WORKING PAPER 2023-01

FEBRUARY 2023

Battery electric and plug-in hybrid vehicle uptake in European cities

Authors: Irem Kok, Dale Hall

Keywords: Battery-electric vehicles, plug-in hybrid vehicles, charging infrastructure, European cities

Introduction

By the end of 2021, Europe was the second-largest battery electric vehicle (BEV) and plug-in hybrid vehicle (PHEV) market globally after China.[1] Plug-in hybrid and battery electric passenger car sales reached 2.3 million, registering a 66% increase from 2020. The European Union (EU) CO_2 emission standards drove higher levels of BEV and PHEV adoption in 2020 and 2021, as automakers had to comply with more stringent regulations.[2] All manufacturers met their 2021 CO_2 targets, with average emissions declining to 113 g/km.[3]

Alongside the growth in BEV and PHEV vehicle sales, public charging deployment has also accelerated in Europe. By the end of 2021, the EU had approximately 400,000 public chargers in place, a 53% increase year-on-year. In July 2021, the European Commission proposed the Regulation on the Deployment of Alternative Fuels Infrastructure (AFIR) which, if adopted, will be the first binding regulation at the EU level.[4] Under the AFIR, Member States will need to satisfy mandatory minimum power output targets for BEVs and PHEVs. The new regulation will help to harmonize charging requirements and promote the deployment of a robust charging network across Europe.

Significant disparities remain among European countries. Northern European countries lead with strong policies and extensive public charging networks. Within countries, levels of BEV and PHEV uptake differ at the city level, with certain cities having much

1 In this paper, Europe refers to the 27 European Union (EU) members, the European Free Trade Association (Iceland, Norway, Liechtenstein, and Switzerland), and the United Kingdom (UK).

2 Previous ICCT studies shows that battery-electric vehicles (BEVs), which have an electric drivetrain, offer deep decarbonization potential with about 66%–69% fewer life-cycle greenhouse gas emissions compared to gasoline cars in Europe. In comparison, plug-in hybrid vehicles (PHEVs), which combine an electric and a combustion engine drivetrain, produce tailpipe emissions and typically offer 25%–27% fewer GHG emissions. For more details, see: Georg Bieker, "A New Life-Cycle Assessment of the Greenhouse Gas Emissions of Combustion Engine and Electric Passenger Cars in Major Markets," (Washington, DC: ICCT, 2021), https://theicct.org/publication/a-global-comparison-of-the-life-cycle-greenhouse-gas-emissions-of-combustion-engine-and-electric-passenger-cars/.

3 Uwe Tietge, Jan Dornoff, Peter Mock, and Sonsoles Díaz, "CO_2 Emissions from New Passenger Cars in Europe: Car Manufacturers' Performance in 2021," (Berlin: ICCT, 2022), https://theicct.org/publication/co2-new-passenger-cars-europe-aug22/.

4 European Commission, "Proposal for a Regulation of the European Parliament and of the Council on the Deployment of Alternative Fuels Infrastructure, and Repealing Directive 2014/94/EU of the European Parliament and of the Council," (2021), https://eur-lex.europa.eu/legal-content/en/TXT/?uri=CELEX%3A52021PC0559.

www.theicct.org

communications@theicct.org

twitter @theicct

icct
THE INTERNATIONAL COUNCIL ON CLEAN TRANSPORTATION

higher uptake than their nationwide averages. The leading European cities with higher BEV and PHEV shares offer valuable insights for designing supportive electric vehicle (EV) and charging infrastructure policies at the local level.

This paper, an update of a previous ICCT analysis, provides an overview of how the European EV markets evolved in 2021, assessing BEV and PHEV penetration, charging infrastructure availability, and supportive policies.[5] First, it analyzes the 16 largest national EV markets based on 2021 new BEV and PHEV passenger car registrations, and the 48 metropolitan regions with the highest BEV and PHEV shares and passenger car registrations. The data presents the BEV and PHEV share of new passenger car sales at the national level and new electric car registrations at the local level. The paper also investigates the top 10 national markets with the most public chargers installed in 2021 and public charger deployment at the local level. Finally, the paper elaborates on local policies supporting the BEV and PHEV transition in leading metropolitan regions that could serve as examples for other regions to increase BEV and PHEV uptake.

European battery electric and plug-in hybrid vehicle uptake

European annual battery electric and plug-in hybrid passenger car sales climbed to 2.3 million in 2021, a 66% increase from 2020. More than 1.2 million new passenger cars were battery electric, and around 1.1 million were plug-in hybrids. Figure 1 illustrates the growth in cumulative plug-in hybrid and battery electric vehicles from 2011 to 2021, with corresponding values shown on the left axis. The line shows the EV share of new passenger car sales on the right axis.

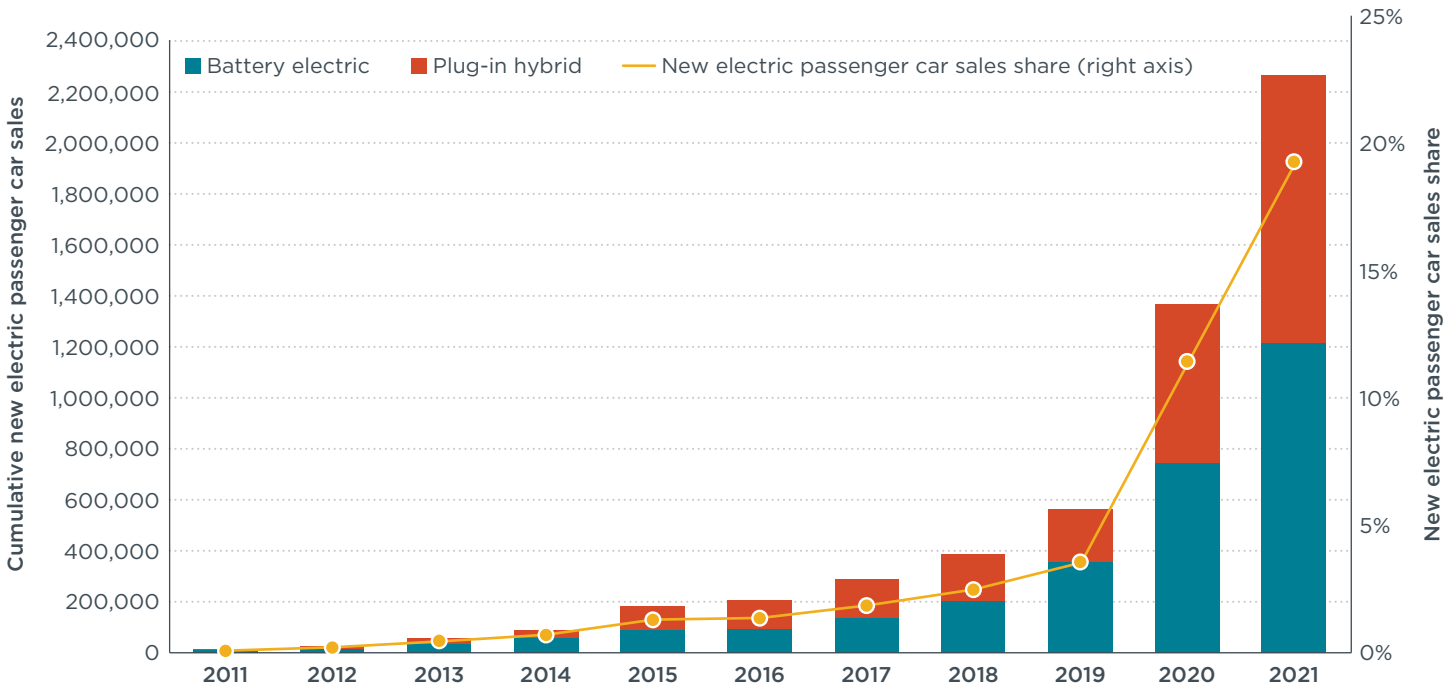

Figure 1. Cumulative new plug-in hybrid and battery electric passenger car sales in Europe. EV-Volumes, Passenger car sales data, 2022, https://www.ev-volumes.com/datacenter/.

BEV and PHEV sales have grown precipitously from a few thousand in 2011 to over 2 million in 2021. Much of this growth occurred against the backdrop of a passenger car market downturn in the last two years. The COVID-19 outbreak in 2020 resulted in a

5 Marie Rajon Bernard, Dale Hall, and Nic Lutsey, "Update on Electric Vehicle Uptake in European Cities" (Washington, DC: ICCT, 2021), https://theicct.org/publication/update-on-electric-vehicle-uptake-in-european-cities/.

sharp drop in new passenger car sales, surpassing the previous lowest point of 11.8 million in 2013.[6] New car registrations across Europe stood at 11.7 million in 2021, a 34% decline compared to pre-pandemic levels.

Battery electric and plug-in hybrid vehicles accounted for 19% of new passenger car sales in 2021, up from 11% in 2020 and 4% in 2019. The EU CO_2 emission standards were the main driver of this market growth, requiring automakers to reduce their fleet emissions to 95 g CO_2/km for 95% of vehicles in 2020 and 100% of vehicles in 2021.[7] The shares of BEVs and PHEVs both rose in 2021, representing 10% and 9% of new passenger car sales, respectively.

On July 14, 2021, the European Commission's Fit-for-55 package proposed to require all new passenger cars and vans to be zero-emission by 2035.[8] In June 2022, the Council of the European Union backed the proposed phase-out date, reaching an agreement on the next round of CO_2 standards for new cars and vans.[9] Binding regulations will signal policy certainty to automakers. The share of BEVs and PHEVs in the EU could reach 84% by 2035, if manufacturers meet their announced goals.[10]

A growing number of European governments have pledged to end new international combustion vehicle (ICE) sales.[11] As of June 2022, 10 European countries committed to non-binding ICE phase-out targets for passenger cars and vans.[12] Norway set the earliest target of 2025, followed by Austria, Denmark, Greece, Iceland, the Netherlands, and Slovenia in 2030, the United Kingdom in 2035, and France and Spain in 2040. Eight countries target only BEV and fuel cell vehicle sales by their phase-out date, while Denmark and Slovenia permit PHEV sales until 2035 and 2030, respectively.

National battery-electric and plug-in hybrid vehicle uptake

Electrification of passenger cars accelerated across all of Europe in 2021. Figure 2 compares the 2021 and 2020 BEV and PHEV shares in 16 European countries with the highest passenger car sales in absolute terms. The 16 countries collectively represent 93% of new passenger car sales and 98% of electric car registrations in Europe.

6 Sandra Wappelhorst, Uwe Tietge, Georg Bieker, and Peter Mock, "Europe's CO_2 Emission Performance Standards for New Passenger Cars: Lessons from 2020 and Future Prospects," (Berlin: ICCT, 2021), https://theicct.org/publication/europes-co2-emission-performance-standards-for-new-passenger-cars-lessons-from-2020-and-future-prospects/.

7 Wappelhorst, Tietge, Bieker, and Mock, "Europe's CO_2 Emission Performance Standards for New Passenger Cars: Lessons from 2020 and Future Prospects."

8 Jan Dornoff, Peter Mock, Chelsea Baldino, Georg Bieker, Sonsoles Díaz, Josh Miller, Arijit Sen, Uwe Tietge, and Sandra Wappelhorst, "Fit for 55: A Review and Evaluation of the European Commission Proposal for Amending the CO_2 Targets for New Cars and Vans," (Berlin: ICCT, 2021), https://theicct.org/publication/fit-for-55-a-review-and-evaluation-of-the-european-commission-proposal-for-amending-the-co2-targets-for-new-cars-and-vans/.

9 Council of the EU, "Fit for 55 Package: Council Reaches General Approaches Relating to Emissions Reductions and Their Social Impacts", June 29, 2022, https://www.consilium.europa.eu/en/press/press-releases/2022/06/29/fit-for-55-council-reaches-general-approaches-relating-to-emissions-reductions-and-removals-and-their-social-impacts/.

10 Peter Mock and Jan Dornoff, "E-Fuels: The Magic Lollipop to Keep Combustion Engines Alive (Or Not)," *ICCT staff blog*, (June 30, 2022), https://theicct.org/e-fuels-eu-co2-standards-jun22/.

11 Sandra Wappelhorst, "Update on Government Targets for Phasing out New Sales of Internal Combustion Engine Passenger Cars" (Washington, DC: ICCT, 2021), https://theicct.org/publication/update-on-government-targets-for-phasing-out-new-sales-of-internal-combustion-engine-passenger-cars/.

12 International Council on Clean Transportation, "Internal Combustion Engine Phase-Outs," September 2022, https://theicct.org/ice-phase-outs/.

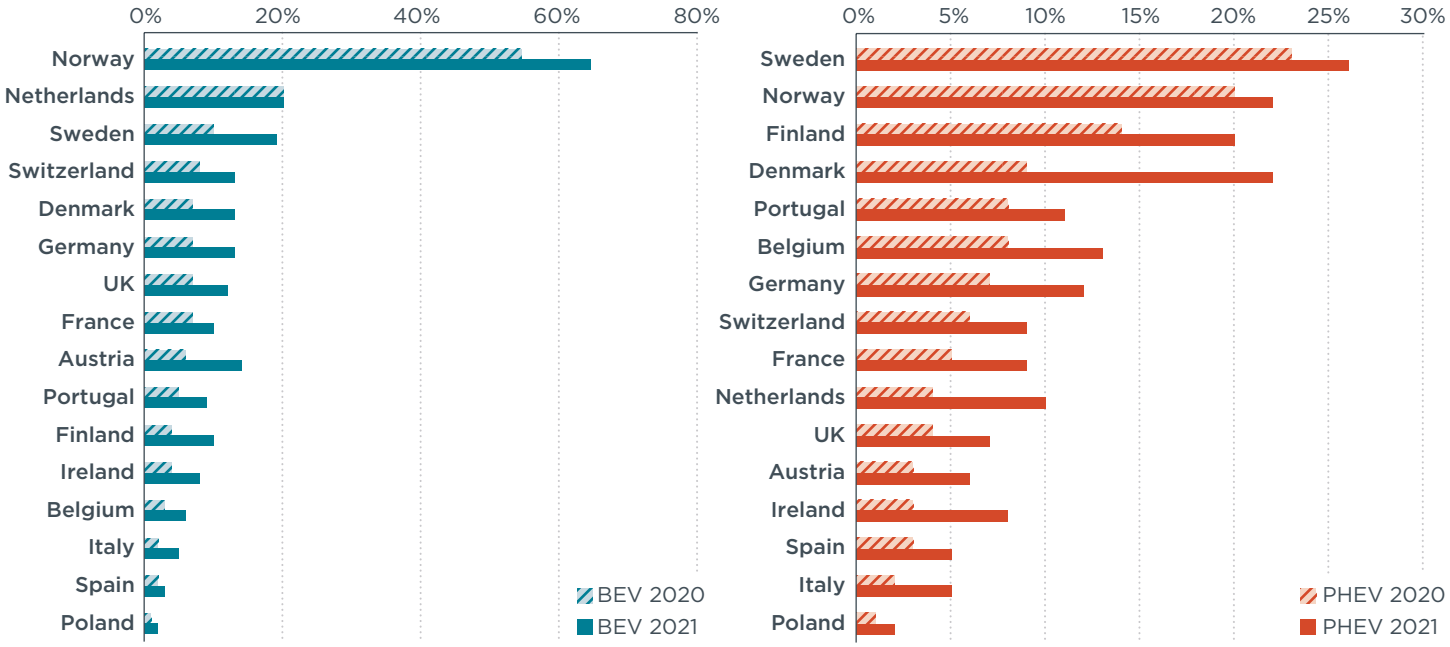

Figure 2. Share of BEVs and PHEVs in all new passenger car sales in 2020 and 2021. EV-Volumes, Passenger car sales data, 2022, https://www.ev-volumes.com/datacenter/.

Norway, the Netherlands, and Sweden had the highest BEV sales shares in 2021. Norway was the most mature market with a 64% BEV and 22% PHEV share in 2021, up from a 54% BEV and 20% PHEV share in 2020. Sweden had the highest PHEV share (26%) in Europe, and its BEV share increased from 10% in 2020 to 19% in 2021. In contrast, the Netherlands ramped up its PHEV share from 4% to 10% year-on-year, while its BEV share (20%) remained flat. Spain and Poland had BEV shares below 5% in 2021, far less than the European average of 10%.

Three major car markets—Germany, France, and the United Kingdom—accounted for 57% of total EV sales in Europe. Germany had the most battery electric and plug-in hybrid passenger sales across Europe in absolute terms, doubling to 674,000 in 2021. The United Kingdom and France placed second and third, with their electric passenger car sales reaching 312,140 and 306,600, respectively.

Local battery-electric and plug-in hybrid vehicle uptake

Examining EV uptake at the local level gives a detailed picture of differing regional dynamics within each country. Figure 3 shows the distribution of new BEV and PHEV registration shares in metropolitan and non-metropolitan regions of the 15 European countries with the most BEV and PHEV sales.[13] The metropolitan-level data analysis is based on the third level of the Nomenclature of Territorial Units for Statistics (NUTS 3) of the Eurostat's 2021 NUTS classification.[14] The shaded areas refer to BEV and PHEV registration shares, with black outlines indicating 48 selected metropolitan regions. The 48 metropolitan regions represent the top two regions with the most BEV and PHEV registrations and the top two with the highest BEV and PHEV share in 2021 within each country. As some regions with the most BEV and PHEV registrations also have the highest BEV and PHEV shares, this selection yielded two to four regions per country,

13 These countries are the top 15 European countries with the most EV sales in absolute terms. Ireland was excluded from the analysis due to a lack of data at the metropolitan level.

14 A NUTS 3 statistical area refers to smaller territorial regions based on geographical, environmental, and socio-economic factors. Based on Eurostat's typology, metropolitan regions refer to one or more NUTS 3 regions where a minimum of 50% of the population resides in urban areas of at least 250,000 inhabitants. NUTS 3 regions that do not satisfy this criteria are classified as non-metropolitan regions. European Union, "Statistical Regions in the European Union and Partner Countries: NUTs and Statistical Regions, 2021 Edition," January 2020, https://ec.europa.eu/eurostat/documents/3859598/10967554/KS-GQ-20-092-EN-N.pdf/9d57ae79-3ee7-3c14-da3e-34726da385cf?t=1591285035000.

resulting in a total of 48 metropolitan regions. These regions constitute the main focus of analysis in this paper.

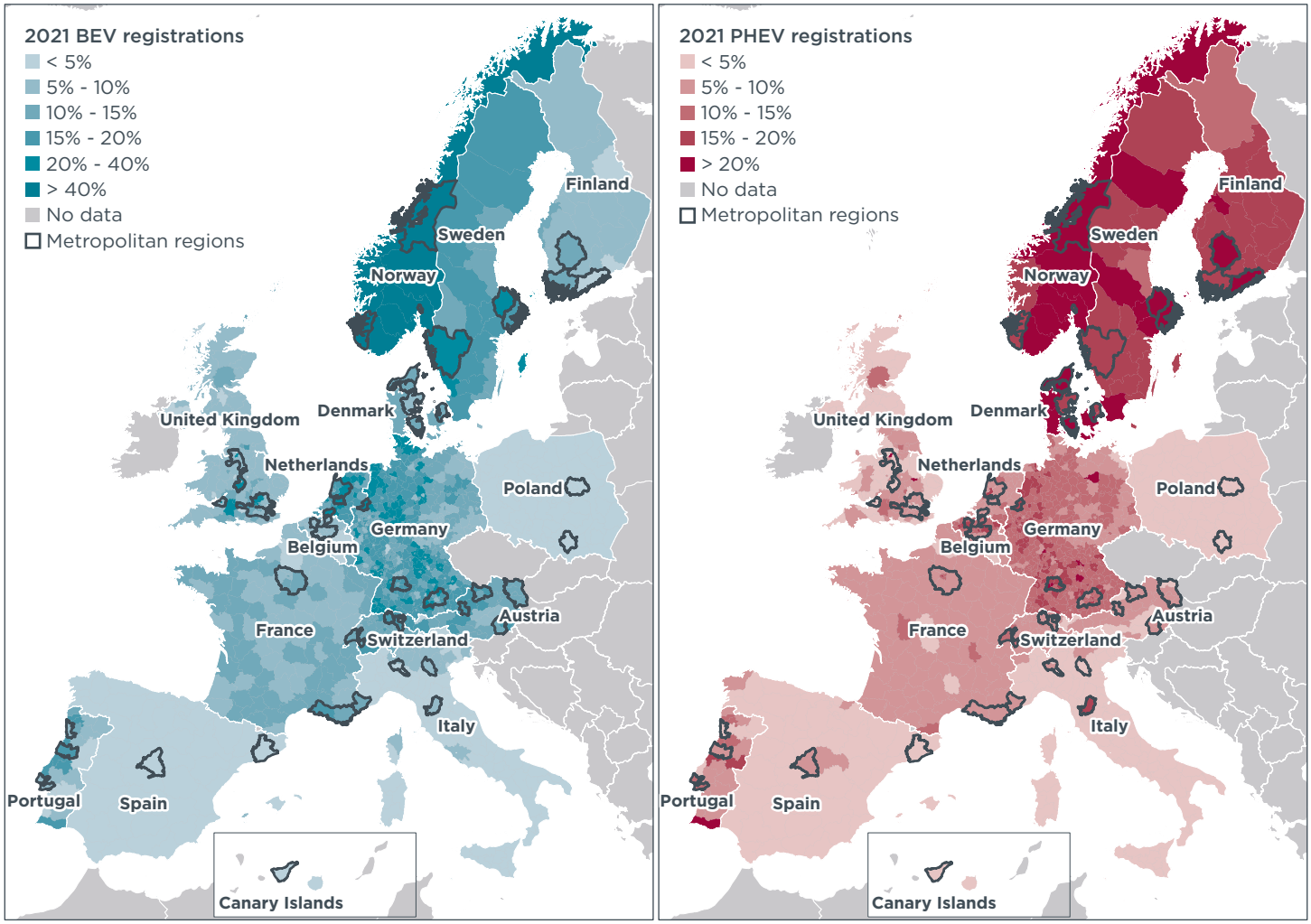

Figure 3. Map of new plug-in hybrid and battery electric vehicle share in selected European metropolitan regions. Dataforce, BEV and PHEV registration data, 2022, https://www.dataforce.de/.

The maps show that regions in Northern Europe had the highest PHEV and BEV shares in 2021. More than half of NUTS 3 regions had higher BEV and PHEV shares than the European average of 10% and 9%, respectively. All NUTS 3 regions in Norway, Sweden, Denmark, Finland, and the Netherlands surpassed the European average. Among the three largest passenger car markets, 39 out of 400 NUTS 3 regions were below the European average in Germany, followed by France with 75 out of 101 regions and the United Kingdom with 151 out of 179 regions. In contrast, all NUTS 3 regions of Spain and Poland were below the European average, with only one out of 107 regions in Italy reaching above the average. Overall, the distribution of PHEV and BEV shares varies significantly between metropolitan regions in each country, reflecting regional disparities in EV adoption.

Of the selected metropolitan regions 40 out of 48 had PHEV and BEV shares above or equal to the European average in 2021. Figure 4 illustrates the PHEV and BEV share of new passenger car sales in these metropolitan regions, reflecting overall growth from 2020 (hashed bars) to 2021 (plain bars). At the top of the list, Oslo's EV share jumped from 79% in 2020 to 89% in 2021, followed by Bergen and Trondheim with 87%. EVs constituted more than half of Stockholm's new passenger car sales in 2021, up from 33% in 2020. Milan (10%), Madrid (10%), and Warsaw (4%) had lower EV

shares than the European average of 19%, even though 2021 absolute EV sales almost doubled from 2020.

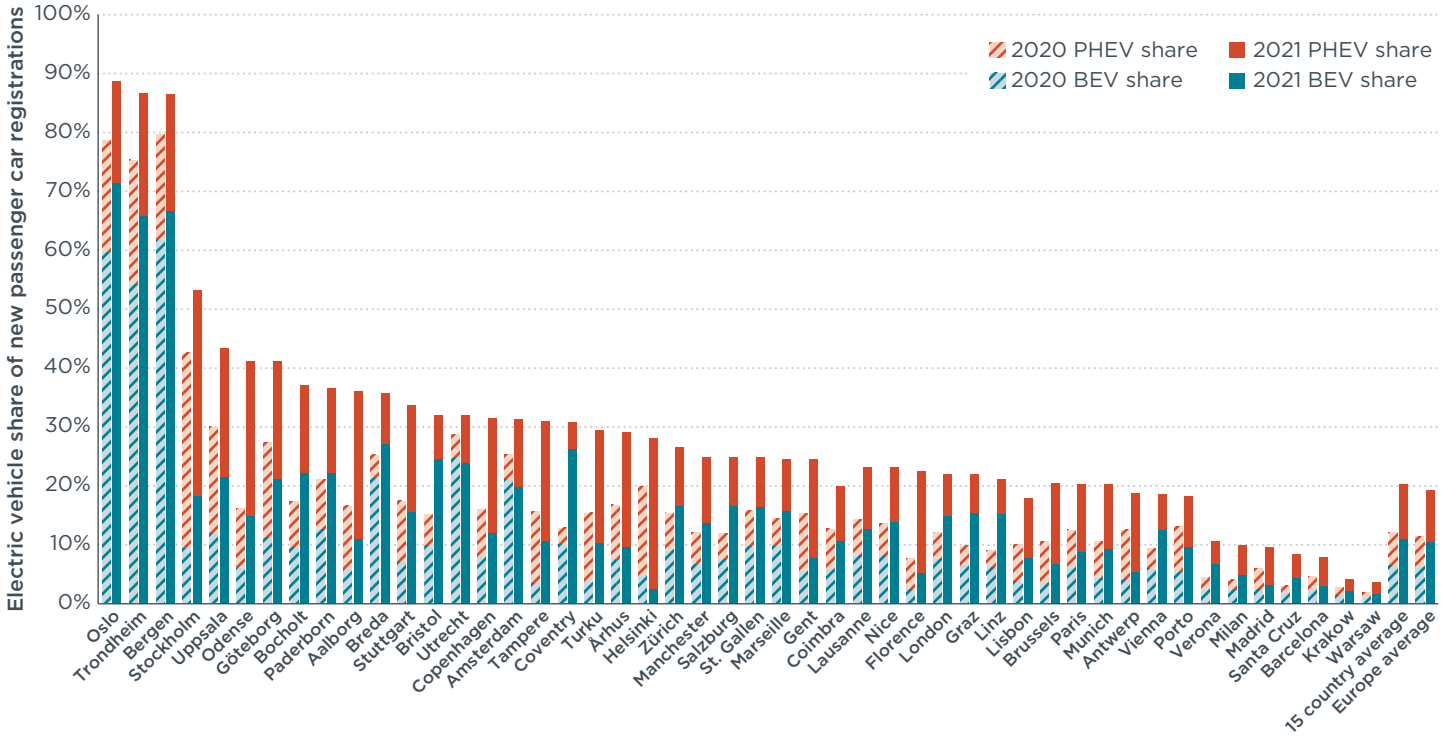

Figure 4. BEV and PHEV shares of new passenger car registrations for the selected 48 European metropolitan regions in 2021 (plain bars) and 2020 (hashed bars). Dataforce, 2022, https://www.dataforce.de/.

In the top three metropolitan regions with the highest BEV share, BEVs accounted for 71% of new passenger car sales in Oslo, 67% in Bergen, and 66% in Trondheim. Stockholm had the highest PHEV sales share of 35%, followed by Odense and Helsinki with a 26% PHEV share. London ranked first in BEV registration volume, and Stockholm topped the list in new PHEV sales in absolute terms. In six metropolitan regions—Bristol, Coventry, Manchester, Florence, Verona, and Lisbon—new PHEV and BEV registrations were at least three times as high as in 2020.

A divide between Northern and Southern Europe in EV adoption was evident at the metropolitan area level in 2021. While EV adoption accelerated in Northern metropolitan regions, most Southern and Central European areas had BEV and PHEV shares below 10%. EV capitals of Europe—Oslo, London, Stockholm, and Amsterdam—had higher EV shares than their respective countries.[15] Major metropolitan regions in Germany doubled their EV sales in cumulative terms, even though most new EV registrations were concentrated in western regions of the country.

Public charging infrastructure deployment

Building out public charging infrastructure is critical to the EV transition, increasing consumer confidence and accessibility for drivers who lack charging options at home.[16]

15 Marie Rajon Bernard, Dale Hall, Hongyang Cui, and Jin Li, "Electric Vehicle Capitals: Accelerating Electric Mobility in a Year of Disruption" (Washington, DC: ICCT, 2021), https://theicct.org/publication/electric-vehicle-capitals-accelerating-electric-mobility-in-a-year-of-disruption/.

16 Gordon Bauer, Chih-Wei Hsu, Mike Nicholas, and Nic Lutsey, "Charging up America: Assessing the Growing Need for US Charging Infrastructure through 2030," (Washington, DC: ICCT, 2021), https://theicct.org/publication/charging-up-america-assessing-the-growing-need-for-u-s-charging-infrastructure-through-2030/.

As charging needs vary across countries, national governments play a crucial role in planning a charging infrastructure strategy to accelerate the transition.

Public charging installations have expanded significantly in leading European EV markets. Europe had 396,280 public chargers in 2021, an increase of 53% from the previous year.[17] In 2021, direct current (DC) fast chargers with a charging speed of 50 kilowatts (kW) or greater accounted for 11% of European public chargers. The rest were regular alternating current (AC) chargers with typical speeds of 3–22 kW. These figures represented an average of 858 chargers for every million people in Europe. Figure 5 illustrates the number of public chargers per million population in the top ten national markets with the most public chargers installed in 2021 and public chargers deployed at the local level in 2020 and 2021, accounting for 88% of public chargers in Europe.

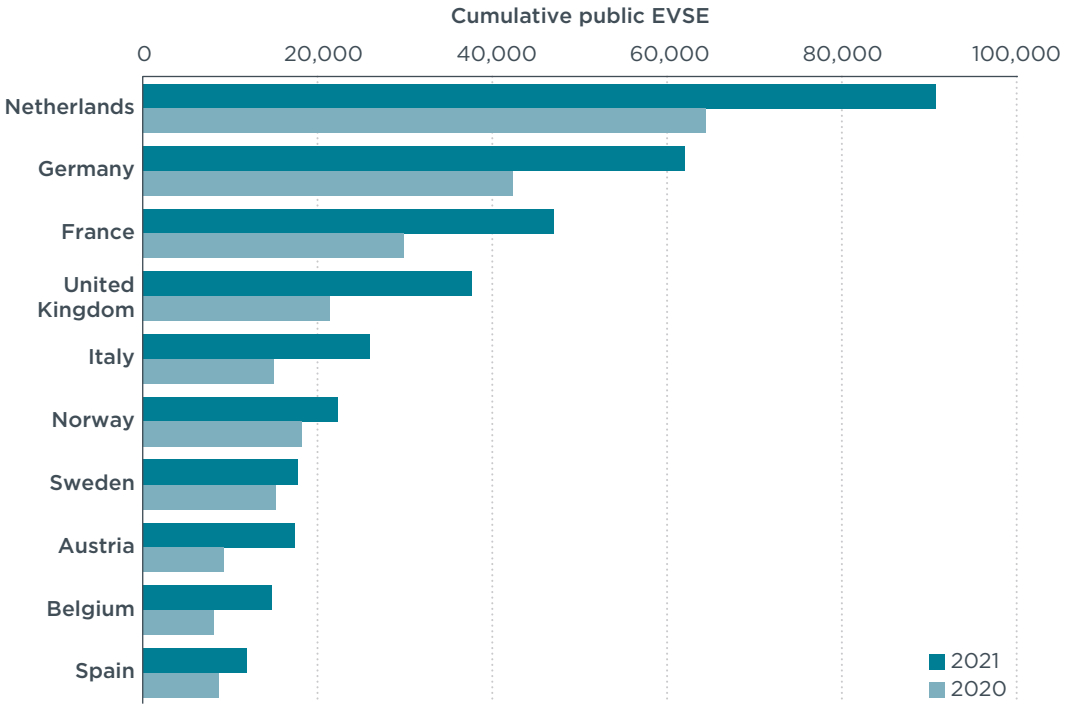

Figure 5. Public charging infrastructure deployment. Eco-Movement, Cumulative Public EVSE Data, 2022, https://www.eco-movement.com.

In 2021, the Netherlands maintained the top position with the most public chargers per million population (5,300), a 41% increase from the 3,750 chargers per million in 2020. Norway (4,200) and Austria (2,000) were the second and third markets for this indicator, registering a 22% and 88% jump from 2020, respectively. Nearly all public chargers were AC chargers in the Netherlands (97%), whereas Norway had the highest DC charger ratio (24%) in Europe in 2021. Following Norway, DC charger ratios in Germany (15%), Spain (17%), and the UK (17%) surpassed the European share of 11% in 2021.

National markets vary significantly in terms of EVs per public charger ratio. In 2021, the Netherlands (4.3) and Italy (9.1) were the only countries with fewer than 10 EVs per charger, whereas Norway (26) and Germany (21.7) had the highest number of EVs per public charger. No universal pattern for the EV-to-charger ratio is observable in these markets. Divergence can be explained by a country's stage of EV adoption and other factors, including access to private home and workplace charging, vehicle use patterns, and the share of fast versus slow chargers. As markets mature, a faster and

17 European Alternative Fuels Observatory, "European Union Charging Infrastructure Statistics," 2021, https://alternative-fuels-observatory.ec.europa.eu/transport-mode/road/european-union-eu27/infrastructure.

more efficient charging network can support more vehicles per charger.[18] For instance, DC fast chargers made up 24% and 15% of charging points in Norway and Germany, respectively, above the European average of 11%. In the Netherlands, however, only 2% were DC fast chargers in 2021.

On July 14, 2021, the European Commission proposed the Regulation on the Deployment of Alternative Fuels Infrastructure (AFIR), recommending at least 1 kW of public charger capacity per BEV and 0.66 kW per PHEV.[19] The proposed regulation focuses on the power output needed to meet the growing charging demand, although several studies suggest that greater public charging capacity per vehicle is necessary during the early stages of the EV transition.[20] A final decision on the adoption of the regulation is expected in 2023. In 2021, over three-quarters of the EU Member States had twice as much power output per EV as the proposed AFIR target.[21] The Netherlands had 4 kW of power installed for each EV, followed by Italy (2.9 kW), Germany (2 kW), and France (1.7 kW).

More European governments announced new policies to accelerate public charging deployment as electric vehicle sales grew. In March 2022, the UK government committed to ramping up EV chargers tenfold by 2030, earmarking £1.6 billion (€1.8 billion) in funding to support the installation of public chargers by local authorities and private companies.[22] It will invest £500 million (€570 million) to expand public chargers across the country, with the existing £950 million (€1.1 billion) Rapid Charging Fund financing 6,000 rapid chargers by 2035. In May 2021, Germany passed the Fast Charging Act, providing the legal basis for tendering a nationwide network of rapid chargers.[23] Approximately €2 billion will be used for the installation of 1,000 rapid charging hubs, each with more than 150 kW of power output, by 2023.[24]

Local public charging infrastructure roll out

Building on these national trends, charging infrastructure deployment varied locally. Figure 7 illustrates the new EV sales share (vertical axis) and public chargers per million population in the 48 metropolitan regions with the highest EV sales in Europe (horizontal axis). Circle sizes represent the cumulative EV registrations at the metropolitan level, with colors representing corresponding countries.

18 Marion Rajon Bernard, Michael Nicholas, Sandra Wappelhorst, and Dale Hall, "A Review of the AFIR Proposal: How Much Power Output Is Needed for Public Charging Infrastructure in the European Union?" (Berlin: ICCT, 2022), https://theicct.org/publication/europe-ldv-review-of-afir-proposal-how-much-power-output-needed-for-public-charging-infrastructure-in-the-eu-mar22/.

19 European Commission, Proposal for a regulation of the European Parliament and of the Council on the deployment of alternative fuels infrastructure, and repealing Directive 2014/94/EU of the European Parliament and of the Council.

20 Rajon Bernard, Nicholas, Wappelhorst, and Hall, "A Review of the AFIR Proposal"; Transport & Environment, "AFIR." https://www.transportenvironment.org/wp-content/uploads/2021/11/20211004_AFIR_Briefing.pdf

21 "A Review of the AFIR Proposal."

22 The UK Government, "UK Electric Vehicle Infrastructure Strategy," March 25, 2022, https://www.gov.uk/government/publications/uk-electric-vehicle-infrastructure-strategy.

23 Bundesministeriums für Digitales und Verkehr, "Bundesrat Beschließt Schnellladegesetz: Rechtsgrundlage Für Ausschreibung von 1.000-Schnellladehubs Steht," May 28, 2021, https://dserver.bundestag.de/btd/19/281/1928184.pdf.

24 Bundesministeriums für Digitales und Verkehr, "The Deutschlandnetz: Basic Principles of the Call for Tenders for 1,000 Locations with High-Power Charging Points Based on the Fast Charging Act," June 2, 2021, https://www.bmvi.de/SharedDocs/DE/Anlage/G/deutschlandnetz-konzept-ausschreibung-englisch.pdf?__blob=publicationFile.

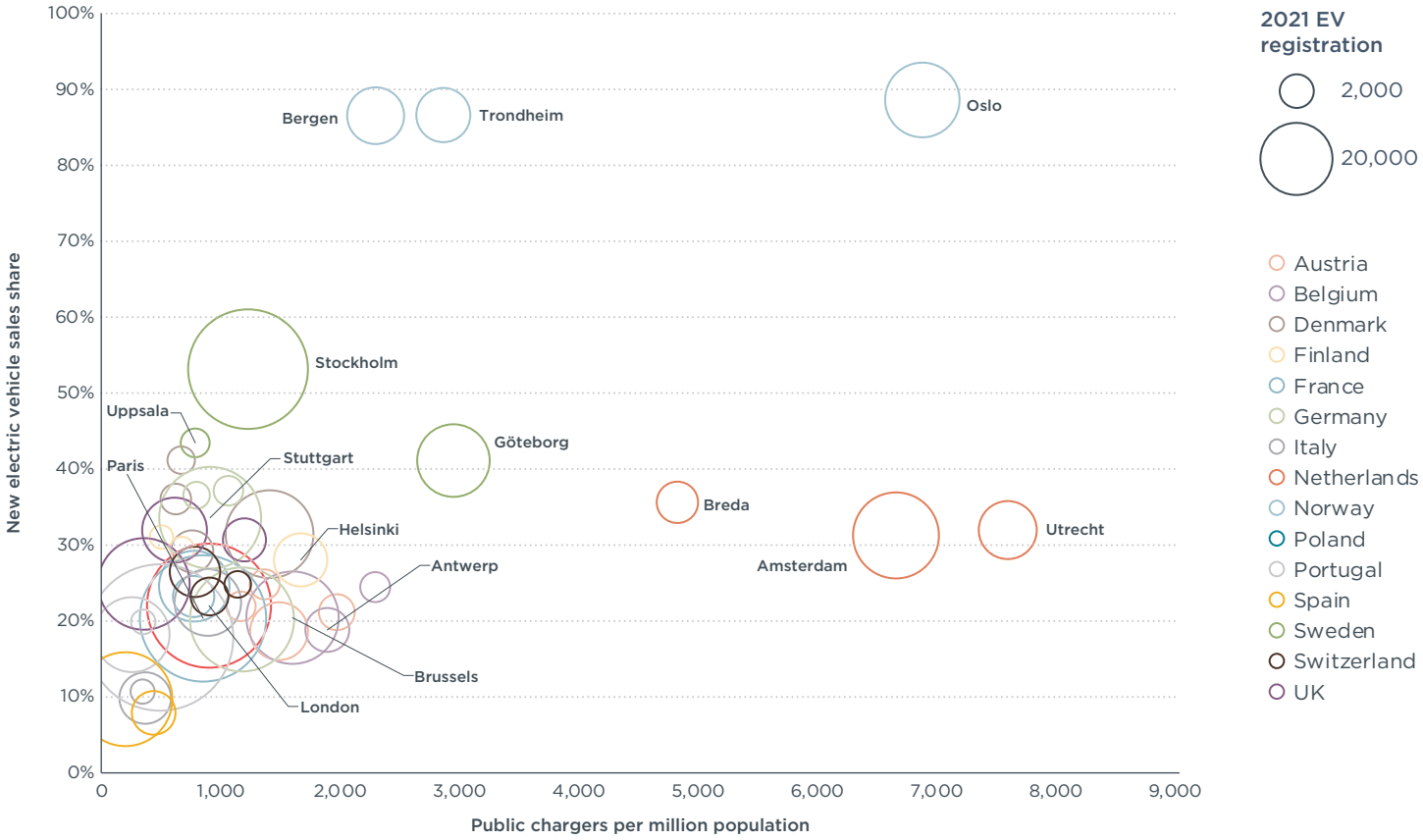

Figure 6. 2021 EV sales shares and public chargers per million population in 48 metropolitan regions. Eco-Movement and Dataforce, 2022, https://www.eco-movement.com, https://www.dataforce.de/.

Public charging density is uneven across European metropolitan regions. Northern Europe has the densest charging networks. Norway and the Netherlands are outliers in the chart above, having both higher charger density and electric vehicle sales shares. Utrecht ranks first with almost 7,600 public chargers per million population, followed by Oslo (6,900), Amsterdam (6,600), Breda (4,800), and Trondheim (2,800). Amsterdam and Utrecht also have the highest share of AC chargers (98%) and the lowest ratios of electric vehicles per public chargers (1.4). Trondheim (29%) and Bergen (27%) have higher shares of DC fast chargers, resulting in 9 and 12 EVs per charger, respectively. In contrast, metropolitan regions with low EV registrations in Southern and Central Europe have fewer public chargers. Spain and Poland have the lowest public chargers per million, correlated with lower EV sales shares.

Table 1 compares total public chargers, share of DC fast chargers, and chargers per million population in metropolitan regions with the most public chargers in 2021. Three metropolitan regions—Amsterdam, London, and Paris—now exceed 10,000 public chargers. Amsterdam accounts for a quarter of public chargers and a third of new EV registrations in the Netherlands. As the leading capitals with the most EV registrations in 2021, the London and Paris metropolitan regions accounted for 34% and 22% of public chargers in the UK and France, respectively.

Table 1. Public charger counts in five European metropolitan regions as of the end of 2021.

Metropolitan region	PHEV share	BEV share	Public chargers	Public DC fast chargers	Share of public DC chargers	Public chargers per million population
Amsterdam	11%	20%	21,900	410	2%	6,600
London	7%	15%	12,900	1,400	11%	900
Paris	11%	9%	10,450	660	6%	850
Utrecht	8%	24%	9,990	230	2%	7,600
Oslo	18%	71%	4,750	310	6%	6,900

Source: Eco-Movement and Dataforce, 2022, https://www.eco-movement.com, https://www.dataforce.de/.

Local electric vehicle policies

Leading EV markets deploy an array of national and local policies to encourage EV uptake and remove barriers to mass adoption. Cities have implemented a range of policy options to improve air quality and reduce greenhouse gas emissions from passenger cars. While most financial incentives are implemented at the national level, some cities offer additional subsidies to bring down the cost of buying a new electric car and installing charging points for convenience. City-run information campaigns raise consumer awareness and address the most common myths about EVs. This section outlines examples of local policies intended to encourage EV uptake in metropolitan regions.

Urban access regulations. Low-emission zones (LEZs) are implemented by city governments to improve air quality by imposing access restrictions for polluting vehicles to urban centers or entire metropolitan areas. From 2019 to 2022, the number of LEZs established in Europe jumped from 228 to 320, registering a 40% increase.[25]

A growing number of European cities are converting their LEZs to zero-emission zones (ZEZs) or near-ZEZs, granting access to zero-emission vehicles and, in some cases, plug-in hybrids. As of June 2022, 10 European cities have implemented or announced plans for a ZEZ or its variants.[26] For instance, Amsterdam will strengthen its current LEZ restrictions and only allow zero-emission trucks and delivery vans to enter the city center by 2025, expanding this policy to all traffic going through the city by 2030.[27] In February 2021, the Netherlands announced that 30 to 40 cities will allow only zero-emission urban delivery vehicles in city centers and neighboring areas by 2025.[28] In October 2021, London increased the size of its ultra-low emission zone from central London to inner London, with further plans to cover the entire city in 2023.[29] London plans to establish a ZEZ in central London by 2025 and a citywide ZEZ by 2050.[30] Brussels will progressively ban ICE vehicles from driving in the city-wide LEZ. [31] By 2035, the city will extend the restrictions to all light-duty non-zero-emission vehicles.[32]

25 The Clean Cities Campaign, "Clean Cities: The Development Trends of Low and Zero-Emission Zones in Europe," July 2022, https://cleancitiescampaign.org/wp-content/uploads/2022/07/The-development-trends-of-low-emission-and-zero-emission-zones-in-Europe-1.pdf.

26 Sandra Wappelhorst and Hongyang Cui, "Update on Zero-Emission Zone Development Progress in Cities" Washington, DC: ICCT, 2022), https://theicct.org/publication/update-on-zero-emission-zone-progress-aug22/.

27 City of Amsterdam, "The Clean Air Action Plan," October 2019, https://www.amsterdam.nl/en/policy/sustainability/clean-air/.

28 Government of the Netherlands, "New Agreements on Urban Deliveries without CO_2 Emission," February 11, 2021, https://www.government.nl/latest/news/2021/02/11/new-agreements-on-urban-deliveries-without-co2-emission.

29 City of London, "The Ultra Low Emission Zone for London," October 25, 2021, https://www.london.gov.uk/what-we-do/environment/pollution-and-air-quality/mayors-ultra-low-emission-zone-london.

30 Transport for London, "Zero Emission Zones: Taking Forward the Mayor's Transport Strategy Proposal for Zero Emission Zones," September 2019, https://content.tfl.gov.uk/tfl-guidance-for-local-zero-emission-zones.pdf.

31 City of Brussels, "Low Emission Zone," July 30, 2022, https://lez.brussels/mytax/.

32 Brussels Environment, "Calendrier Lez Pour La Periode 2025-2035," October 6, 2022, https://environnement.brussels/sites/default/files/user_files/calendrier_de_sortie_du_thermique_2025-2035_1_0.pdf.

Purchase incentives. While most national governments give purchase incentives and tax exemptions to buy an EV, some cities provide additional subsidies targeting certain vehicle segments.[33] In July 2021, the Grand Paris metropolitan government introduced a subsidy of €6,000 to scrap and replace an old polluting vehicle with a new or used EV with a range of at least 50 km.[34]

Some cities offer purchase subsidies for emission-free commercial vehicles in line with the cities' zero-emission vehicle transition plans. On August 13, 2021, Oxford announced a £5,000 (€6,000) grant for taxi drivers to buy a new EV, a subsidy that can be combined with the UK plug-in taxi grant.[35] Since 2018, the city of London has given taxi drivers grants of up to £7,500 (€9,000) to purchase EVs and £10,000 (€12,000) to delicense their old vehicles.[36]

Road access benefits. Some local governments allow preferential road access to spur EV demand. As part of the UK's Go Ultra Low City scheme, EVs are allowed to drive in bus lanes in Milton Keynes, Nottinghamshire, and Derby.[37] In Berlin, Düsseldorf, and Dortmund, EVs are allowed to access bus lanes following the Electric Mobility Act of 2015.[38] Battery-electric cars can drive in the bus lanes of Sevilla and in high-occupancy lanes with a single occupant in Madrid.[39] As EV sales grow, such policies could lead to greater congestion and hinder public transport, so cities will need to evaluate these permissions carefully as the market grows.

Parking benefits. Electric vehicles can benefit from free or discounted parking in cities with limited parking spaces and expensive permits. For example, EV owners in Paris can park in 130,000 paid locations free of charge with a low-emission card.[40] As early adopters, Oslo and Bergen are phasing out free parking for electric cars; drivers currently pay 20% and 50% of standard parking fees in these cities, respectively.[41] In Copenhagen, only zero-emission vehicles can park for free in public parking spaces, whereas PHEVs must pay to park.[42] Certain London boroughs offer free or discounted parking for EVs. Hammersmith and Fulham residents can obtain a free parking permit for fully electric cars or pay a £60 (€68) annual fee for low-emission vehicles.[43] EVs park for free at on-street charging points in Westminster.[44]

---

33 Sandra Wappelhorst, "Economic Recovery Packages In Response To COVID-19: Another Push For Electric Vehicles In Europe?" ICCT staff blog, August 3, 2020, https://theicct.org/economic-recovery-packages-in-response-to-covid-19-another-push-for-electric-vehicles-in-europe/.

34 Métropole du Grand Paris, "Métropole Roule Propre!," accessed March 22, 2022, https://www.metropolegrandparis.fr/fr/metropolerouleprope.

35 Oxford City Council, "£5000 Grant Available to Support Hackney Carriages to Transition to Electric Vehicles," August 13, 2021, https://www.oxford.gov.uk/news/article/1949/5000_grant_available_to_support_hackney_carriages_to_transition_to_electric_vehicles.

36 Transport for London, "Emissions Standards for Taxis," March 24, 2022, https://tfl.gov.uk/info-for/taxis-and-private-hire/emissions-standards-for-taxis.

37 The UK Government, "£40 million to Drive Green Car Revolution across UK Cities," January 25, 2016, https://www.gov.uk/government/news/40-million-to-drive-green-car-revolution-across-uk-cities.

38 Federal Ministry for Economic Affairs and Climate Action, "Regulatory Environment and Incentives for Using Electric Vehicles and Developing a Charging Infrastructure," accessed March 23, 2022, https://www.bmwi.de/Redaktion/EN/Artikel/Industry/regulatory-environment-and-incentives-for-using-electric-vehicles.html.

39 International Energy Agency, "Access to Reserved Traffic Lanes for EVs," October 14, 2019, https://www.iea.org/policies/6679-access-to-reserved-traffic-lanes-for-evs.

40 City of Paris, "Many Offers Exist for Electric Vehicles and Car Sharing," March 7, 2019, https://www.paris.fr/pages/de-nombreuses-offres-existent-pour-les-vehicules-electriques-et-en-autopartage-5930/.

41 Oslo Kommune, "Prices and Payment for Parking," accessed March 24, 2022, https://www.oslo.kommune.no/gate-transport-og-parkering/parkering/priser-og-betaling-for-parkering/; Bergen Kommune, "Parking and Charging for Electric Car," March 24, 2022, https://www.bergen.kommune.no/innbyggerhjelpen/vann-vei-og-trafikk/kjoretoy/elbil/parkering-og-lading-for-elbil.

42 København Kommune, "Elbiler Og Ladestandere i København," March 24, 2022, https://www.kk.dk/ladestandere.

43 London Borough of Hammersmith & Fulham, "Green Vehicle Permits," March 24, 2022, https://www.lbhf.gov.uk/parking/parking-permits/green-vehicle-permits.

44 City of Westminster, "Electric Vehicles," accessed March 24, 2022, https://www.westminster.gov.uk/parking/electric-vehicles.

Electric vehicle awareness programs. Consumer interest in electric cars grew in 2021, with four in ten consumers surveyed across 13 countries planning to buy an EV for their next car.[45] While electric car sales boomed in Europe, consumer awareness remains a significant barrier to EV adoption. According to a survey in 2021, a plurality of the new car buying population in the UK (42%), France (42%), and Germany (33%) are categorized as "uninterested rejectors," citing lack of access to charging and high vehicle cost as their main concerns.[46]

Local governments are implementing consumer-facing communication campaigns to improve public understanding of electric cars and charging technologies. The UK's Go Ultra Low campaign funded the EV Vehicle Experience Centre, which gives advice on the benefits of EVs and charging options in the city of Milton Keynes.[47] Oslo's municipality has an online platform to debunk myths about electric cars to raise the profile of EVs with consumers.[48]

Public fleet electrification. Many leading European cities have implemented procurement programs to electrify light-duty fleets in the early stages of electrification. Setting EV procurement targets accelerates electrification of municipal fleets. For instance, London plans to purchase only zero-emission capable cars and vans from 2025.[49] Stockholm adopted an EV-first procurement strategy, targeting the electrification of municipal vehicles through 2030.[50] Paris is targeting a transition to a 90% electric municipal fleet by 2025.[51]

Private fleet electrification. Some cities have set targets for the electrification of private fleets. Notably, London introduced new requirements for all new black cabs to be zero-emission capable from January 2018, with a long-term plan for the entire fleet to be zero-emission by 2032.[52] As of June 2022, 38% of London's taxi fleet was zero-emission capable.[53] London's most significant private taxi courier, Addison Lee, and the carsharing company Uber plan to be fully electric by 2023 and 2025, respectively.[54] The car-sharing fleet in Paris, which can park in 2,500 spaces allocated by the city, is already 100% battery-electric.[55] Milan waives a parking fee of €1,200 for electric carsharing operators, which are required to phase out combustion vehicles by 2024.[56] In April 2022, the Netherlands announced that major Dutch cities would be allowed to permit only zero-emission taxis and rental cars from 2025, extending the vehicle restrictions for planned ZEZs.[57] Five major Dutch cities—Amsterdam, Rotterdam,

45 EY, "Four in Ten Consumers Plan Electric Vehicle Purchase as Market Moves into High Gear," July 20, 2021, https://www.ey.com/en_gl/news/2021/07/four-in-ten-consumers-plan-electric-vehicle-purchase-as-market-moves-into-high-gear.

46 Element Energy, "Electric Mobility: Inevitable, or Not?," January 2022, https://www.platformelectromobility.eu/wp-content/uploads/2022/01/20220110_InevitableEV_Final.pdf.

47 "The Electric Vehicle Experience Centre," accessed March 25, 2022, https://evexperiencecentre.co.uk/.

48 Klima Oslo, "Climate Myths," accessed March 25, 2022, https://www.klimamyter.no/.

49 Mayor of London, "Fleet Supply and Replacement Planning 2021 and 2025," November 26, 2019, https://www.london.gov.uk/sites/default/files/pcd_640_fleet_supply_and_replacement_planning_2021_to_2025.pdf.

50 IEA, "EV City Casebook" (Paris, France, March 2021), https://iea.blob.core.windows.net/assets/a38038c8-0ccf-4782-9e00-66da140d8035/EV_City_Casebook_and_Policy_Guide_2021_Edition.pdf.

51 City of Paris, "Paris Climate Action Plan: Towards A Carbon Neutral City," November 23, 2020, https://cdn.paris.fr/paris/2020/11/23/257b26474ba3ba08ee02baa096f9c5dd.pdf.

52 Transport for London, "Emissions Standards for Taxis."

53 Transport for London, "Licensing information," June 15, 2022, https://tfl.gov.uk/info-for/taxis-and-private-hire/licensing/licensing-information.

54 Electrek, "London's Largest Taxi Firm to Go Fully Electric by 2023 with 4,000 EVs," September 21, 2021, https://electrek.co/2021/09/21/londons-largest-taxi-firm-to-go-fully-electric-by-2023-with-4000-evs/; Uber, "The next Phase of Uber's Clean Air Plan in London," May 4, 2021, https://www.uber.com/en-GB/newsroom/the-next-phase-of-ubers-clean-air-plan-in-london/.

55 Michael Nicholas and Marie Rajon Bernard, "Success Factors for Electric Carsharing" (ICCT: Washington, DC, 2021), https://theicct.org/publication/success-factors-for-electric-carsharing/

56 IEA, "EV City Casebook."

57 The Government of the Netherlands, "Volgende Stap Op Weg Naar Schone En Stille Taxi's," April 21, 2022, https://www.nieuwsienw.nl/2202164.aspx.

Eindhoven, Tilburg, and the Hague—and several taxi and rental car companies have signed the agreement.

Charging infrastructure incentives. The lack of charging infrastructure can be a barrier to EV uptake.[58] In the initial stages of EV adoption, cities can roll out a comprehensive public charging network at scale to ease drivers' range anxiety. As the market matures, cities can incentivize the installation of charging stations in locations where demand is highest.

Some European cities have provided subsidies for charging infrastructure on top of national incentives. Paris had over 10,000 public chargers, 6% of which are fast chargers in 2021. France and Paris provide an example of how local, regional, and national incentives for building charging infrastructure can decrease installation costs. Companies can receive a subsidy of €2,500 from the Île de France region (home to Paris) and up to €500 from the city of Paris per normal public charger.[59] These subsidies can be combined with the national Advenir bonus, which finances up to 20% for companies and public entities and 50% for residential collectives.[60] Oslo funds up to 20% (max of NOK 5,000, or €550) of installation costs per charging point in housing cooperatives.[61] In major Dutch cities, EV owners can request an off-street public charger in their neighborhood when they do not have access to home charging.[62]

European cities have adopted divergent public charging strategies. Amsterdam supported a demand-driven approach and paid private operators to install the stations. In 2016, the municipality partnered with the utility company Nuon to ensure EV users have access to nearby overnight charging.[63] This strategy led to a higher share of regular AC chargers in Amsterdam. In contrast, London embraced a mix of planning-oriented and demand-driven approaches, resulting in the build-out of the most DC fast chargers among European cities.[64] The London Electric Infrastructure Delivery Plan of 2019 aims to deliver five rapid charging hubs for taxis and commercial fleets in every sub-region by 2025.[65] Transport for London oversees the planning of fast charging stations, while private companies help with the operation and funding of these chargers.

Summary of policies

Sustained local policy support can encourage EV uptake and charging infrastructure deployment in European cities. Table 2 showcases policies that have been implemented local markets. The table does not intend to rank policies, but rather provides examples of approaches in each area, such as urban access regulations and purchase incentives. As EV markets expand, cities can learn from each other and adapt their policies.

58 Dale Hall and Nic Lutsey, "Emerging Best Practices for Electric Vehicle Charging Infrastructure" (ICCT: Washington, DC, October 2017), https://theicct.org/publication/emerging-best-practices-for-electric-vehicle-charging-infrastructure/.

59 Rajon Bernard, Hall, and Lutsey, "Update on Electric Vehicle Uptake."

60 Oslo Kommune, "Klimabudsjettet: Kraftige Utslippskutt, Men det Gjenstår Fortsatt Mye Arbeid," March 24, 2022, https://www.oslo.kommune.no/politikk/byradet/for-pressen/pressemeldinger-fra-byradet/klimabudsjettet-kraftige-utslippskutt-men-det-gjenstar-fortsatt-mye-arbeid.

61 Klima Oslo, "Charging Infrastructure for Housing Associations and Co-Owners," accessed March 25, 2022, https://klimatilskudd.no/ladeinfrastruktur-til-borettslag-og-sameier.

62 Municipality of Rotterdam, "Electric Driving," accessed March 25, 2022, https://www.rotterdam.nl/wonen-leven/elektrisch-rijden/.

63 Julie Chenadec, "Amsterdam's Demand-Driven Charging Infrastructure," Interreg Europe, October 22, 2018, https://www.interregeurope.eu/good-practices/amsterdams-demand-driven-charging-infrastructure.

64 Marie Rajon Bernard and Dale Hall, "Efficient Planning and Implementation of Public Chargers: Lessons Learned from European Cities" (ICCT: Washington, DC, June 2021), https://theicct.org/publication/efficient-planning-and-implementation-of-public-chargers-lessons-learned-from-european-cities/.

65 Transport for London, "London Electric Vehicle Infrastructure Delivery Plan," June 2019, https://tfl.gov.uk/ruc-cdn/static/cms/documents/tfl-london-electric-vehicle-infrastructure-delivery-plan.pdf.

Table 2. Examples of local policies in leading European metropolitan regions

Policy area	City	Description
Urban access	Brussels	All non-zero-emission cars, vans, and minibuses will be banned from entering the LEZ by 2035.
	Amsterdam	Only zero-emission trucks and delivery vans are allowed to enter the city center from 2025.
Purchase incentives	Paris	€6,000 to swap older cars for new or used BEVs, a subsidy that can be combined with the national bonus.
	Oxford	£5,000 grant for taxi drivers to switch to an EV, a subsidy that can be combined with the UK plug-in grant of £7,500.
Congestion charging exemptions	London	A £15 daily congestion charge is waived for zero-emission vehicles until 2025. PHEVs do not qualify as exempt vehicles.
	Oslo	Battery-electric passenger cars pay less than ICE vehicles, while full-electric vans are exempt.
Parking benefits	Copenhagen	Zero-emission vehicles have access to free public parking, whereas PHEVs must pay to park.
	London	Hammersmith and Fulham offer free parking permits for BEVs or a £60 annual fee for low-emission vehicles.
Public fleet electrification	Paris	Municipal fleet must be 90% electric by 2025.
	London	Only zero-emission capable car and van procurement by 2025.
Private fleet electrification	Milan	Electric carsharing operators must phase out ICE vehicles by 2024.
	Amsterdam, Rotterdam, Eindhoven, Tilburg, Hague	All new taxis and rental cars must be zero-emission from 2025.
Charging infrastructure incentives	Paris	Up to €500 for hardware and installation costs, which can be combined with the national Advenir program.
	Oslo	Up to 20% of installation costs are capped at NOK 5,000 for housing cooperatives.

Conclusions

This paper analyses the EV uptake and public charging infrastructure at the local level in 2021, focusing on 48 metropolitan regions with the largest EV registrations volumes and shares in Europe. It also reviews national and local policies supporting the EV transition. Some of the key findings include:

Electric vehicle uptake in European cities accelerated in 2021, yet regional disparities remain. European EV sales increased 66% from 2020, reaching 2.3 million with over 1.2 million BEVs and 1.1 million PHEVs registered in 2021. Of the metropolitan regions 40 out of 48 achieved greater EV shares than the European average of 19%. The seven metropolitan regions with more than twice the European average EV share are in Norway, Sweden, and Denmark. Southern and Central European regions had lower EV shares than the European average. EV shares doubled in Italian, Polish, and Spanish cities from 2020 to 2021, but these countries' EV shares remained well below the EU average. For instance, Warsaw's share increased from 2% in 2020 to 4% in 2021. As the leading EV capitals, Amsterdam (31%), London (22%), Oslo (89%), and Paris (20%) reached higher levels of EV penetration than their national average in 2021.

Charging infrastructure deployment varies significantly across cities. Public chargers in Europe rose to almost 400,000 in 2021, measuring 53% growth from 2020. Of public chargers, 11% were DC fast chargers, and the rest were regular AC chargers. However, significant disparities remain among the 48 metropolitan regions studied. Norway and the Netherlands have higher public charger densities correlated with their EV shares. Amsterdam and Utrecht also have a greater share of normal AC public chargers (98%), with the lowest ratio of EVs per public charger. Trondheim and Bergen have a much higher share of public chargers that are DC fast chargers (29% and 27%, respectively). Amsterdam and London have expanded their public charging through innovative

strategies, including partnerships with utilities for on-demand regular charging installation and financing regional fast charging hubs.

Sustained policy support drives electric vehicle uptake in leading European cities. Leading national and local governments adopted policies intended to spur the deployment of EVs and charging infrastructure. A growing number of governments have set 100% zero-emission vehicle sales targets, sending a strong market signal. Purchase subsidies at the national and local levels reduce the cost of buying EVs among early adopters. Rolling out public charging infrastructure can increase convenience and remedy range anxiety, especially before the EV market matures. Other nonfinancial incentives include preferential access to parking spaces, public charging stations, toll roads, and bus lanes. European capitals such as Amsterdam, London, Paris, and Oslo have implemented some of the strongest policies.

Cities are leading the transition to zero-emission vehicles. As of June 2022, ten European cities have committed to phasing in zero-emission vehicles and plan to implement ZEZs or near-ZEZs by 2030, restricting access to polluting vehicles to designated zones in metropolitan regions. Paris plans to extend its city-wide LEZ to a ZEZ by 2030, affecting all vehicle types. These targets complement other policies such as communicating the benefits of ZEZs and setting charging infrastructure targets. Although most cities are in the initial stages of planning, the growth in EV shares in these cities indicate that these policies could potentially accelerate transportation electrification.