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Update on electric vehicle uptake in European cities

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Keywords: electric vehicles, European cities, local policies, charging infrastructure, model availability

Introduction

The European electric vehicle (EV) market experienced unprecedented growth in 2020. More than 1.36 million new electric passenger cars, including battery electric (BEV) and plug-in hybrid electric vehicles (PHEV), were sold across the region, a 143% increase from 2019. The robust sales in 2020 made Europe the largest EV market globally, surpassing China.[1] This came during a period of major disruption in the vehicle market due to COVID-19: Although sales of all new cars in Europe fell by 20%, the surge in EV sales boosted the EV share to 11%. Several individual European markets achieved far greater shares of new EV sales: 75% in Norway, 32% in Sweden, 25% in the Netherlands, 18% in Finland, 16% in Denmark, 14% in Switzerland and Portugal, 13% in Germany, and 11% in France, Belgium, and the United Kingdom.

The EV growth in Europe was largely fueled by the need for manufacturers to comply with more stringent European Union CO_2 standards for new passenger cars and vans from January 2020.[2] However, there was substantial variation across the European market, reflecting the influence of national and local policies as well as other factors such as the availability of electric models and charging infrastructure across local markets.[3] This relative local-level success in EV uptake could hold lessons for designing, adopting, and sustaining local EV policy and programs going forward.

This paper provides updates on the European EV market in 2020 at the European, national, and local levels. The data include new passenger car sales at the European and national levels and new registrations, which are considered a proxy for new car sales, at

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

2 Peter Mock, Uwe Tietge, Sandra Wappelhorst, Georg Bieker, and Jan Dornoff, *Market Monitor: European Passenger Car Registrations, January–December 2020* (ICCT: Washington, DC, February 3, 2021), https://theicct.org/publications/eu-ev-pv-co2-emission-performance-sept21.

3 Sandra Wappelhorst, Dale Hall, Michael Nicholas, and Nic Lutsey, *Analyzing Policies to Grow the Electric Vehicle Market in European Cities* (ICCT: Washington, DC, 2020), https://theicct.org/publications/electric-vehicle-policies-eu-cities.

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the subnational level. Data on new vehicle registrations, model availability, and charging infrastructure are presented at the metropolitan region level for major markets across Europe.[4] The analysis includes the 17 largest national EV markets in Europe in terms of 2020 EV sales volume, and includes local-level data, where available, for 16 of these countries. The paper also summarizes and provides examples of local EV policies that have driven high levels of EV uptake in several metropolitan regions.

European and national electric vehicle uptake

European new electric passenger car sales reached more than 1.36 million vehicles in 2020, a 143% increase over 2019 sales. The new EVs in 2020 included around 745,000 BEVs and 625,000 PHEVs. The growth in electric vehicles from 2011 to 2020 is displayed in Figure 1, including BEVs (dark blue bars) and PHEVs (light blue bars) corresponding to the left axis. The figure also plots the share of new passenger cars sales that were electric (BEV or PHEV) on the red line (right axis). The relative increase in EV sales share from 2019 to 2020 notably coincided with the contraction of the overall passenger car market by 20% during the COVID-19 pandemic. As shown, the EV sales share increased from 4% to more than 11% between 2019 and 2020.

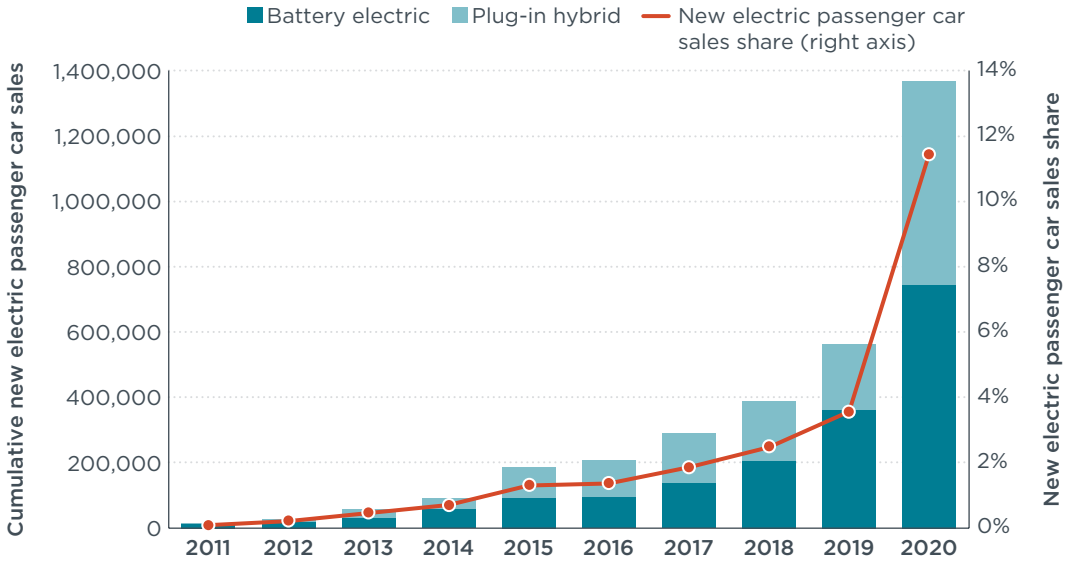

Figure 1. Cumulative new electric passenger car sales (left) and sales share (right) in Europe.

Much of the market growth in 2020 can be attributed to the increased stringency of European Union (EU) CO_2 emission standards for new passenger cars.[5] With this regulation, from January 2020 onward vehicle manufacturers had to meet an average CO_2 emission standard of 95 grams of carbon dioxide per kilometer (g/km) traveled in New European Driving Cycle (NEDC) tests for passenger cars, although this only applied to 95% of their new car registrations in that year, with 100% compliance in 2021.[6] The previous passenger car CO_2 standard, in place since 2015, was 130 g/km in NEDC. The average new car CO_2 emission level went from 112 g/km (NEDC) in 2019 to an estimated 97 g/km (NEDC) in 2020 with manufacturers at or near compliance. This reduction rate of 15 g/km from 2019 to 2020 compares to a more modest 2.4 g/km reduction

4 "Background–Metropolitan Regions–Eurostat," n.d., https://ec.europa.eu/eurostat/web/metropolitan-regions/background.

5 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* (ICCT: Washington, DC, 2021), https://theicct.org/sites/default/files/publications/eu-ev-pv-co2-emission-performance-sept21.pdf.

6 European Commission, "Reducing CO_2 Emissions from Passenger Cars - before 2020," Text, Climate Action - European Commission, November 23, 2016, https://ec.europa.eu/clima/policies/transport/vehicles/regulation_en.

between 2015 and 2019.[7] Although the regulation covers both passenger cars and light commercial vehicles (LCVs), the CO_2 emission targets for LCVs were less strict, partially explaining the lower electric sales share of LCVs (2%) compared to passenger cars in 2020. Nonetheless, electric LCV sales in 2020 still increased by 28% compared to 2019.[8]

National phase-out targets. Reinforcing the EU-wide CO_2 regulations, several national governments have set targets for the phase-out of new internal combustion engine passenger car sales or registrations. These countries include Norway in 2025; Austria, Denmark, Iceland, Ireland, the Netherlands, Slovenia, and Sweden in 2030; the United Kingdom in 2035 (moved up from 2040); and France and Spain in 2040.[9] Targets for Norway, Slovenia, the UK, France, and Spain also include vans. Although not legally binding, these targets serve as important guides for other government policies and for planning public and private investments, such as vehicle manufacturing and charging infrastructure.

Figure 2 displays the 2020 (plain bars) and 2019 (hashed bars) new EV sales share for the 17 European countries with the highest EV sales volume in 2020; dark blue bars represent BEVs and light blue bars represent PHEVs.[10] These countries are displayed in the order of their 2020 new EV sales shares and represent 93% of Europe's new passenger car registrations, 98% of Europe's new electric registrations, and 43% of global new electric passenger car sales in 2020. Norway is the largest market in terms of new electric passenger car share, with 75% in 2020, up from 56% in 2019. Europe overall reached 11% EV sales share in 2020, up from 3.6% in 2019.

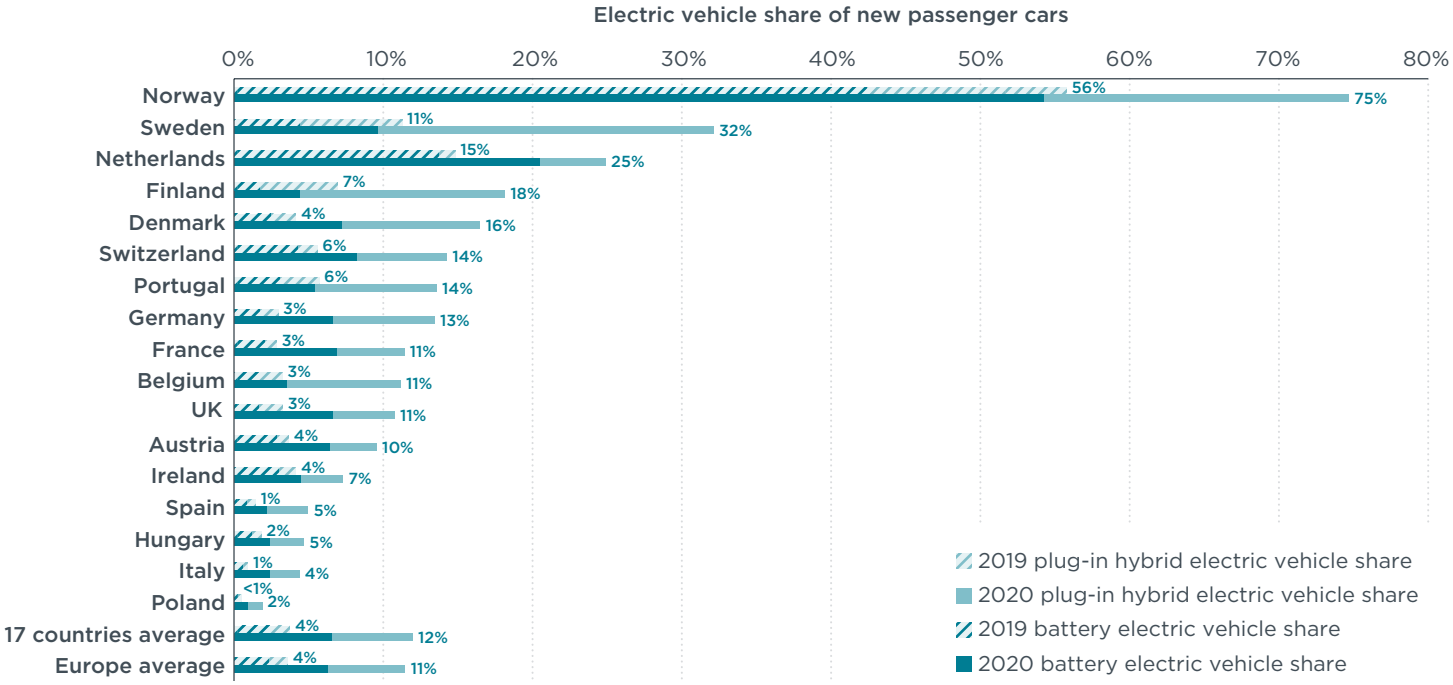

Figure 2. Battery (dark blue) and plug-in hybrid (light blue) electric vehicle share of new passenger cars for 17 European countries. Plain bars represent 2020 data and hashed bars represent 2019 data.

7 Peter Mock, et al., *Market Monitor: European Passenger Car Registrations, January–December 2020*.

8 Sonsoles Díaz, "The Often Forgotten Larger, Heavier Cousins of Passenger Cars: Europe's CO_2 Regulation for Vans," *ICCT Staff Blog* (blog), June 17, 2021, https://theicct.org/blog/staff/europe-co2-regulation-vans-jun2021.

9 Sandra Wappelhorst, *Update on Government Targets for Phasing out New Sales of Internal Combustion Engine Passenger Cars* (ICCT: Washington, DC, June 15, 2021), https://theicct.org/publications/update-govt-targets-ice-phaseouts-jun2021.

10 EV-Volumes (EV Data Center, 2020), http://www.ev-volumes.com/datacenter/.

Figure 2 also shows the variation in new EV sales shares across Europe. Five countries had 2020 new EV sales shares above 15%: Norway, Sweden, the Netherlands, Finland, and Denmark. The markets of Switzerland, Portugal, Germany, France, Belgium, United Kingdom, Austria, and Ireland, with EV uptake from 7% to 14%, were similar to the average for Europe. However, the national markets of Hungary, Spain, Italy, and Poland had EV shares of 2% to 5%, or less than half the European average. Also shown in the figure, the underlying technology breakdown across Europe is 55% BEVs and 45% PHEVs, with most national markets reflecting this trend. Outliers to this trend include Finland and Sweden, where 24% and 30% of new EVs sold in 2020 were BEVs, and Norway and Netherlands, with 73% and 82% BEV shares of new EV sales in 2020. Although not shown in the figure, each of the 17 markets increased its EV sales by at least 33% from 2019 to 2020, with a 143% increase across Europe as a whole. Five of these national markets more than tripled their sales of new EVs from 2019 to 2020: Germany, Denmark, Italy, Poland, and France.[11]

Local electric vehicle uptake

Local-level EV uptake data reveal more granular trends underlying national level data. New electric passenger car registrations as a share of all registrations in 2020 is displayed in Figure 3 for the 16 countries for which NUTS 3-level[12] data were available: Austria, Belgium, Denmark, Finland, France, Germany, Hungary, Italy, the Netherlands, Norway, Poland, Portugal, Spain, Sweden, Switzerland, and the United Kingdom.[13] Darker shades of red indicate higher shares of EV registrations, which are considered a proxy for new EV sales. Selected metropolitan regions are outlined in blue. These regions were selected to identify the top two with most new passenger EVs and the top two with the highest new EV sales share, in 2020. Because some regions with the most new EVs sold are also those with the highest EV share, this selection process results in between two and four regions per country and 50 total regions. These regions are the focus of our analysis in this paper.

11 Peter Mock, et al., *Market Monitor: European Passenger Car Registrations, January–December 2020*.

12 Eurostat, "NUTS - Nomenclature of Territorial Units for Statistics," accessed July 1, 2021. https://ec.europa.eu/eurostat/web/nuts/background.

13 IHS Markit (New vehicle registration data, 2020), https://ihsmarkit.com/.

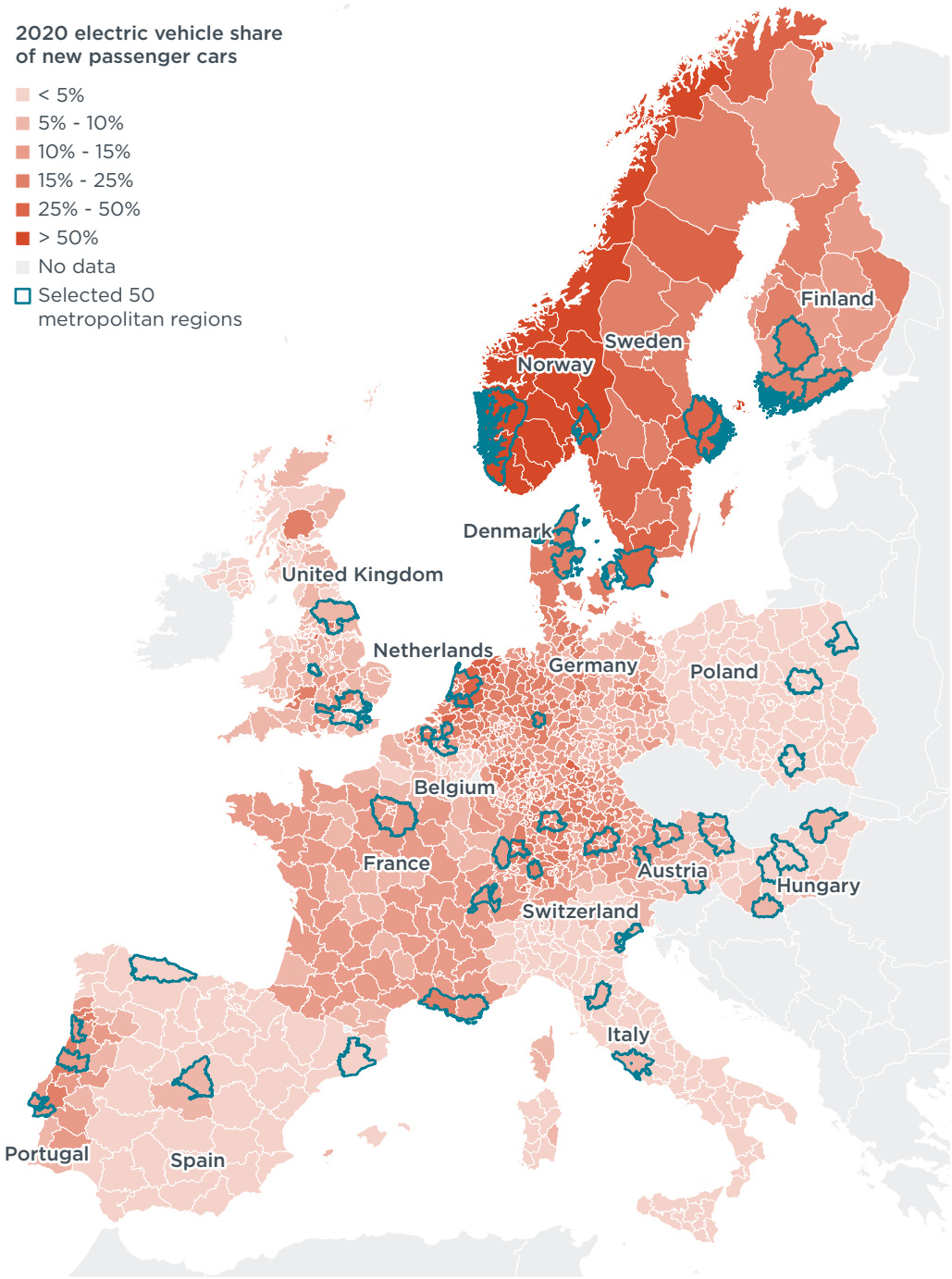

Figure 3. New electric passenger car registration share in 2020 in selected European countries.

The map shows that regions in northern Europe, especially in Norway, had the highest EV shares in 2020. The three Norwegian metropolitan regions of Bergen, Oslo, and Trondheim had 80%, 79% and 75% EV shares, respectively, and about three-quarters of those EVs were BEVs. The 17 regions with the highest EV shares were all in Norway, Sweden, or the Netherlands. Of the European metropolitan regions, the 40 with the highest EV share are all located in the northern European countries of Norway, the Netherlands, Germany, Sweden, Finland, Denmark, and the United Kingdom. Across Europe, metropolitan regions generally led the EV market: In 13 of 16 countries, the metropolitan regions had higher EV shares than the rural areas outside the metropolitan regions. The exceptions were Belgium, Denmark, and Portugal.

Among the European markets analyzed, there was greater variation across countries than within countries. For example, every NUTS 3 region in Denmark, the Netherlands,

Finland, and Sweden was above the European average share of EV registrations, 11%. In the largest national market of Germany (13% EV share), all except two NUTS 3 regions had an EV share of 5% or higher, and 316 of the 401 NUTS 3 regions were above Europe's average of 11%. On the other hand, many countries in southern and eastern Europe experienced much lower EV registrations: All NUTS 3 regions of Italy, Poland, and Hungary had 2020 EV registration shares below the European average of 11% and only 3 of 59 NUTS 3 regions of Spain, 5 of 107 regions of Italy, and 0 of 73 regions of Poland recorded shares at or above half of the European average (5.5%).

Figure 4 provides more details on EV registrations in the 50 metropolitan regions highlighted in Figure 3. The bars represent 2019 (hashed) and 2020 (plain) EV share of new passenger cars registered. Also included on the right side are the average shares for Europe and for the 16 countries where local-level data were available. All together, these 50 metropolitan regions represent 35% of the EV registrations and 29% of passenger cars registrations across these 16 countries. The registration shares range from 2% in Warsaw to 80% in Bergen. As shown, Bergen and Oslo led in EV and BEV registration shares in both 2020 and 2019. The top eight cities are in Norway, the Netherlands, and Sweden.

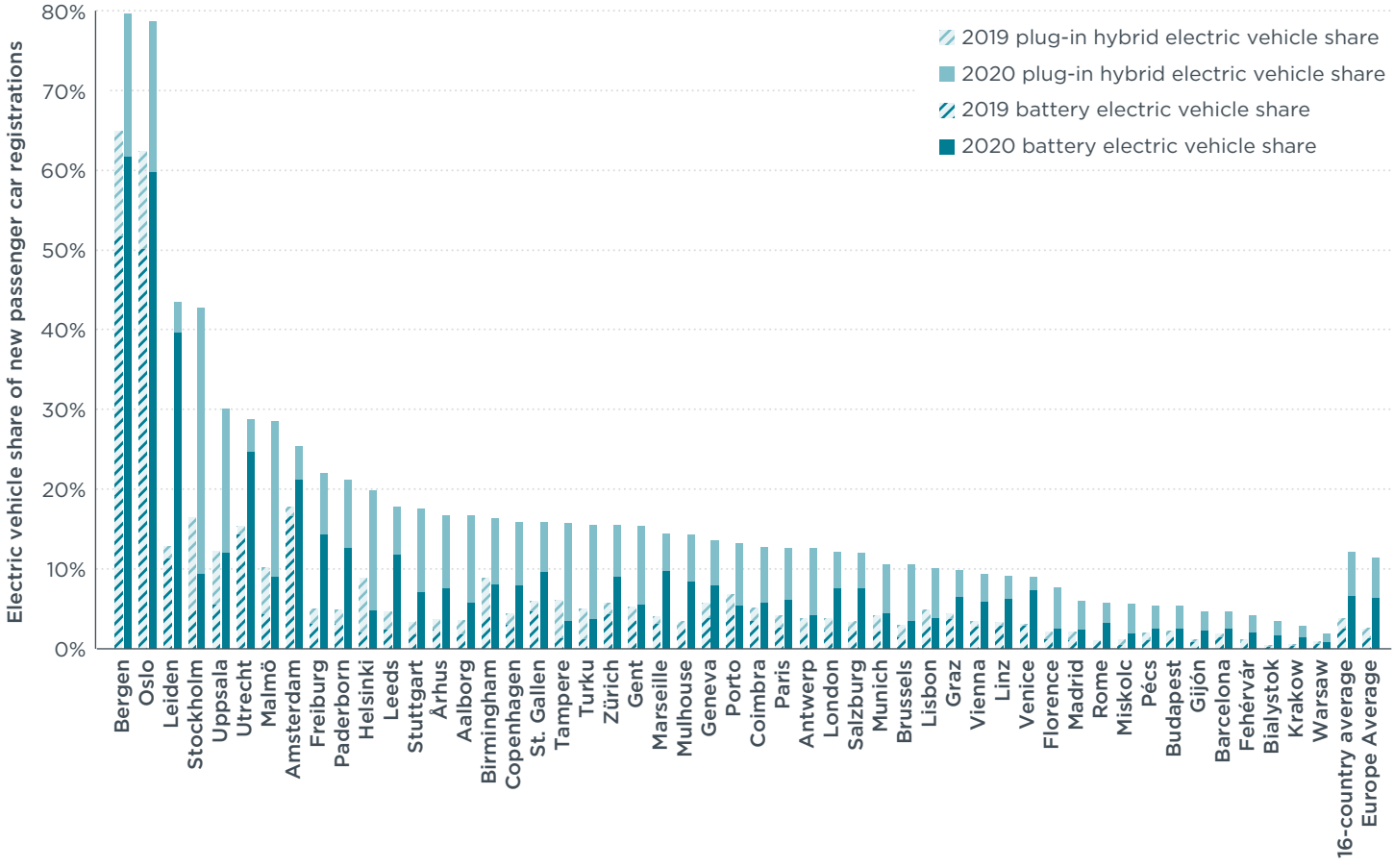

Figure 4. 2020 (plain bars) and 2019 (hashed bars) EV share of new passenger car registrations for the selected 50 European metropolitan regions. Dark blue bars represent BEVs and light blue bars represent PHEVs.

The figure shows that each of the 50 metropolitan regions increased its EV share of registrations between 2019 and 2020. For 31 of the 50 metropolitan regions, the EV share of registrations in 2020 was above the European average. The graph also reveals that BEV and PHEV registrations are unequally distributed across leading markets. For example, Stockholm ranks fourth in EV share but 12th in BEV share.

Although not shown, when considering 2020 registration volume, Stockholm ranks first in EV but ninth in BEV because 78% of its newly registered EVs were PHEVs. On the other hand, Oslo ranks fourth in 2020 EV registration volume but first in BEV with 76% of its newly registered EVs being BEVs. It is also noteworthy that all 50 metropolitan regions increased their new EV sales volume between 2019 and 2020, despite a 20% decrease in overall passenger car sales across Europe from 2019 to 2020. In six of these metropolitan regions—Freiburg and Stuttgart, Germany; Aalborg, Denmark; Geneva, Switzerland; and Bialystok and Krakow, Poland—EV registrations in 2020 were at least 4 times those in 2019.

Model availability

Vehicle manufacturers are increasingly announcing and producing vehicles across different segments to appeal to different consumers in the mainstream market.[14] Figure 5 plots the 2020 EV registrations share on the y-axis against the number of EV models available in 2020 for the 257 metropolitan regions of the 16 countries analyzed as part of this study. A model was considered available in a metropolitan region if it accounted for at least 0.02% of new light-duty vehicles sold in 2020. For example, in a metropolitan region with 100,000 new vehicles registered in 2020 (like Marseille, France, or Birmingham, United Kingdom), a model would be counted if at least 20 were sold in 2020. Both passenger cars and light-duty vehicles are included in this analysis, as some models are registered under both categories depending on purchaser and intended use. The 50 metropolitan regions discussed above are colored according to their country; data points for additional metropolitan regions in these same markets are shown in grey to further illustrate the trend. Across Europe, 185 EV models were available in at least one metropolitan region according to this metric, up from 115 the year before. Of these, 119 models recorded sales of at least 1,000 units in 2020 across the 16 countries where data was available.

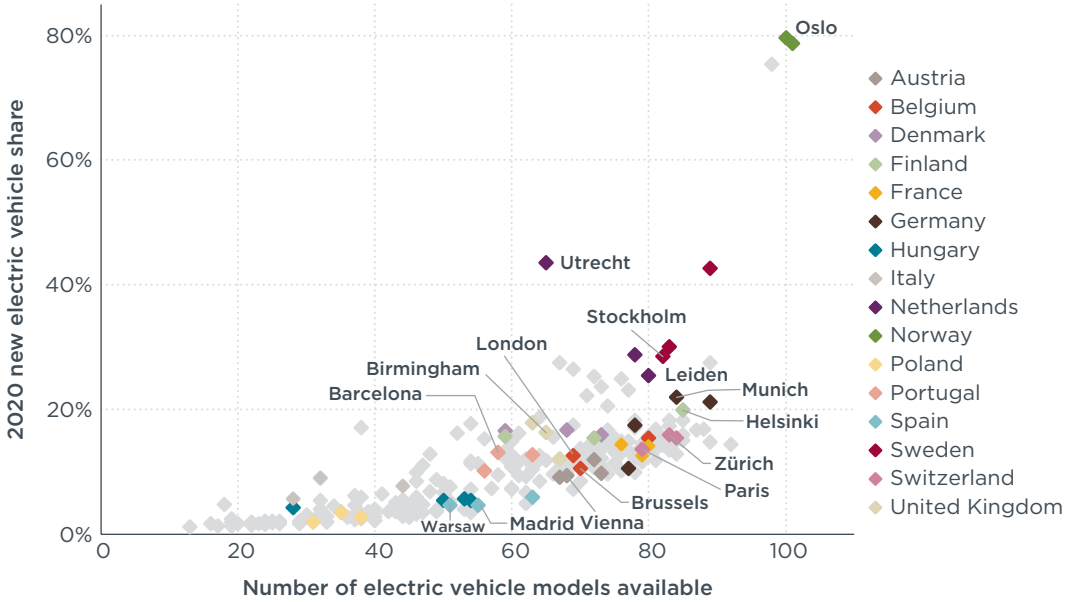

Figure 5. 2020 new EV share and number of EV models available by metropolitan region.

Figure 5 shows a generally positive relationship between the number of EV models available and the new EV registrations share, in line with previous research showing

14 Anh Bui, Peter Slowik, and Nic Lutsey, *Power Play: Evaluating the U.S. Position in the Global Electric Vehicle Transition* (ICCT: Washington, D.C.: June 29, 2021), https://theicct.org/publications/us-position-global-ev-jun2021.

a statistical relationship between model availability and electric vehicle uptake.[15] The metropolitan regions with the most EV models available are Oslo and Bergen, with 101 and 100 models, respectively (48 being BEVs for both); they are followed by Trondheim (Norway), Cologne (Germany), and Stockholm (Sweden) with 98, 92, and 89 models, respectively. Oslo also led all metropolitan regions in 2019 but had 61 models available using the same criteria. All 50 previously selected regions increased their number of EV models available by at least 50% between 2019 and 2020, demonstrating EV uptake increasing alongside expanded model availability.

The median number of models available across all 257 European metropolitan regions was 63 in 2020. Every metropolitan region whose share of EV registrations topped 20% in 2020 had at least 65 models available, and every region with a share greater than 10% had at least 38 available. On the other hand, metropolitan regions with an EV share below 5% had 36 models on average and those with an EV share below 3% had 28 on average (and no more than 45), indicating that those areas with fewer models available lag in the transition to EVs. For broader context one third of the population in Europe lived in an area with fewer than 45 models available in 2020 and almost 55% lived in an area with fewer than 60 models available.

Differences in model availability can also be seen at the national level by comparing the number of models available in at least one metropolitan region in a country. The number of models available is greatest in Germany (132), the Netherlands (112), the United Kingdom and France (both 110), and Norway (109), revealing that manufacturers generally provide more EV options to countries with the most new car registrations,[16] those with the highest EV shares, and those with strong EV policies in place. About 50%–80% of a country's models were available in most metropolitan regions within a given country (up to 90% in Helsinki, Oslo, Bergen, Stockholm, Copenhagen, and Ghent), but only in Oslo and Bergen were more than half of all European models available. On the other end of the spectrum, metropolitan regions with fewer than 30 models available were all in Italy, Poland, or Hungary (among regions where data were available).

Public charging infrastructure rollout

A broadly accessible EV charging infrastructure ecosystem is a key element of the transition to EVs. This encompasses charging of many types, including at homes, workplaces, public destinations, and along travel corridors. Although most charging in the early market has taken place at home,[17] public charging is vital for promoting range confidence and for making EVs available to those without off-street parking.

There is significant variation among markets in charging availability but charging infrastructure has grown in all markets alongside new EV sales. Figure 6 plots the number of public chargers as a function of the cumulative new EV sales for the nine European countries with more than 5,000 chargers at the end of 2020.[18] Data from 2013 to 2020 are provided for each market, moving from left to right along each line. These nine countries together accounted for 267,000 of the approximately 285,500 public chargers in Europe overall; about one in eight of these were direct current (DC) fast chargers with a charging speed of 50 kilowatts (kW) or greater. The remainder were

15 Peter Slowik and Nic Lutsey, *The Continued Transition to Electric Vehicles in U.S. Cities* (ICCT: Washington, D.C., 2018), https://theicct.org/publications/continued-EV-transition-us-cities-2018.

16 Peter Mock, et al., *Market Monitor: European Passenger Car Registrations, January–December 2020*.

17 Matthias Vogt and Konrad Fels, "Bedarfsorientierte Ladeinfrastruktur aus Kunensicht," ATZelektronik 12, 56-61, https://doi.org/10.1007/s35658-017-0036-z; Alexander Lewis-Jones, Matti Kahola, and John Murray, "Who Is the EV Customer? 'Early Adopter' Customer Segmentation." (EVS32 International Battery, Hybrid and Fuel Cell Electric Vehicle Symposium, Lyon, France: Delta Energy & Environment, 2019).

18 European Alternative Fuels Observatory, (Charging infrastructure stats, 2020), https://www.eafo.eu/alternative-fuels/electricity/charging-infra-stats#

normal alternating current (AC) chargers with typical speeds of 3–22 kW. This equates to an average of 536 chargers per million population.

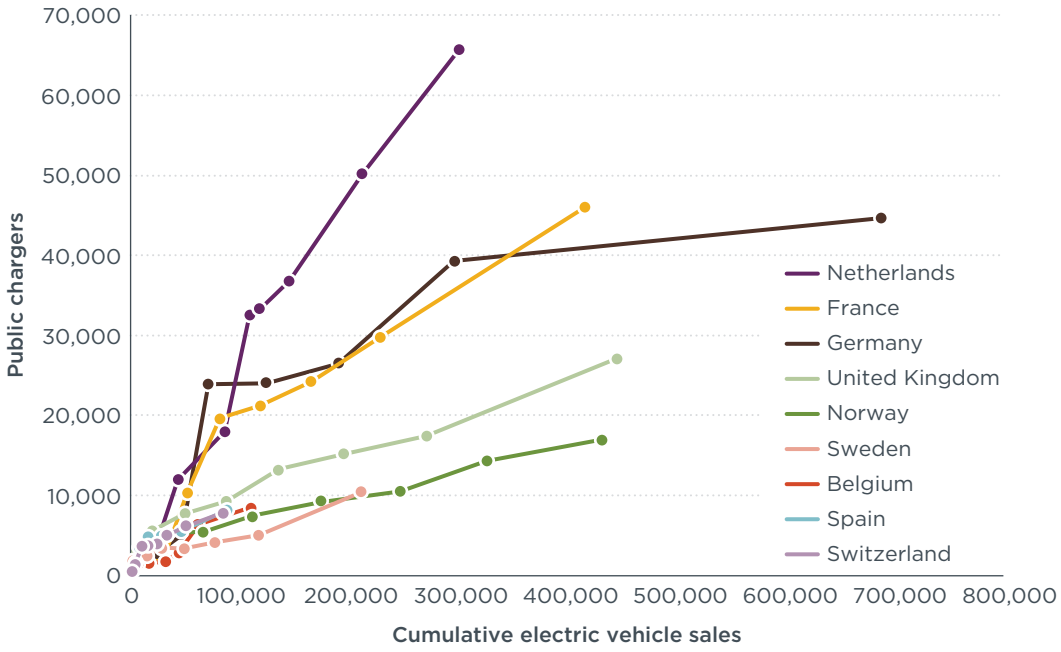

Figure 6. Charging infrastructure deployment in nine European countries as a function of cumulative new EV sales.

Despite some differences across markets, Figure 6 indicates that charging infrastructure expand in tandem with the EV market. In some cases, as in Germany and France, charger deployment increased more quickly than new EV sales in early years, suggesting that it may be beneficial to build charging infrastructure in advance of demand to provide confidence to drivers. The markets vary widely in the amount of charging capacity installed: The Netherlands has the most public chargers (65,600), followed by France (46,000) and Germany (44,700). The Netherlands also had the highest number of public chargers per million population with 3,800, compared to France and Germany with 690 and 540, respectively.

National markets also vary in the ratio of EVs per charger, indicated by the coordinates of the last point. The Netherlands has 4.6 EVs per public charger, by far the lowest among these nine countries; Italy and Finland follow at 7.5 and 8.9. Norway and Sweden have much higher ratios at 25 and 20 EVs per public charger, respectively. These ratios depend on a number of factors including the share of DC fast versus normal charging (DC fast chargers can supply 5-20 times as much power as normal AC chargers), home charging access, share of BEVs versus PHEVs, and travel patterns. These trends reveal sustained growth of EVs and their charging infrastructure, effectively growing in unison, with different ratios across markets generally pointing toward an increasing number of EVs supported per public charger with greater electric vehicle penetration. This indicates that there is no universal or long-term target EV-to-charger ratio that can serve as a useful benchmark across different markets.

Charging infrastructure in metropolitan regions. Aside from these national trends, there is also variation in charging infrastructure deployment at the local level.[19] Figure 7 displays the share of new EV sales (vertical axis) as a function of public chargers per million population (horizontal axis), with the circle size representing the number of new EVs registered in 2020 for each of the previously selected 50 metropolitan regions.

19 Eco-movement, EV Charge Point Data, 2021, https://www.eco-movement.com/.

The circles are colored according to country, following the scheme of Figures 5 and 6. Norway and the Netherlands are clear outliers with far more chargers per million population than other markets.

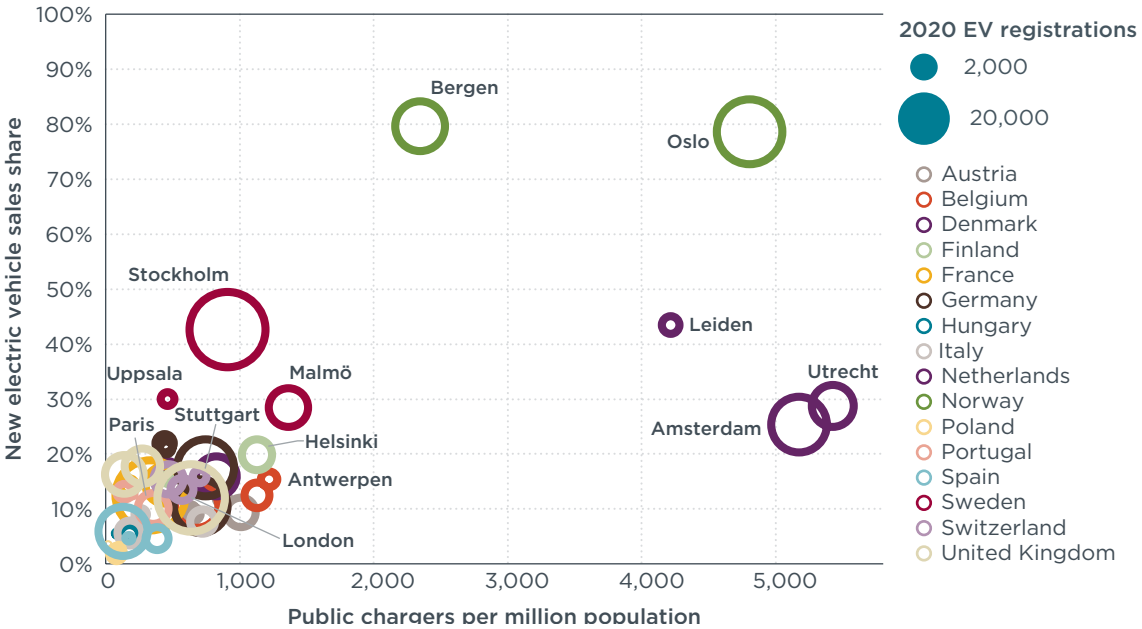

Figure 7. 2020 New electric vehicle sales share as a function of public chargers per million population in the 50 selected metropolitan regions.

Overall, Figure 7 shows a positive relationship between EV sales share and public chargers per million population. Of the 50 cities studied in this paper, the six with the most public charging per million population are in Norway, the Netherlands, or Sweden, the markets with the highest electric vehicle sales shares. Cities in the Netherlands stand out as having many more public chargers per million population relative to their electric vehicle uptake: Utrecht leads all metropolitan regions with 5,426. This can be explained partially by a higher share of normal chargers (98%–99% compared to a European average of 91%) as well as low availability of home charging. With 4,800 chargers, Oslo has the most chargers per million population outside of the Netherlands. Divergent public charging strategies, described below, partly explain the differences observed in Figure 7.

Public chargers are far from evenly distributed: 75% of Europe's population lives in an area with charging below the overall European average of 536 chargers per million population, indicating that the average is heavily skewed by the dense charging networks in northern European markets. Metropolitan regions in Eastern and Southern Europe with lower EV uptake also tend to have much less public charging infrastructure, generally with fewer than 200 chargers per million population.

In absolute numbers, public electric vehicle chargers now exceed 10,000 in the leading metropolitan regions. Table 1 shows the number of public chargers, DC fast chargers, and chargers per million population for the metropolitan regions with the most public chargers through 2020. Thirty-six metropolitan regions had more than 1,000 public chargers through the end of 2020. In total, Europe has 285,500 public chargers (9% DC fast), or 536 chargers per million population.

Table 1. Public charger counts in leading European metropolitan regions

Metropolitan region	Public chargers	Public DC fast chargers	Share of chargers that are DC fast	Public chargers per million population
Amsterdam	17,089	321	2%	5,174
Rotterdam-the Hague	15,046	227	2%	5,060
London	9,170	1,033	11%	638
Utrecht	7,158	169	2%	5,425
Oslo	6,375	689	11%	4,805
Paris	4,984	166	3%	405

City-level public charging strategies and policies. Figure 7 and Table 1 show that, as the market has expanded, European cities have adopted divergent public charging strategies, with differing emphases on central planning versus response to evolving demand as well as varying levels of focus on normal and DC fast charging.[20] The experiences of three cities with robust charging networks—Amsterdam, London, and Paris—illuminate different policy opportunities to encourage greater charging network development.

As seen in Figure 6, the Netherlands has the highest number of public chargers as well as the lowest number of EVs per public charger among markets in Europe. Amsterdam, home to more than a quarter of the EVs and public chargers in the Netherlands, has developed its extensive network through an innovative, demand-driven charging infrastructure rollout strategy that has been mirrored in other Dutch cities. Since 2016, the city has been partnering with electricity company Nuon, to ensure that any EV owner will have access to convenient, nearby overnight charging despite the limited access to off-street parking.[21] This strategy has led to a large share of normal chargers (98% of the 17,100 public chargers), and to Amsterdam having among the most chargers per million population of Europe (5,175). Amsterdam also outperforms the Netherlands' chargers per million population by 36%.

London has taken a different approach with a heavier emphasis on DC fast charging. The metropolitan region has more than 1,000 DC fast chargers, the most of any European metropolitan region, including dedicated DC fast chargers for its taxis to support the fleet's electrification. London's charging infrastructure strategy was developed by the Electric Vehicle Infrastructure Taskforce, established in 2018 and composed of stakeholders and representatives ranging from business, energy, and infrastructure to multiple levels of governments. The taskforce published a delivery plan in 2019 quantifying the charging needed by 2025 and outlining policies to close the gap.[22] In total, London has 638 chargers per million population, compared to 502 in the United Kingdom overall.

Paris ranks 7th in terms of absolute number of public chargers with almost 5,000 units, 3% of which are fast chargers. Paris exemplifies how local, regional, and national government programs can work together to build the charging infrastructure ecosystem. Companies or local governments installing public chargers benefit from subsidies from

20 Marie Rajon Bernard and Dale Hall, *Efficient Planning and Implementation of Public Chargers: Lessons Learned from European Cities* (ICCT: Washington, DC, 2021), https://theicct.org/publications/European-cities-charging-infra-feb2021.

21 "Laadpalen Amsterdam: Aanvragen & Informatie | Vattenfall InCharge." Accessed September 4, 2020. https://incharge.vattenfall.nl/openbare-laadpalen/laadpaal-amsterdam/; Neupert, Hannes. "Mathieu Wijnen on Strictly City-Driven Charging Infrastructure." electrive.com, April 3, 2019. https://www.electrive.com/2019/04/03/amsterdam-a-city-driven-ev-charging-infrastructure/; Robert van den Hoed et al., "Emobility: Getting Smart with Data" (Amsterdam University of Applied Sciences: Amsterdam, June 2019), https://pure.hva.nl/ws/files/5796298/HvA_Emob_DIGI.pdf.

22 The Mayor's Electric Vehicle Infrastructure Taskforce, "London Electric Vehicle Infrastructure Delivery Plan" (June 2019), http://lruc.content.tfl.gov.uk/london-electric-vehicle-infrastructure-taskforce-delivery-plan.pdf.

the privately funded Advenir program, created in 2016 by the French Ministry of the Environmental Transition and implemented by the electric mobility association Avere, covering up to 60% of the charger hardware and installation cost.[23] This program subsidizes public and private chargers at homes and workplaces. Along with France's nationwide program, the Île-de-France region (home to Paris) covers 50% of material, installation, and grid connection costs up to €2,500 per public normal charger.[24] Finally, the city of Paris covers 50% of the cost of chargers themselves (up to €500) and civil works related to the installation in multiunit dwellings (up to €4,000).[25]

Local electric vehicle policies

CO_2 emission standards, implemented at the European Union level, and financial incentives, implemented primarily at a national level, have been primary drivers of Europe's leading EV uptake. However, cities also have numerous policy options to further accelerate EV uptake to promote air quality and reduce greenhouse gas emissions. This section discusses local EV policies that have enabled market growth in European cities, including targets for urban access, incentives, and use benefits, and gives examples from the 50 metropolitan regions listed above.

City 100% ZEV stock targets and zero-emission zones

An increasing number of local governments are announcing plans to phase out combustion engine vehicles in urban centers, cities, or metropolitan regions. In contrast to national targets, which generally apply to new vehicle sales, local phase-out and vehicle access policies or plans refer to all vehicles on the roads. At least nine cities in Europe have set targets for restricting combustion or diesel engine passenger car access up to 2035: Bergen (2025), Oslo (2030), London (2025 for Central London, 2040 Inner London, 2050 London-wide), Paris (2024 diesel, 2030 combustion engines), Amsterdam (2030), Brussels (2030 diesel, 2035 combustion engines), Strasbourg (2025 diesel), and Milan (2027 diesel).[26]

Although targets to phase out the use of combustion vehicles have not yet been in place long enough to evaluate, regulations on diesel cars with faster timelines indicate that such policies may be effective. As an example, in Paris and Strasbourg, the diesel shares of new vehicles decreased from 57% to 24% and 28% respectively between 2015 and 2020 compared to the national decrease of 57% to 31% over the same period. In Oslo, the EV share increased from 22% in 2015 to 79% in 2020, slightly faster than the national increase of 22% to 75% over the same period. Seven of the eight cities with a combustion engine phase-out target outperformed their national EV share in 2020. The exception was Brussels, which announced its urban access regulations in mid-2021 and has approximately the same EV share as Belgium.

In addition to long-term targets to fully remove combustion vehicles from cities, frontrunner cities appear to have developed more detailed plans to implement zero-emission zones (ZEZs), or areas of the city where combustion vehicles would be restricted or fined. In the Netherlands, the 2019 National Climate Agreement included a requirement that by 2025 the 30–40 largest Dutch municipalities introduce ZEZ for freight, meaning that only purely electric delivery vans and trucks will be allowed to

23 "Les montants d'aide du programme ADVENIR," ADVENIR, accessed July 16, 2021, https://advenir.mobi/montant/.

24 "En Ile-de-France, le nombre de bornes de recharge va tripler d'ici 2023," Avere France, December 4, 2019, http://www.avere-france.org/Site/Article/?article_id=7752&from_espace_adherent=0

25 "Mobilité électrique et bornes de recharge : de nouvelles aides financières pour 3 000 copropriétés!" Agence Parisienne du Climat, February 8, 2021. https://www.apc-paris.com/actualite/mobilite-electrique-bornes-recharge-nouvelles-aides-financieres-pour-3-000-coproprietes.

26 Cui, Hongyang, Pramoda Gode, and Sandra Wappelhorst. "A Global Overview of Zero-Emission Zones in Cities and Their Development Progress." Washington, D.C.: International Council on Clean Transportation, August 30, 2021. https://theicct.org/publications/global-cities-zez-dev-EN-aug21.

drive through the zone.[27] Also, 15 of the 50 metropolitan regions presented in Figure 4 have signed the C40 Fossil Fuel Free Streets declaration, pledging to have a major area of their city become zero-emission by 2030.[28] London is home to the world's first near zero-emission zones (NZEZ, with PHEVs as well as BEVs allowed to enter) in City of London, Hackney, and Islington covering one to five short road sections. Rotterdam has had a zero-emission delivery street in place since 2015, affecting heavy duty trucks in a limited area of the city. A number of these leading European cities have announced plans to create ZEZs either by converting existing low emission zones, as planned in Paris and Amsterdam, or from scratch, as in Oxford.[29] The Norwegian government recently announced its support for ZEZs in Oslo and Bergen, which are set to take effect in 2022 in Oslo, expanding in 2026, and in 2023 in Bergen, expanding in 2030.[30]

The environmental benefits of adopting urban access regulations go beyond a city's borders as they can encourage collective action among other governments, paving the way for national commitments.[31] As an example, London set the target of 100% electric new cars and light commercial vehicles registered starting in 2030 in the Mayor's 2018 transport strategy; two years later, in 2020, UK's government set the target for 100% EV or hybrid sales for new vehicles in 2030 and 100% BEV in 2035. Additionally, such commitments can encourage businesses to procure zero-emission vehicles to ensure future access to important markets, which in turn provides impetus for manufacturers to bring additional zero-emission models to market.

Improving EV convenience, affordability, and awareness

EVs still face significant barriers to mainstream adoption including upfront cost, operational convenience, and awareness of available models and incentives. Although most national governments in Europe provide tax incentives and subsidies to mitigate the cost barrier, cities can also use their authorities to further improve the financial proposition with direct subsidies and discounts for congestion zones. Cities are especially well-positioned to act on convenience and awareness with regulations around priority lanes and parking and organization of awareness campaigns.[32]

Purchase incentives. Whereas national governments are generally responsible for upfront EV purchase incentives and tax discounts, a small number of city governments provide additional incentives for priority areas. The Grand Paris metropolitan area government is providing up to €6,000 for the purchase of a new or secondhand EV when scrapping an older polluting vehicle, which can be combined with the national conversion premium and ecological bonus.[33] Nottingham City Council in London offers up to £3,464 of financial support to encourage taxi drivers to purchase electric taxis.[34] This support includes contribution to vehicle license fees, first year insurance, vehicle livery, taxi meter

27 C40 Cities Climate Leadership Group and Transport Decarbonisation Alliance, "Zero Emission Zones for Freight: Lessons from the Netherlands," February 2020, https://www.c40knowledgehub.org/s/article/Zero-Emission-Zones-for-Freight-Lessons-from-the-Netherlands?language=en_US.

28 "Our Commitment to Green and Healthy Streets," C40, accessed July 20, 2020, https://www.c40.org/other/green-and-healthy-streets.

29 Cui, Hongyang, Pramoda Gode, and Sandra Wappelhorst. "A Global Overview of Zero-Emission Zones in Cities and Their Development Progress."

30 "Regjeringen vil la byer prøve ut nullutslippssoner," Norway Ministry of Transport, Regjeringen.no, June 22, 2021, https://www.regjeringen.no/no/aktuelt/regjeringen-vil-la-byer-prove-ut-nullutslippssoner/id2862859/.

31 Transportation Decarbonization Alliance, C40, and POLIS, "Zero-Emission Zones: Don't Wait to Start with Freight" (December, 2020), https://www.polisnetwork.eu/wp-content/uploads/2020/12/ZEZ-F_How-to-Guide_low.pdf.

32 Sandra Wappelhorst, Dale Hall, Michael Nicholas, and Nic Lutsey, *Analyzing Policies to Grow the Electric Vehicle Market in European Cities* (ICCT: Washington, DC, February 23, 2020, https://theicct.org/publications/electric-vehicle-policies-eu-cities.

33 "Métropole Roule Propre!" Métropole du Grand Paris, accessed July 30, 2021, http://www.metropolegrandparis.fr/fr/metropolerouleprop re.

34 "Financial Support for Cab Drivers," Nottingham City Council, accessed July 30, 2021, https://www.transportnottingham.com/driving/electric-taxis/support-for-cab-drivers/.

installation, and a home charger or a charging credit allowance if drivers do not have access to private off-street parking.

Discounted congestion charging. To reduce greenhouse gas emissions, air pollution, and noise, some cities have implemented congestion zones. These zones can also be used to spur EV uptake if EVs receive an exemption or discount on congestion charges, as implemented in cities such as London and Oslo. In London, EVs can enter the inner-city congestion zone free of charge as of 2021, but this advantage will slowly be phased out until 2025 in line with the city's goal to discourage car use in general.[35] In Oslo, EVs were exempted from the charges until 2019; as of 2021, BEVs still receive a discount and pay less than half of what is charged to diesel, gasoline, and plug-in hybrid vehicles.[36]

Access to priority lanes. Another action to reduce congestion is the creation of carpool lanes, or road lanes reserved for vehicles with at least two or three occupants. Allowing EVs to access these priority lanes is another measure that can help spur EV uptake in cities and has been implemented in Lyon, France, and Madrid, Spain.[37] This policy along with many others allowed these two cities to increase their EV uptake by 190% and 285% respectively between 2019 and 2020. Other cities such as Düsseldorf and Dortmund in Germany, Cambridge in the UK, and Oslo, Norway, have also allowed EV access to bus lanes. Although this is a benefit to EV drivers in the early market, it will likely be necessary to scale back these privileges when EVs reach mass adoption, as Oslo has done, to avoid negative impacts on public transportation and overall congestion.

Parking benefits. Cities, which typically are responsible for parking policies, can leverage the scarcity and high cost of parking in a number of ways to improve EV convenience. Prioritized access to coveted parking permits implemented in Amsterdam and free time-limited parking in Paris and Berlin provide a valuable incentive for prospective EV drivers with relatively modest government outlays. In France, five cities provide free or discounted parking for BEVs – Aix-en-Provence, Lyon, Marseille, Nice, and Paris.[38] Each of these cities recorded EV shares above the French average by 20% (Nice) to 60% (Paris).

Electric vehicle awareness programs. Despite growing EV uptake, understanding of and interest in EVs and their benefits remain low in most markets. One survey in 2020 found that a majority of people in Germany (59%) and France (57%) cannot imagine purchasing an electric car, with lack of charging, limited range, and high price representing the top areas of concern.[39] A number of leading cities have organized or supported EV education and awareness campaigns to address these issues, sometimes in partnership with national governments, charging operators, automakers, or drivers associations. In Berlin, an Agency for Electric Mobility was created in 2010, aiming to be the central point of contact for all questions and information related to electric mobility.[40] As another example, Lisbon hosted the Portuguese National Meeting of Electric Vehicles in 2020, a combination of conferences covering topics such as EV subsidies and benefits, charging infrastructure, shared experiences among EV drivers, and EV exhibitions and trials.[41]

35 "Discounts and Exemptions," Transport for London, accessed August 4, 2021, https://www.tfl.gov.uk/modes/driving/congestion-charge/discounts-and-exemptions.

36 "Congestion Charging Rates Oslo," Fjellinjen, accessed December 30, 2020, https://www.fjellinjen.no/private/prices/.

37 N. Wang, L. Tang, and H. Pan, "A global comparison and assessment of incentive policy on electric vehicle promotion," *Sustainable Cities and Society*, 2018, 44: 597–603, https://doi.org/10.1016/j.scs.2018.10.024.

38 "Le stationnement de votre voiture électrique: le parking gratuit?", Beev, May 9, 2021, https://beev.co/voitures-electriques/stationnement-voiture-electrique/.

39 Enno Pigge, "Many People Still Doubtful About Electric Cars' Environmental Friendliness," Continental, January 7, 2021, https://www.continental.com/en/press/press-releases/mobility-study-electric-mobility-244206.

40 "Berlin's Economy: Sustainably Mobile," Berlin Agency for Electromobility eMO, accessed May 25, 2021, https://www.emo-berlin.de/en/.

41 "ENVE 2020 - Lisboa." UVE, September 23, 2020. https://www.uve.pt/page/enve-2020-lisboa-artigos/.

Fleet electrification strategies

City governments often have unique authority over certain vehicle fleets, including municipal fleets, public transport, taxis, and ride-hailing companies. An increasing number of cities are targeting these fleets as early candidates for electrification in order to secure progress toward transport decarbonization targets, achieve near-term air quality benefits, and increase the visibility of EVs.

Public fleet electrification. The electrification of municipal vehicles and public transportation is an opportunity for cities to lead by example and to build public confidence in EVs. Amsterdam, Bergen, London, Oslo, Paris, and many other cities have set electrification goals for public transportation (mostly buses) and municipal fleets over different time horizons.[42] For example, Paris set objectives of a 90% electric municipal fleet in 2021 and a 100% zero-emission public transportation system in 2025.[43]

Private fleet electrification. Beyond the combustion vehicle access regulations set by leading cities, some cities have also set requirements for specific vehicle categories or use cases. London requires that all newly licensed private hire vehicles (PHVs) be zero-emission capable starting in 2023 (a criteria related to CO_2 emissions and zero-emission range); all taxis and PHVs operating in the UK's capital must meet the same requirements by 2033.[44] In Milan, internal combustion engines (ICEs) will be prohibited from carsharing schemes in 2024.[45] In Paris, the free-floating carsharing fleet is already 100% BEVs, incentivized by Paris's policy of reserving parking places for these vehicles and offering discounted parking fees.[46]

Summary of policies

Research has consistently demonstrated a link between city policies and electric vehicle uptake, and developments of 2020 indicate a continuation of this trend.[47] Table 2 lists some of the strongest examples of each of the policies discussed across six of the most successful local EV markets in Europe. The table reflects the broad array of policies across different areas used by leading markets to overcome barriers of model availability, cost, convenience, and consumer awareness. As the market continues to grow and evolve, cities can learn from each other and strengthen and adapt policies accordingly.

42 Dale Hall, Hongyang Cui, Marie Rajon Bernard, Shuyang Li, and Nic Lutsey, *Electric Vehicle Capitals: Cities Aim for All-Electric Mobility* (ICCT: Washington, DC, September 29, 2020), https://theicct.org/publications/electric-vehicle-capitals-update-sept2020.

43 Ville de Paris, "Plan Climat de Paris", November 2020, https://cdn.paris.fr/paris/2020/11/23/99f03e85e9f0d542fad72566520c578c.pdf

44 "Licensing Information," Transport for London, accessed August 4, 2020, https://www.tfl.gov.uk/info-for/taxis-and-private-hire/licensing/licensing-information.

45 Walter Gobbi, "Milano car sharing: solo elettrico dal 2024," Club Alfa, November 5, 2019, https://www.clubalfa.it/76529-milano-car-sharing-solo-elettrico-dal-2024.

46 "Règlement relatif à la délivrance des titres d'occupation aux opérateurs de véhicules partagés en libre-service sans station d'attache," Bulletin official de la ville de Paris, January 29, 2021, https://cdn.paris.fr/paris/2021/01/29/fdccee8e0e9fa4f9fd3a76bf3fa35f8c.pdf.

47 Sandra Wappelhorst, Dale Hall, Michael Nicholas, and Nic Lutsey, *Analyzing Policies to Grow the Electric Vehicle Market in European Cities* (ICCT: Washington, D.C., 2020, https://theicct.org/publications/electric-vehicle-policies-eu-cities; Dale Hall et al., *Electric Vehicle Capitals: Cities Aim for All-Electric Mobility*" (ICCT: Washington, D.C., , 2020), https://theicct.org/publications/electric-vehicle-capitals-update-sept2020; Anh Bui, Peter Slowik, and Nic Lutsey, *Update on Electric Vehicle Adoption across U.S. Cities* (ICCT: Washington, DC, 2020), https://theicct.org/publications/ev-update-us-cities-aug2020.

Table 2. Examples of successful policies in leading EU metropolitan regions.

Policy area	City (2020 EV share)	Description
Urban access restrictions	Paris (13%)	All combustion vehicles (including PHEVs) will be restricted from accessing Grand Paris metropolitan area starting in 2030.[a]
	London (12%)	Five streets in two boroughs are near ZEZ (allowing PHEVs) affecting all vehicles and one pilot NZEZ is running in City of London.[b]
Purchase incentives	Paris (13%)	Grand Paris metropolitan area offers up to €6,000 for a new or secondhand EV, a benefit that can be used in conjunction with national incentives.[c]
	London (12%)	Nottingham City Council in London is providing up to £3,464 for taxi drivers to switch to an EV.[d]
Discount for congestion charging	Oslo (79%)	BEVs pay a discounted rate compared to ICE vehicles. This benefit is slowly phased out to discourage car usage in general.[e]
Parking benefits	Amsterdam (25%)	EVs benefit from prioritized access to coveted parking permits.[f]
	Berlin (15%) and Paris (13%)	Free time-limited parking for EVs at certain parking spots.[g]
Electric vehicle awareness programs	Berlin (15%)	Agency for electric mobility created in 2010 to be the central point of contact for all electromobility-related questions.[h]
	Amsterdam (25%)	In 2017, Amsterdam set up an electric mobility information center in the city to inform all stakeholders about electric mobility.[i]
Public fleet electrification	Paris (13%)	Target of 90% electric municipal fleet in 2021 and 100% zero-emission public transportation in 2025.[j]
Private fleet electrification	London (12%)	In 2033, all taxis and PHVs will have to be zero-emission capable.
	Paris (13%)	Only EVs allowed in free-floating carsharing.[k]
Public charging strategy	Amsterdam (25%) and Stockholm (43%)	Amsterdam adopted a demand-driven public charging deployment strategy and published a comprehensive Electric City Plan in 2018.[l] Stockholm adopted a planning-oriented public charging deployment strategy.[m]
	London (12%)	Creation of an Electric Vehicle Charging Infrastructure Taskforce in 2018 composed of all stakeholders from the private and the public sector.[n]

[a] "Zone à faibles émissions métropolitaine," Métropole du Grand Paris, accessed August 5, 2021, https://www.zonefaiblesemissionsmetropolitaine.fr/.

[b] Cui, Hongyang, Pramoda Gode, and Sandra Wappelhorst. "A Global Overview of Zero-Emission Zones in Cities and Their Development Progress."

[c] "Métropole Roule Propre!" Métropole du Grand Paris, accessed July 30, 2021, http://www.metropolegrandparis.fr/fr/metropoleroulepropre.

[d] "Financial Support for Cab Drivers," Nottingham City Council, accessed July 30, 2021, https://www.transportnottingham.com/driving/electric-taxis/support-for-cab-drivers/.

[e] "Congestion Charging Rates Oslo," Fjellinjen, accessed December 30, 2020, https://www.fjellinjen.no/private/prices/.

[f] "Priority for Electric Vehicles," City of Amsterdam, accessed August 5, 2021, https://www.amsterdam.nl/en/parking/apply-for-a-parking-permit-for/priority-electric-vehicles/.

[g] "Stationnement spécifique: basse émission, livraison, 2 roues...," Paris, accessed August 5, 2021, https://www.paris.fr/pages/les-autres-offres-de-stationnement-2355.

[h] "Berlin's Economy: Sustainably Mobile," Berlin Agency for Electromobility eMO, accessed August 5, 2021, https://www.emo-berlin.de/en/.

[i] "EMIC in Amsterdam," e-mobility NSR, 2017, http://e-mobility-nsr.eu/centres/amsterdam/.

[j] "Plan Climat de Paris", Ville de Paris, November 2020, https://cdn.paris.fr/paris/2020/11/23/99f03e85e9f0d542fad72566520c578c.pdf.

[k] "Règlement relatif à la délivrance des titres d'occupation aux opérateurs de véhicules partagés en libre-service sans station d'attache," Bulletin official de la ville de Paris, January 29, 2021, https://cdn.paris.fr/paris/2021/01/29/fdccee8e0e9fa4f9fd3a76bf3fa35f8c.pdf.

[l] "Laadpalen Amsterdam: Aanvragen & Informatie | Vattenfall InCharge." Accessed September 4, 2020. https://incharge.vattenfall.nl/openbare-laadpalen/laadpaal-amsterdam/; Neupert, Hannes. "Mathieu Wijnen on Strictly City-Driven Charging Infrastructure." electrive.com, April 3, 2019. https://www.electrive.com/2019/04/03/amsterdam-a-city-driven-ev-charging-infrastructure/;

[m] "Ansök Om Att Etablera Nya Laddplatser För Elbil," Stockholms Stad, accessed September 4, 2020, https://tillstand.stockholm/tillstand-regler-och-tillsyn/parkering/ansok-om-att-etablera-nya-laddplatser-for-elbil/.

[n] The Mayor's Electric Vehicle Infrastructure Taskforce, "London Electric Vehicle Infrastructure Delivery Plan" (June 2019), http://lruc.content.tfl.gov.uk/london-electric-vehicle-infrastructure-taskforce-delivery-plan.pdf.

These cities demonstrate that comprehensive strong local policies across multiple areas can lead to higher EV uptake. The cities listed in Table 2 are among the leading EV markets in Europe, outperforming the 2020 Europe-wide EV share by 6% (London) to 587% (Oslo). They also each outperform their country EV share by 2% (Amsterdam) to 33% (Stockholm). Across a 3-year span, they increased their EV share by 9 percentage points (London) to more than 35 percentage points for Oslo and Stockholm. As a comparison, Europe increased its EV share by 8 percentage points in the same time frame, growing from a 3% to 11% EV share between 2017 and 2020.

Conclusions

This paper provides new analysis of EV uptake at a local level in 2020, with particular focus on 50 metropolitan regions with the greatest EV registrations volume and shares in Europe. It also provides updates on key policies enabling the transition in the most successful local markets. This research yields the following high-level conclusions:

European cities experienced strong electric vehicle market growth in 2020, but EV distribution remains unequal. With the tightening of European Union CO_2 standards, 2020 was a record-setting year for EVs in Europe with around 745,000 new passenger BEVs and 625,000 PHEVs registered, a 143% increase from 2019. This growth is also reflected in the number of EV models available; in Oslo, EV model options increased from 61 in 2019 to 101 in 2020. Metropolitan regions continued to lead the transition: In 13 of 16 countries, the EV sales shares within metropolitan regions were greater than the national average. However, uptake remains unequal across Europe, and regions in northern Europe continued to see the greatest uptake. All of the 16 metropolitan regions with twice the European average EV share (23%) were located in Norway, the Netherlands, or Sweden. Although regions of southern and eastern Europe had comparatively low new EV sales shares, they still experienced steep increases from 2019 levels. For example, Rome boosted its new EV sales share from 1% in 2019 to 5.5% in 2020.

Charging infrastructure is increasing, but trends and approaches across markets vary widely. In each of the major European markets, public charging has expanded alongside new EV sales. However, different patterns of public charging infrastructure are emerging among leading European markets. Cities in the Netherlands have the most public charging infrastructure, but also have a low share of DC fast charging, representing less than 5% of public chargers. The number of EVs per public charger generally falls between 10 and 20, though the numbers are lower in the Netherlands and higher in Norway. This variation indicates that there is no universal EV-to-charger ratio that can serve as a benchmark across different markets, though the number of electric vehicles supported per public charging tends to rise as markets mature. Cities are supporting charging growth by providing subsidies for key segments like multiunit dwellings and creating comprehensive strategies with stakeholders like electric utilities and charging operators.

Policies at the European Union, national, and local level are contributing to electric vehicle uptake. Across Europe, the passenger car EV market in 2020 has been driven largely by European Union CO_2 emission standards for new passenger cars, as well as financial incentives provided by national governments. However, leading European cities have also implemented innovative policies to further spur uptake by improving EV convenience, awareness, and affordability. Some top EV markets in Europe are implementing ZEZs, providing parking benefits, allowing access to priority lanes to improve EV convenience, and offering discounts on tolls and congestion zones. The cities with the strongest local policies in place, such as London, Paris, Amsterdam, Oslo, and Stockholm, have EV shares greater than their respective national and European averages.

City strategies are increasingly aiming toward 100% ZEVs. A growing number of local governments are announcing plans to regulate or restrict access to combustion engine vehicles in urban centers, cities, or metropolitan regions, often ahead of national targets to end new combustion vehicle sales or registrations. European capitals are leading the way: London has implemented small street-based near-zero-emission zones in three areas and Amsterdam and Paris have announced plans for citywide ZEZs in 2030. Cities are also leveraging their unique authority over public and private fleets to accelerate EV uptake in high-visibility segments. Paris has set the goals of having a 90% electric municipal fleet in 2021 and 100% zero-emission public transportation in 2025. London requires that all newly licensed private hire vehicles be zero-emission capable starting in 2023 and that the entire taxi and private hire vehicle fleet be converted by 2033.

These long-term visions can be achieved through comprehensive strategies regarding infrastructure and local policies to plan for all zero-emission mobility.

Beyond the steep growth in the European EV market in 2020, new electric passenger car registrations continue to climb in 2021.[48] Nonetheless, most European markets remain in the early phases of the transition to all zero-emission vehicles. Future research could track and infer lessons on the rollout of ZEZs, suggest targets and guidance on charging infrastructure, and examine the role of company cars, which account for a majority of EVs in many cities. Renewed and expanded policies at the city level will be critical to meet the EV targets proposed by national governments and the European Union as well as the economy-wide CO_2 reduction goals, which will require a still faster transition.[49] Through actions to ensure that EVs are accessible, affordable, and convenient for the mainstream market, cities can continue to lead the transition to EVs and reap the benefits for climate and clean air.

48 Peter Mock, Uwe Tietge, Sandra Wappelhorst, Georg Bieker, and Jan Dornoff, *Market Monitor: European Passenger Car and Light-Commercial Vehicle Registrations, January–June 2021*, (ICCT: Washington, D.C., 2021), https://theicct.org/publications/market-monitor-eu-jul2021

49 Peter Mock, *European Union CO_2 Standards for New Passenger Cars and Vans: New Vehicle CO_2 Target Levels*, (ICCT: Washington, DC, 2021), https://theicct.org/publications/eu-co2-FS1-jun2021.