the construction partners.

Through several fleet initiatives, Warsaw has also begun integrating electric vehicles into the city municipal fleets. DPD Polska, a delivery service operating in

Warsaw, plans to add 50 new electric bus vehicles to their fleet with additional charging stations being built in Krakow and Gdansk.<sup>81</sup> The MZA, the bus operating company of Warsaw, purchased 130 new electric buses for their fleet, bringing the total to 160 electric buses. The MZA is the largest electric bus operating company for a city in eastern and central Europe to make use of EU assistance funds, and the project initiative has received positive public opinions due to the perceived reduction of air and noise pollution.<sup>82</sup>

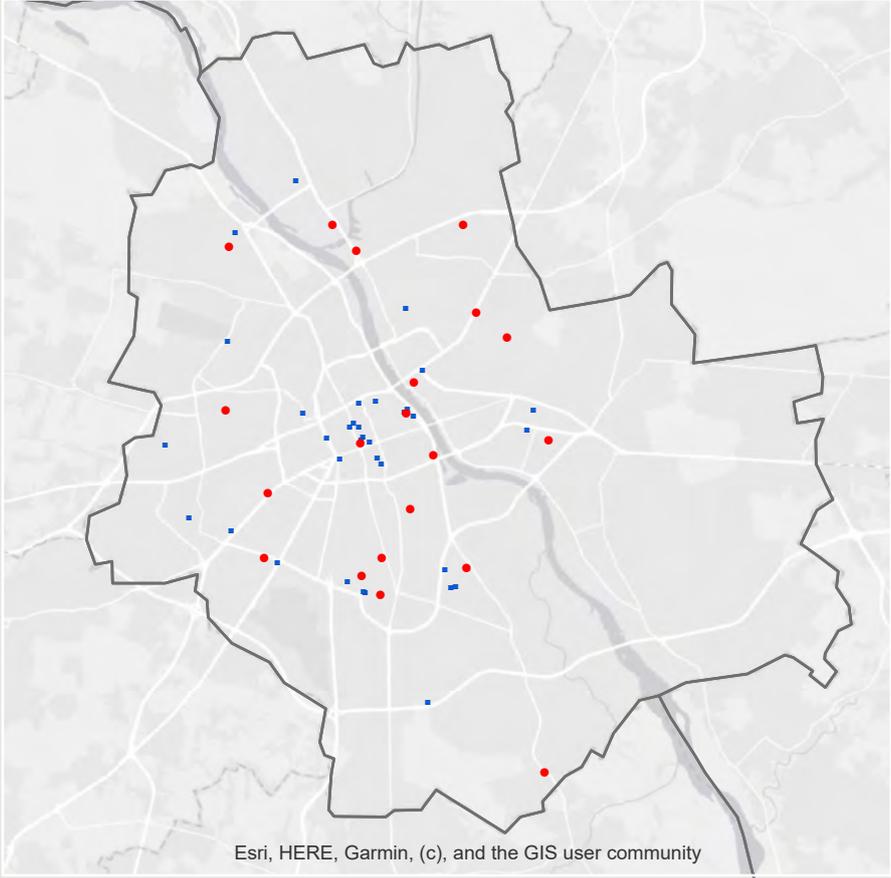
As the other cities previously mentioned, Warsaw is a member of the C40 city leadership group. The mayorship of Warsaw is ranked as having strong powers in regards to public transport, city roads, and urban land use, displaying the local government's ability to enact electromobility changes. In addition, Warsaw has signed

81 Wrocław naszemiasto (2021).

82 mza (2020).

Absolute charging infrastructure deployment in Warsaw 2020

Figure 26



□ City boundaries      ■ Normal charging points      ● Fast charging points

the Clean Bus Declaration and the Green and Healthy Streets Declaration.<sup>83</sup> Warsaw is also competing in the 2023 Green Capital of Europe Competition. This initiative grants competing cities throughout Europe the title based on the sustainable actions undertaken and are ranked based on 12 environmental indicators, including air quality, noise, and sustainable urban mobility.

**KRAKÓW: With 2.4% of new passenger cars registered being electric cars, their uptake was slightly above the 1.9% Poland average in 2020; companies dominate in their registrations; public charging infrastructure is sparsely distributed**

Krakow is the second largest city in Poland, with a population of over 760,000 inhabitants in 2019. In past years, the city has pledged to increase levels of electromobility to help reduce air pollution and fight climate change. In 2020, the total share of newly registered electric vehicles stood at 2.4%, with both BEVs and PHEVs accounting for 1.2% each. This put Krakow above the Polish average of 1.9% with about 600 total new electric vehicle registrations for 2020. Krakow is one of the top metropolitan regions in Poland for new electric vehicle registrations and this is in part due to the local policies the city has passed, for example consistent municipal fleet electrification and the Smart City Polska initiative.

The electric passenger car market in Krakow has displayed steady growth in terms of total and shares of BEV and PHEV vehicles from 2019 to 2020 (Figure 27). New BEV registrations rose from over 80 to over 300 cars, and new PHEV registrations increased from over 80 to almost 300 cars (Figure 27, left). This led to a rise in new registrations from 0.3% to 1.2% for both BEVs and PHEVs (Figure 27, right).

In Krakow, new electric passenger car registration shares varied by holder group in 2020 with true fleets accounting for the highest shares at 53% (Figure 28, right). Short term rentals, OEMs, and dealerships accounted for 33%, and private individuals were the smallest group at 14%. The distribution was similar for all new passenger car registrations in Krakow in 2020 (Figure 28, left).

Examining new passenger car registration shares by fuel type, the overall distribution of electric cars ranged between 1% and 2% for all holder groups. BEVs and PHEVs accounted for about 1% of each holder group's share, apart from BEVs for short term rentals, OEMs, and dealerships, which accounted for 2% of all new passenger car registrations (Figure 29).

Looking at public charging infrastructure deployment in Krakow, the network was sparsely distributed by the end of 2020 (Figure 30). There were about 70 normal and 30 fast public charging points across the city by the end of 2020. Public charging points are mostly located along main roads and intersections with a concentration of normal charging points in the city center and fast charging point locations outside the center. Some neighborhoods in Krakow, particularly in the east, southeast, and west did not have any charging points by the end of 2020.

Krakow has several examples of city-government level initiatives to support electric vehicle uptake. For example, the park and ride systems in Krakow are equipped with charging points in important locations throughout the city. There are currently four car park zones that are equipped with accessible charging points which allow free charging for electric vehicles while parked.<sup>84</sup>

The supreme audit office of Poland announced in November 2020 that the city of Krakow had achieved its goal of a 10% share of municipal vehicles with zero emissions. It was noted that only 18% of Polish cities had accomplished the goal at the time. This achievement was in accordance with the Act on Electromobility and Alternative Fuels, which obliges at least 10% zero-emission municipal vehicles by 2022.<sup>85</sup> Moreover, electric tele-buses have been tested in Krakow as a precursor to the city's plan to purchase 60 electric buses and an additional 50 articulated electric buses, utilizing EU funds to finance this proposal. This will make Krakow among the first cities in Poland to launch a bus line completely operated by electric buses.<sup>86</sup>

Krakow employs the Smart City Polska initiative, which operates under several stages to support electromobility

83 C40 Cities (2021).

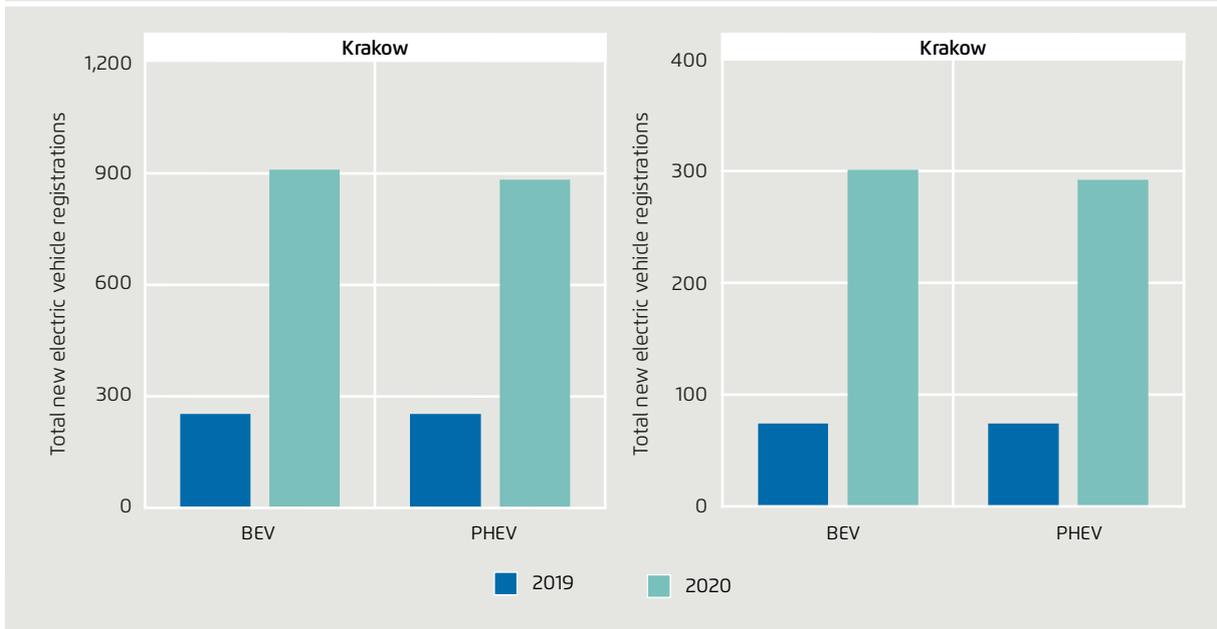
84 Elektromobilność (2020).

85 Magiczny Kraków (2020 b).

86 Magiczny Kraków (2021 b).

Total and share of new electric passenger car registrations in Krakow in 2019 and 2020

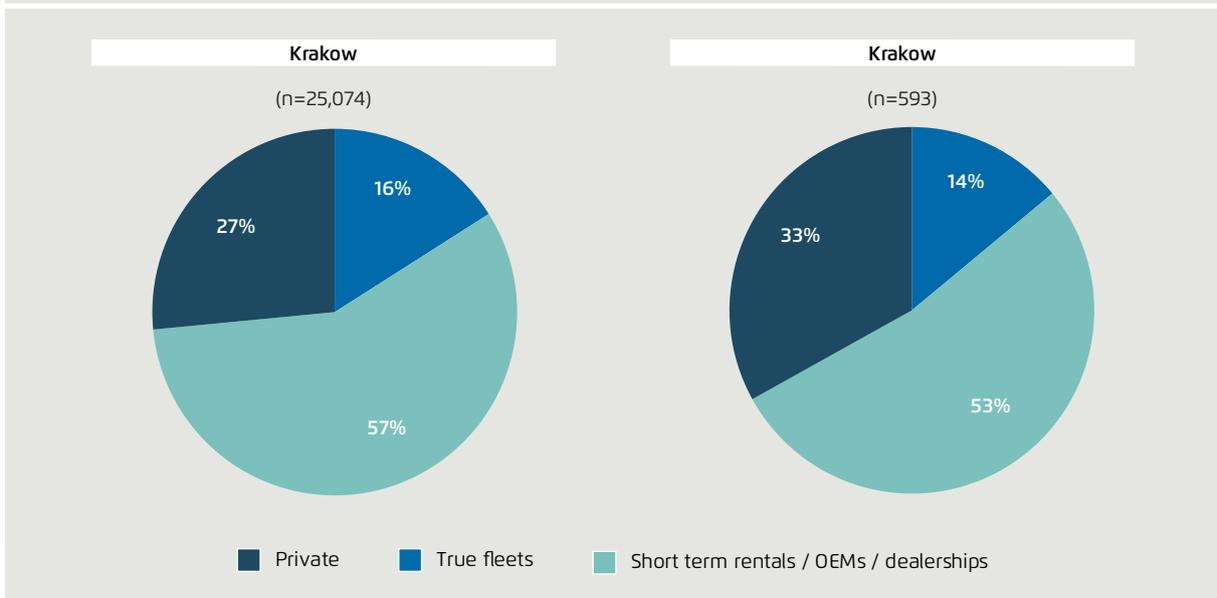
Figure 27



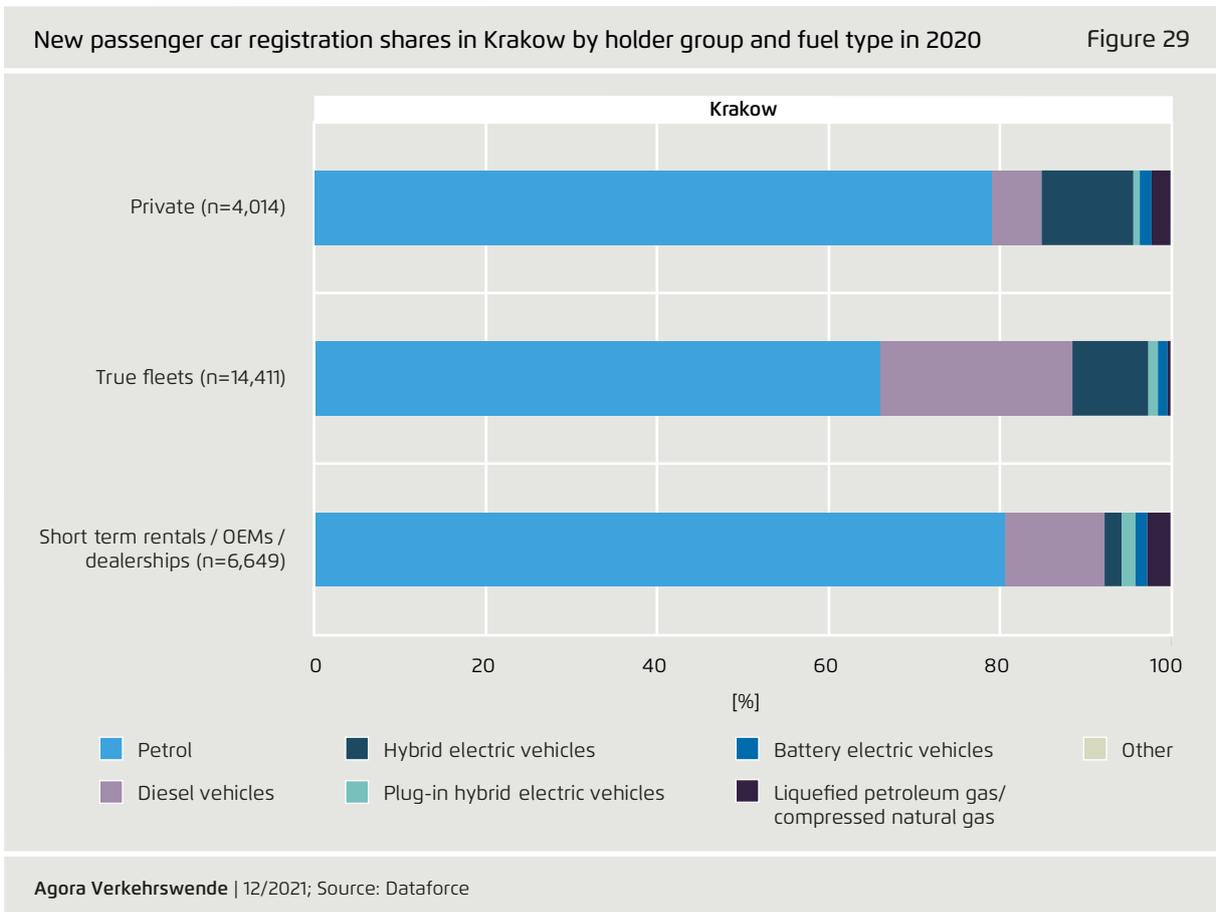
Agora Verkehrswende | 12/2021; Source: Rajon Bernard, et al. (2021)

New passenger car registration shares in Krakow in 2020 by holder group for the entire passenger car market (left) and electric passenger car registrations specifically

Figure 28



Agora Verkehrswende | 12/2021; Source: Dataforce



development. Among many diverse goals, the project seeks to introduce additional charging infrastructure to the city, enhance the electric car sharing system, and connect relevant groups to cooperate.<sup>87</sup> Krakow will also participate in the green capital of Europe competition for 2023 therefore leading the city to focus on sustainable initiatives for the upcoming years.

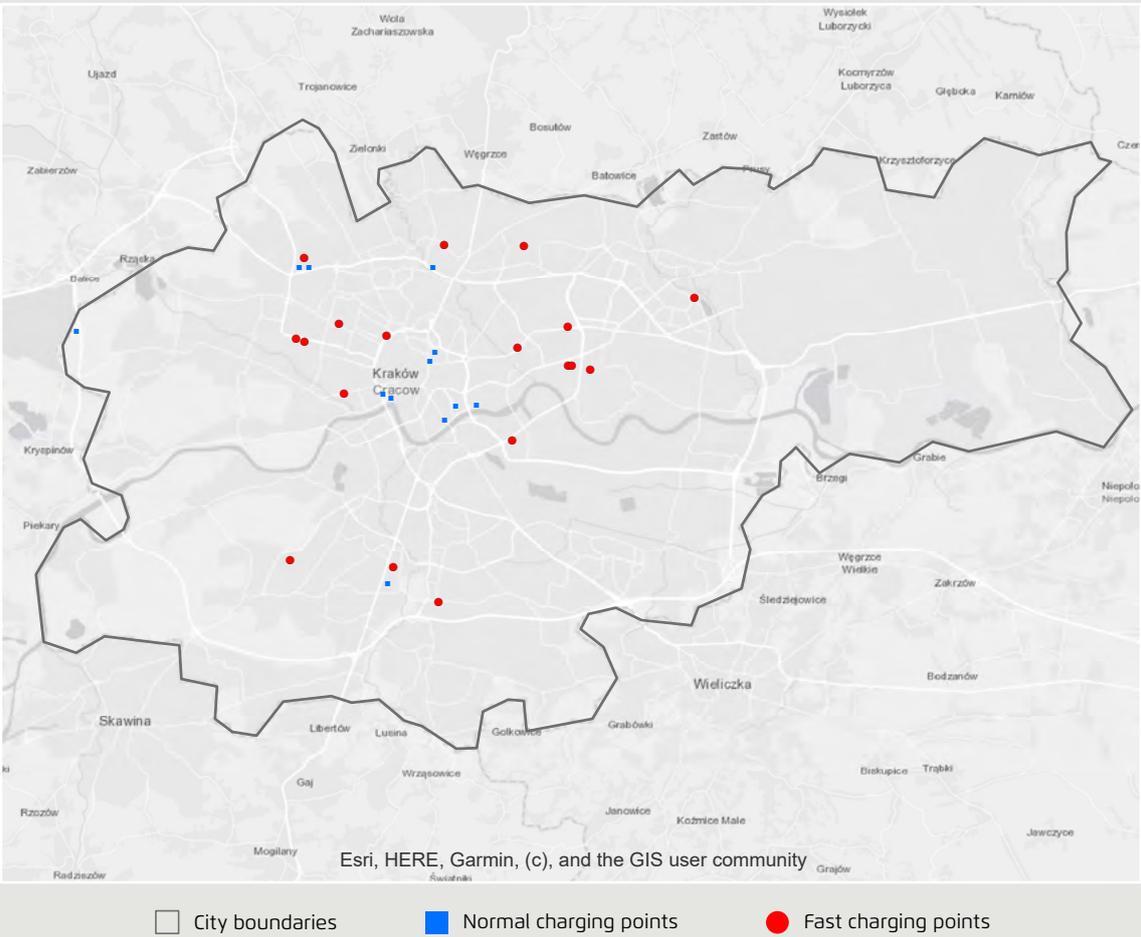
As a part of the E-mobility development strategy, the mayor of Krakow invited the residents of the city to participate in consultations on the ongoing electromobility projects. These consultations, which took place in early 2021, aimed to involve stakeholders in the decision-making process and allowed the city to receive feedback on the cost-benefit analysis strategy.<sup>88</sup>

87 Smart Cities Polska (2021).

88 Magiczny Kraków (2021 c).

Absolute charging infrastructure deployment in Krakow 2020

Figure 30



Agora Verkehrswende | 12/2021; Source: EcoMovement

## 6 | Conclusions and recommendations

The analysis of the electric vehicle market in Germany and Poland, as well as of policies at the EU and national level that highly influence local level actions and electric vehicle uptake, show the complexity of the market, including potential supporting and hindering factors. While the electric vehicle market, specifically the passenger car segment, has increased significantly in Germany in 2020, reaching 14% in 2020, likely largely supported by tighter CO<sub>2</sub> emission performance standards and increased purchase incentives, the market in Poland is still at a nascent stage, with 2% of new cars registered in Poland in 2020 being a BEV or PHEV. Model availability of new electric cars in Poland in 2020 was significantly lower than the availability in Germany, reducing choices for different use cases and user groups. The electrification of the van segment is at a nascent stage in both markets with only a few vehicle models available. This is likely a result of less stringent CO<sub>2</sub> emission performance standards at EU levels compared to cars, pushing automakers less to bring electric vans on the market. Despite a small market in terms of total new motor vehicles registered, the electrification of the bus segment in terms of new registrations was particularly high in Poland with a market share of 13% compared to 6% in Germany.

Developments were similar when looking at urban regions only. New registrations of vehicles – here passenger cars and vans – are still largely dominated by internal combustion engine vehicles, particularly in Poland, while in Germany 13% of new passenger car registrations in urban regions were either a BEV or PHEV. City-level uptake of electric vehicles is also largely dependent on national or supra-national frameworks, including regulations, laws, and incentive and tax policies. Yet, the analysis of selected city governments shows the variety of measures that can be implemented in urban settings to help electrifying car, van, and bus fleets and address potential barriers in cost, charging infrastructure deployment, and awareness.

The analysis and interviews with local stakeholder show that there is still a misperception in terms of electric vehicles. Topics of misinformation involve true costs of operation and purchases, environmental impacts, and driving distances. Information, education, and awareness continue to play an important role in the electrification of urban vehicle fleets. The cities analysed have adopted a mix of measures to address this point.

- **Communicating the benefits of electric vehicles.** Spreading information and awareness to the public on electric vehicles is crucial to promoting electric purchases and achieve electromobility goals. Cities across Germany and Poland have implemented various measures to provide more information on the benefits of electric uptake. Actions include showcase showrooms on electromobility, such as those established in Berlin, and awareness raising campaigns, such as the “Stuttgart steigt um” in the city of Stuttgart, provide information on sustainable mobility and local transportation initiatives. Rallies or special days dedicated to electromobility regularly take place in Leipzig or Stuttgart. Krakow also held a training on “Electromobility in Practice.” Additionally, a common practice is providing information about electromobility on local authority webpages which helps to inform and educate a broader audience. Continued efforts are crucial as long as misperceptions exist regarding electric vehicles.
- **Fostering collaborations.** Collaborations or initiatives bringing together different stakeholders operating in urban settings and beyond could help to foster the exchange of lessons learned in the transition to electric vehicles as well as potential supporting and hindering factors. The cities analysed as part of this study are involved in different local, regional, national, or sub-national initiatives to best utilize actions taken and policies adapted to electrify urban vehicle fleets and support alternative modes of transportation.

Higher costs for the purchase of a new electric vehicle are one of the main barriers of electric vehicle adoption. Particularly in Poland, the one-time subsidies for BEVs by the government are not sufficient to make them cost-competitive compared to their comparable international combustion engine counterparts.

To spur the purchase and operation of electric vehicles, cities in Germany and Poland could consider the following measures at local levels:

- **Introducing local electric vehicle parking and charging benefits.** Both Germany and Poland have a national framework in place that allows municipalities and cities to grant or require parking benefits for electric vehicle drivers. In Stuttgart, electric vehi-

cles park for free without time limitations on public streets and chargeable parking spaces whereas in Berlin this privilege is only granted while charging. In Poland, BEVs are legally exempt from parking fees in municipal paid parking zones. Granting free parking without paying fees could also support electric vehicle adoption. In the center of Krakow for example, parking costs are waived if driving a BEV. Free charging is less common despite some park and ride parks in the cities of Warsaw, Krakow, and Poznan not applying electric vehicle charging fees. Particularly in the early adoption phase, these types of benefits could help to spur the electrification of vehicle fleets in urban settings, providing a cost advantage on fueling costs compared to conventional vehicles.

- **Implementing zero-emission zones.** Many cities in Germany have introduced low-emission zones (LEZs), including the three cities of Berlin, Leipzig, and Stuttgart which are analysed in more detail as part of this study. Berlin also plans for a zero-emission zone (ZEZ) in the inner-city area without having a set date yet. Krakow introduced a ZEZ in the city center in 2019 but it was terminated after a few months. Only allowing electric vehicles to certain parts or entire city areas could help to spur their adaptation. LEZs can be effective in reducing transport related pollutant emissions, yet the experience of German cities shows that most vehicles – specifically combustion engine vehicles – currently comply with the set emission standards. Beyond the legal national frameworks necessary to allow the implementation of ZEZs, key stakeholders must also be considered. For example, the protests of the LEZ in Krakow by business owners show that stakeholder integration plays a key part in raising awareness and acceptance. In addition, examples from other cities outside Germany and Poland display that the implementation of such zones should be accompanied by local measures to financially support the acquisition of electric vehicles plus policy actions supporting alternatives, particularly in terms of private car use.
- **Fostering electric vehicle adoption in shared fleets and on-demand services.** All six cities evaluated have carsharing or ride-hailing offers in their cities which provide electric vehicles. Yet, these services are mostly fully commercial, with no support from local or

central governments. An exception is the ride-sharing service Berlkönig in Berlin, offered by the local public transport operator in cooperation with ViaVan as an addition to public transport to serve the last mile e.g., to public transport nodes which are served less frequently. The service consists mostly of electric vans. Such local electric on-demand services could also help to reduce traffic and encourage the shift from the private car. Local governments could also create strategies for shared fleets that include electrification goals. Cities should play an active role in fostering electric adoption in carsharing and ride-hailing services. Specific policies that can promote this shift include coordinated awareness campaigns, ambitious electrification goals, preferential parking options, and priority lane access to electric ride-hailing fleets.

- **Introducing local level electric vehicle subsidies.** While subsidies for the purchase of new electric vehicles are typically introduced at national levels, in Germany and in Poland in 2021, cities could further spur the electrification of vehicle fleets by providing additional grants. The city of Berlin, for example, offers purchase grants for commercial businesses, non-profits, and self-employed individuals purchasing a new van since 2018. Since 2021, the city also offers a maximum grant of €15,000 for the purchase of a new van or car as part of taxi operations, which can be combined with the national subsidy of a maximum of €9,000 including the car manufacturer's share of €3,000. Supporting the electrification of the commercial vehicle fleet is of particular relevance to the urban context as they enable last-mile deliveries or the transportation of passengers. Next to funding taxi companies, cities could also consider additional funding for shared services such as car sharing or ride-hailing services, also helping to electrify these fleets. Extending shared mobility services in addition to public transport systems could also help to shift from private car to shared mobility services, preferably offered as electrified services. While subsidies are commonly targeted at new vehicles, it could also be considered to support the purchase of used electric vehicles. Such national level activities exist in countries such as the Netherlands and France. Providing support for this market segment could also aid to address a wider consumer group if considering cars or vans.

- **Introducing electric vehicles to municipal fleets.**

Cities such as Berlin, Leipzig, Stuttgart, Warsaw, Krakow, and Poznan have begun to incorporate electric vehicles into their public municipal fleets. This includes passenger cars, vans, and buses, in part due to goals set at national levels to electrify these fleets. Local city authorities are important forerunners and should continue leading by example to push other organizations and institutions towards the electrification of their fleets. However, exchanging these fleets with electric vehicles imposes high costs, particularly if considering larger vehicle types including buses. Here, additional funding as outlined above would be necessary, but it is supplemented by funds from national or EU levels as the examples of Germany and Poland show.

The extension of the public charging infrastructure network is of particular importance in urban settings as the majority of people live in multi-dwelling buildings without the opportunity to charge an electric vehicle in a garage or private parking space. This also applies to companies wishing to charge an electric vehicle at private company premises. In cities such as Warsaw and Krakow, the public charging infrastructure network is only sparsely distributed across the city.

To support public, private home, and workplace charging, cities could consider the following measures for charging infrastructure deployment and access:

- **Simplifying the local permitting process to speed up the development of charging infrastructure.** The analysis also showed that factors hindering faster adoption of charging infrastructure, such as the long application and building processes, could also obstruct potential electric vehicle buyers. Local authorities could therefore monitor processes and develop strategies to streamline long wait times for consumers applying for a charging point.
- **Introducing local level support for charging facilities.** The city of Berlin offers commercial businesses, non-profits, self-employed individuals, and taxi companies purchasing an electric van or car grants for charging infrastructure on publicly accessible and non-publicly accessible locations. Subsidies are granted for wall boxes, normal, and fast charging

stations with maximum amounts ranging between €2,500 and €30,000. The city previously offered support to private owners of an electric car to install a publicly accessible charging station in areas with no or limited access to charging in dense urban city areas. Supporting the electrification of commercial vehicle fleets, including aid for charging infrastructure and installation of additional public charging stations, could help to facilitate electric vehicle adoption for a wider consumer group. Additionally, the creation of a local charging development plan could help to aid in comprehensive charging infrastructure network. Local tax write-offs are an alternative incentive to grants that promote installation of charging points as a deduction on taxes paid. These can be offered at the national and local-levels.

Both Germany and Poland have shown the potential they have for development of their electric vehicle fleets at national and city levels. A mix of EU, national and city-level policies have supported this thus far, even though the progress varies in both countries depending on vehicle types considered. However, lessons learned in both countries from national and local-level policies and continued exchange could aid in spurring electrification in both countries.

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## Agora Verkehrswende

In partnership with key players in the fields of politics, business, academia and civil society, Agora Verkehrswende aims to lay the foundation for a comprehensive climate protection strategy for the German transport sector, with the ultimate goal of complete decarbonisation. The climate protection strategy elaborated by Agora Verkehrswende is focused on transitioning the entire transport system from fossil fuels to electricity and fuel generated by renewables. Other important aspects of the strategy include increasing the efficiency of the entire transport system by avoiding unnecessary transport demand, transitioning to environmentally friendly modes of transport and increasing the efficiency of individual transport modes. Active collaboration is required at all levels of politics to bring about the transformation of the transport sector, from the level of national and international policy down to local municipalities. The think tank seeks to consider the necessary interaction between these various levels while striving to promote a shared understanding between stakeholders on promising ways to transition to a decarbonised transport system.

## Forum Energii

Forum Energii is a think tank, focused on forging the foundation for a clean, innovative, safe, and efficient energy sector based on data and analysis. Forum Energii observes world trends and analyses data and changes in regulations. The mission is that changes in the power sector should proceed in accordance with global trends. For that, Forum Energii deals with energy sector and heating as well as European energy and climate regulations and develops concepts on how Poland can proceed with low-carbon modernization of the energy sector in a cost-effective and social-friendly manner. The think tank supports the process of improving air quality and eliminating smog in Polish cities.

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