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# Beyond major cities: Analysis of electric passenger car uptake in European rural regions

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## Introduction

In 2019, over 560,000 new electric passenger cars were registered in Europe, a share of 3.6% of all new passenger car registrations.[1] This included battery electric vehicles (BEVs) and plug-in hybrid electric vehicles (PHEVs). Norway continued to be the frontrunner by market share with 58% of new passenger cars registered being a BEV or PHEV, followed by Iceland with a share of 26%, the Netherlands (15%), Sweden (11%), and Finland (7%).[2]

Yet, there are regional differences in electric vehicle uptake depending on the population share.[3] Most new electric cars were registered in urban regions. In the urban regions of the 17 selected European countries assessed as part of this study, a total of over 322,000 BEVs and PHEVs were registered (Figure 1).[4] In intermediate regions, BEVs and PHEVs accounted for almost 175,000 of registrations, and in rural regions about 50,000 new electric passenger cars were registered. On a per capita basis, electric passenger car registrations were also the highest in urban regions with 15 registrations per 10,000 inhabitants. In intermediate regions, the ratio was 11 electric passenger car registrations per 10,000 inhabitants and in rural regions the ratio was 7 per 10,000 inhabitants. Comparing the share of electric passenger car registrations based on all new passenger car registrations in 2019, urban regions had also the highest average market share with 4.0%, followed by intermediate regions with a market share of 3.5%. The share was the lowest in rural regions at 2.9%.

1 This includes the 27 Member States of the European Union, the United Kingdom, and the countries of the European Free Trade Association (EFTA), i.e. Iceland, Liechtenstein, Norway, and Switzerland.

2 Dale Hall, Sandra Wappelhorst, Peter Mock, and Nic Lutsey, *European Electric Vehicle Factbook 2019/2020*, (ICCT: Washington, DC, 2020), https://theicct.org/sites/default/files/publications/EV-EU-Factbook-2020.pdf

3 This paper differentiates by predominantly urban, intermediate, and predominantly rural regions based on Eurostat's urban-rural typology definition which is applied at NUTS 3 level regions. Predominantly urban regions, referred to here as urban regions, are regions where more than 80% of the population live in urban clusters, i.e. a cluster of contiguous grid cells of 1 $km^2$ with a population density of at least 300 inhabitants per $km^2$ and a minimum population of 5,000 inhabitants. Intermediate regions are regions where more than 50% and up to 80% of the population live in urban clusters. Predominantly rural regions, referred to as rural regions here, are regions where at least 50% of the population live in rural grid cells, or grid cells that are not identified as urban centers or as urban clusters.

4 The paper focuses on 17 European countries including 13 EU Member States, the United Kingdom, Liechtenstein, Norway, and Switzerland based on data availability.

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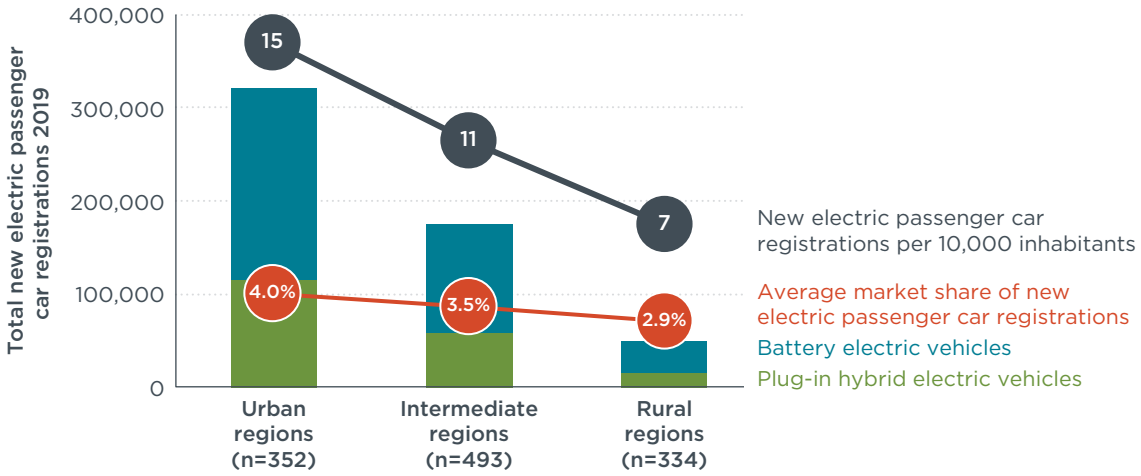


**Figure 1.** New electric passenger car registrations by territorial typology (urban, intermediate, rural) in 2019. Data is based on 13 EU Member States, the United Kingdom, Liechtenstein, Norway, and Switzerland.

To put these numbers into perspective, 48% of the population in the selected 17 countries analyzed lived in urban regions in 2019. Here, 54% of all new passenger cars and 59% of all new electric vehicles were registered. In the intermediate regions where 36% of the population lived, 34% of all new passenger cars and 32% of new electric vehicles were registered. Lastly, in rural regions where 16% of the population lived, 12% of all new passenger cars were registered and 9% of all new electric passenger cars were registered.

There were wide variations among European markets, as shown in Figure 2. Overall, in each of the 17 European countries analyzed the average electric passenger car registration share of new registrations was the lowest in rural regions compared to urban and intermediate regions. In Denmark, Italy, and Portugal, the average BEV and PHEV registrations shares were the highest in intermediate regions, while for the remaining 14 countries the averages were highest in urban regions. The differential between urban and rural regions was most pronounced in Norway (18.9 percentage points), the Netherlands (9.2 percentage points), Sweden (7.2 percentage points), and Finland (4.3 percentage points). In five countries, the difference in average registration shares was half a percentage point (Germany) or less, with Austria having the smallest at 0.2 percentage points. In terms of relative difference between urban and rural average new electric passenger car registrations, it was the highest in Poland, where the average share in urban regions was 3.6 times higher than in rural regions. This was followed by Hungary, where the average share in urban regions was 3.1 times higher than in rural regions. The relative difference between urban and rural average electric passenger car registrations shares was the lowest in Denmark and Portugal, where it was twice as high in urban regions compared to rural regions.

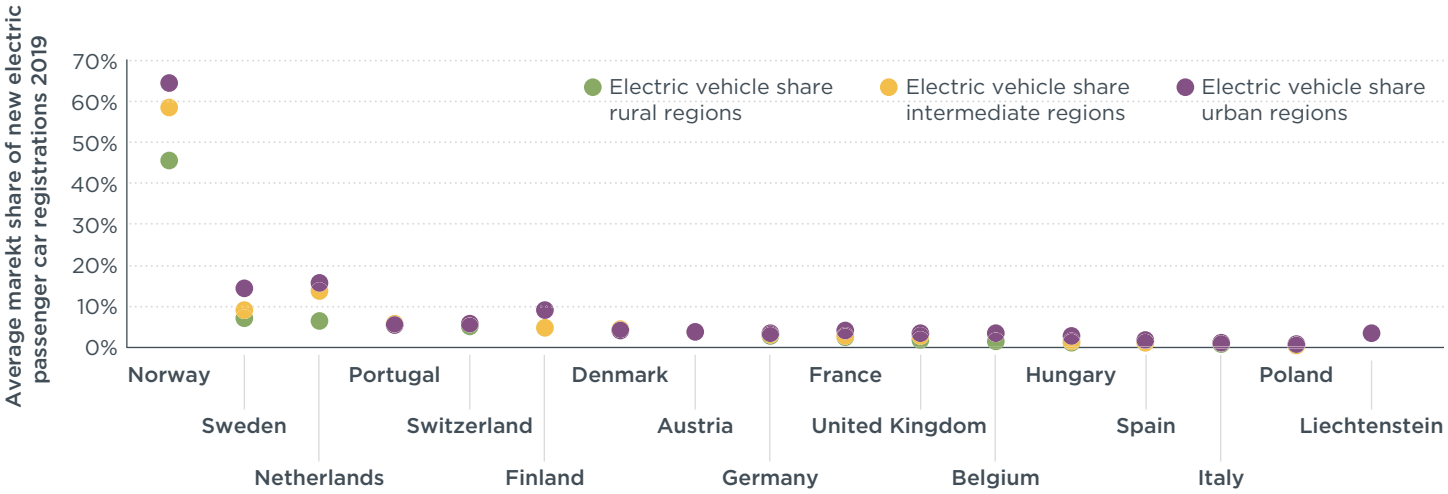


**Figure 2.** Average market share of electric passenger car registration shares by country and territorial typology (urban, intermediate, rural) in 2019.

Overall, new electric passenger car registrations by total numbers, shares, and on a per capita basis were the highest in urban and intermediate regions in 2019. Yet, rural regions offer great potential to electrify the non-avoidable motorized car fleet. Dependence on the private automobile and the motorization rate is often much higher in rural areas, particularly if there is a lack of alternative modes of transportation such as public transport.[5] In addition, because of the high proportion of one- and two-family houses with garages or off-street parking, there is a greater opportunity to charge an electric car on private premises.[6] In the early transition phase, this aspect can be an advantage compared to intermediate and urban regions.

This paper focuses on new electric passenger car registrations in rural regions and analyzes policies in leading rural electric passenger car markets that might have driven the uptake. First, we assess new electric passenger car registrations for 17 selected European countries, differentiated by urban, intermediate, and rural regions. Second, we evaluate the electric passenger car market for the rural areas and the potential effects of public charging infrastructure deployment and the regional economic situation. Third, we evaluate national, regional, and local policies which have been adopted in the leading rural electric vehicle markets to foster electric vehicle adoption. Finally, the paper summarizes the main findings and provides recommendations for how governments might enhance electric passenger car adoption in less populated areas.

## Analysis of the electric passenger car market in European regions

The following section analyzes electric passenger car uptake in urban, intermediate, and rural regions for the year 2019. Figure 3 gives an overview of the data analysis steps. The analysis covers 17 European countries: the 13 member states of the European Union (EU), the United Kingdom, Liechtenstein, Norway, and Switzerland. For a more detailed analysis of electric passenger car uptake, we use regional-level data based on the European Electric Vehicle Factbook.[7] The data presented are classified using the Nomenclature of Territorial Units for Statistics third level (NUTS 3) of the NUTS 2016 classification

5 Eurostat, "Transport statistics at regional level," (2020), https://ec.europa.eu/eurostat/statistics-explained/pdfscache/14273.pdf

6 Eurostat, "Population on 1 January by five year age group, sex and other typologies," (2020), https://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=urt_pjangrp3&lang=en

7 Hall, Wappelhorst, Mock, and Lutsey, *European Electric Vehicle Factbook 2019/2020*

by the EU.[8] Territorial typologies throughout the paper use the urban-rural-typology definition which differentiates NUTS 3 regions by predominantly urban, intermediate, and predominantly rural regions. The 17 countries analyzed are comprised of 1,179 NUTS 3 regions, which in turn include 352 urban, 493 intermediate, and 334 rural regions.

To evaluate which regions experienced high electric passenger car uptakes, we further differentiate urban, intermediate, and rural regions by 2019 electric passenger car registration shares equal to and above the European average of 3.6% or below this threshold, resulting in six different regional clusters. Cluster 1 and Cluster 2 cover urban regions, Cluster 3 and Cluster 4 intermediate regions, and Cluster 5 and Cluster 6 rural regions.

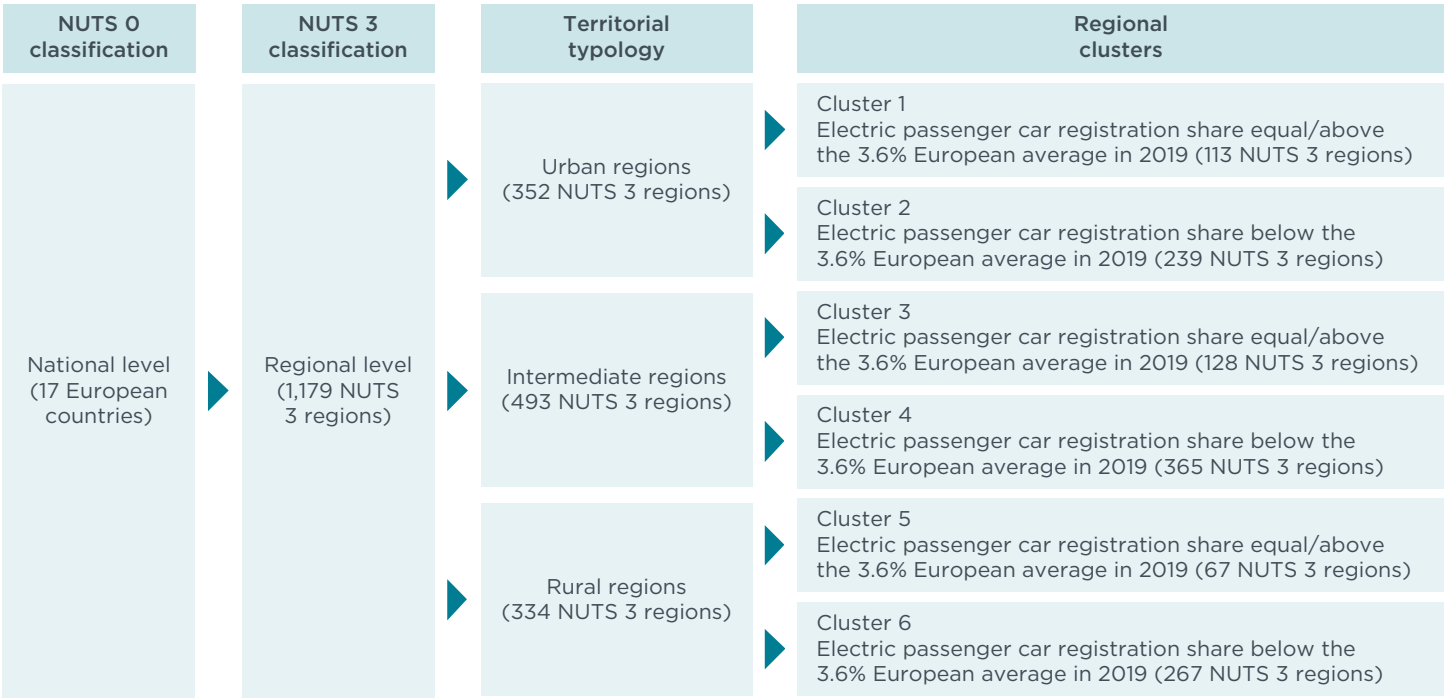


**Figure 3.** Analysis of electric passenger car registration data.

Based on the 17 countries analyzed and the regional clusters defined above, Figure 4 shows that of the 352 urban NUTS 3 regions assessed, 32% recorded electric passenger car registrations shares equal to or above the European 3.6% average (dark purple), while in 68% of urban regions the share was below 3.6% (light purple). In the 493 intermediate NUTS 3 regions, 26% had shares equal to or above the European average (dark yellow), and 74% had shares below the average (light yellow). In the 334 rural NUT 3 regions, 20% had shares equal to or above the average (dark green), and 80% had shares below the average (light green).

8 European Union, "Methodological manual on territorial typologies, 2018 edition," (2019), https://ec.europa.eu/eurostat/documents/3859598/9507230/KS-GQ-18-008-EN-N.pdf/a275fd66-b56b-4ace-8666-f39754ede66b

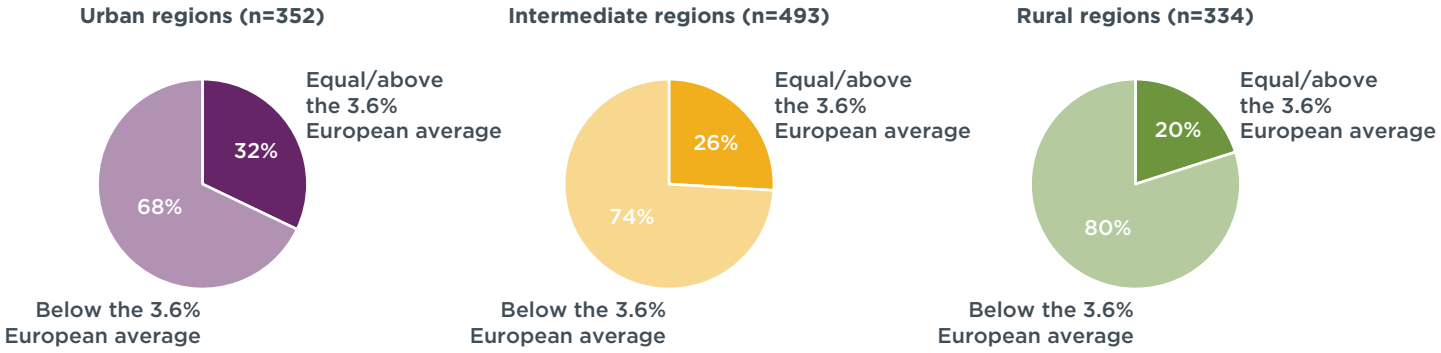


**Figure 4.** Urban, Intermediate, and rural regions with electric passenger car registration shares equal/above and below the European average in 2019.

Figure 5 maps the spatial distribution of the six different regional clusters and labels the national average of new electric passenger car registration shares. The figure displays wide regional variations in terms of electric passenger car registrations shares below or equal to the European average and above the European average of 3.6% among the 17 countries analyzed.

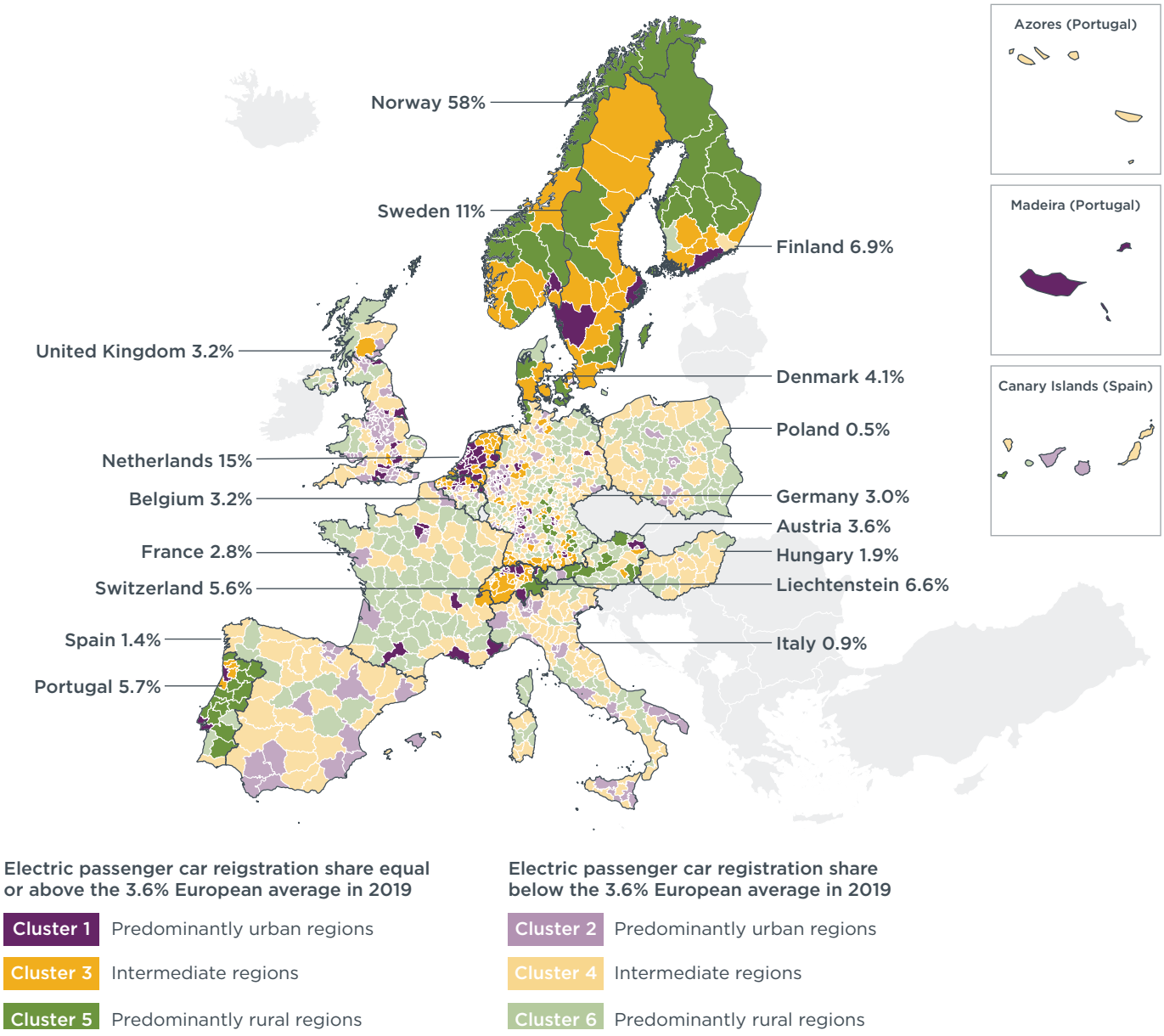


**Figure 5.** New electric passenger car registration shares in European countries in 2019, by NUTS 3 regions.

The countries can be categorized by the four main country typologies described below: countries with high, medium-high, medium-low, and low electric passenger car uptake in 2019. Note that due to the unequal market size of the individual NUTS 3 regions, the share of regions below and equal to or above the European average of 3.6% does not indicate whether a country's share of new electric passenger car registrations was below or equal to/above the European average.

*Countries with high electric passenger car uptake.* This includes countries where all regions—urban, intermediate, and rural—recorded an electric passenger car registration share equal to or above the 3.6% European average in 2019. This applied to four countries: Liechtenstein (average national share 6.6%), Norway (57.9%), Sweden (11.3%), and the Netherlands (15.0%). In *Liechtenstein*, composed of a single urban region, 6.6% of all new passenger car registrations were either a BEV or PHEV. In the 19 regions of *Norway,* electric passenger car registration shares ranged between 21.0% (rural region of Finnmark) and 69.4% (urban capital city region of Oslo). In *Sweden*, new electric passenger car registration shares in the 21 regions varied from 5.0% in the rural province of Kalmar to 16.5% in the capital city urban region of Stockholm. The highest share in the 40 regions of the *Netherlands* was recorded in the intermediate region of Noord-Drenthe with 28.7%. In the only rural region, Zeeuwsch-Vlaanderen, 6.2% of consumers decided on a BEV or PHEV in 2019.

*Countries with medium-high electric passenger car uptake.* This covers countries where more than half of all regions, including urban, intermediate, and rural, had an electric passenger car registration share equal to or above the 3.6% European average in 2019. Four countries belong to this group where the national average was also above this threshold: Denmark (4.1%), Finland (6.9%), Portugal (5.3%), and Switzerland (5.6%). In *Denmark*, 8 out of 11 regions recorded electric passenger car registration shares above the European average in 2019, with the highest in the urban capital city region of Byen København with 6.4%. In *Finland*, this applied to 17 of the 19 regions, with the urban capital city region of Helsinki-Uusimaa having the highest share of new BEVs and PHEVs registered at 8.9%. In *Portugal,* 21 of all 25 regions had electric passenger car registration shares above the European average. The share was the highest in the intermediate region of Ave at 10.7%. In *Switzerland*, only two of the 26 regions had below average registration shares, yet close to the 3.6% European average, with the intermediate region of Uri at 3.3% and the intermediate region of Neuchâtel at 3.5%. The region with the highest share was the urban region of Zug where 8.2% of all new passenger cars registered were a BEV or PHEV.

*Countries with medium-low electric passenger car uptake.* This includes countries where less than half of all urban, intermediate, and rural regions recorded an electric passenger car registration share equal to or above the 3.6% European average in 2019, namely Austria (average national share 3.6%) , Belgium (3.2%), France (2.8%), Germany (3.0%), Spain (1.4%), and the United Kingdom (3.2%). In *Austria*, 12 of the 35 regions had electric passenger car registrations shares above the European average, of which two were urban, two were intermediate, and eight were rural regions. Of all rural regions, the Tiroler Unterland recorded the highest share at 4.9%. In *Belgium*, 17 of the 44 regions had registration shares above the European average, with the urban region of Mechelen recording 6.9%. All rural regions had below-average shares. Nine of the 96 regions in *France* recorded electric passenger car registration shares above the European average. Of those, eight were urban regions, with the capital city region of Paris having the highest share at 7.3%, and one an intermediate region. All rural regions in France recorded below European average shares, the highest in Tarn-et-Garonne with 3.4%. In *Germany*, 85 out of 401 regions recorded above European average electric passenger car registration shares. The region with the highest uptake of electric cars was the rural region of Rhön-Grabfeld at 13.7%. In *Spain,* one out of the 59 regions had an electric passenger car registration share equal the 3.6% European threshold (Canary Island of El

Hierro). In the *United Kingdom*, 34 of the 179 regions registered above European average electric passenger car shares. Of those, 31 were urban regions, with Kensington/Chelsea, and Hammersmith/Fulham in the city of London recording the highest share of 15.1%. No rural region in the United Kingdom had a share above the European average. The rural region of the Orkney Islands, an archipelago belonging to Scotland, recorded the highest share with 2.9%.

*Countries with low electric passenger car uptake.* This category covers countries where no region recorded an electric passenger car registration share equal to or above the 3.6% European average. This applied to Poland (0.5%), Hungary (1.9%), and Italy (0.9%). In *Poland*, electric passenger car registration shares in the 73 regions ranged between 0% (eight regions, all of them rural) and 1.1% in the intermediate region of Szczecin. *Hungary's* new electric passenger car registrations across all 20 regions ranged between 0.6% in the rural region of Tolna and 2.7% in the urban capital region of Budapest. In *Italy's* 110 regions, shares varied between 0.05% in the rural region of Vibo Valentia and 3.1% in the urban region of Venezia.

Overall, the differentiation of territorial typologies (urban, intermediate, rural) by regional clusters shows wide variations in electric passenger car uptakes by markets. Yet, it should be noted that the NUTS 3 regions by country can vary largely by area sizes, number of total NUTS 3 regions (ranging between 1 in Liechtenstein and 401 in Germany), number of territorial typologies, and number of regional clusters. More detailed information can be found in Figure A1 and Table A1 of the Appendix.

## Analysis of the electric passenger car market in European rural regions

The following section analyzes electric passenger car uptake in rural regions in Europe. It assesses public charging infrastructure deployment and the economic situation in rural regions in select European countries in relation to electric vehicle uptake to identify general trends.

### Leading rural electric vehicle regions in Europe

Figure 6 shows the 20 rural NUTS 3 regions which experienced the highest share of new electric passenger car registrations in 2019. The figure displays that the 20 leading rural regions were in six countries: Finland, Germany, Norway, Portugal, Sweden, and the Netherlands. Eight of those were located in Norway (out of eight rural regions), four in Sweden (out of five rural regions), four in Portugal (16 rural regions in total), two in Germany (110 rural regions in total), one in Finland (out of 12 rural regions), and one in the Netherlands (the only rural region). Among the top nine regions, eight were located in Norway where electric passenger car registration shares ranged between 21.0% in the rural region of Finnmark and 51.5% in Aust-Agder. The rural region ranking eighth was Åland in Finland where 31.0% of new passenger car registrations were a BEV or PHEV. The two rural regions in Germany with the highest electric passenger car registration shares were Rhön-Grabfeld (13.7%) and Landsberg am Lech (6.7%). In the four Swedish rural regions, ranking among the top 20 European regions electric passenger car registrations, shares ranged between 6.9% in Dalarnas and 8.9% in Jämtlands. In the four rural regions of Portugal, shares ranged between 6.3% in Douro and 7.0% in Região de Leiria. Finally, the only rural region in the Netherlands ranked in twentieth place where 6.2% of all car registrations were a BEV or PHEV.

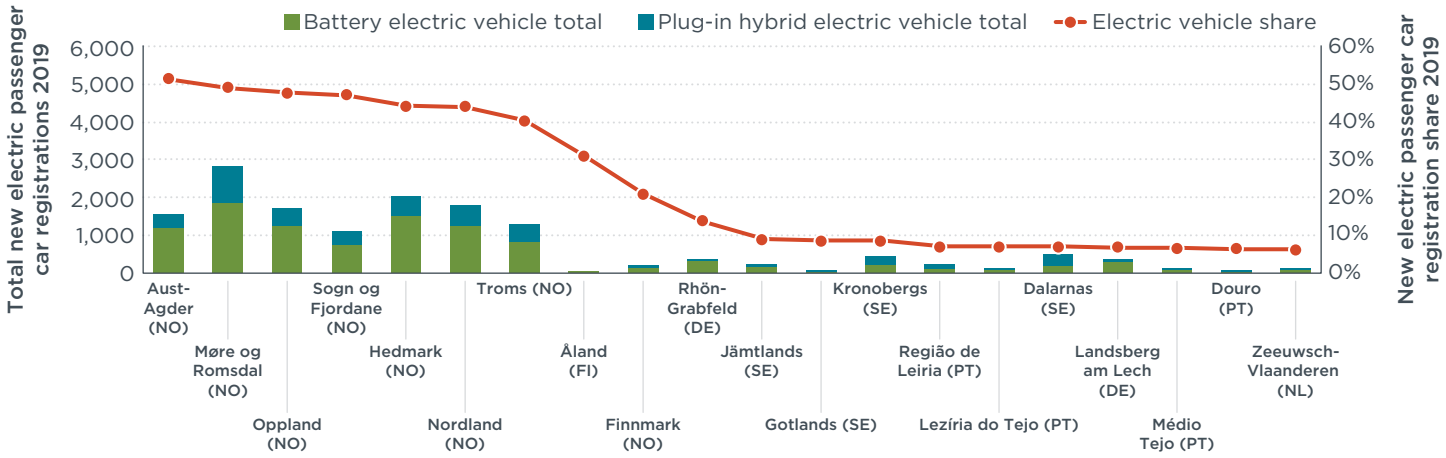


**Figure 6.** Leading rural electric vehicle markets in Europe in 2019 based on 17 European countries analyzed (NO = Norway, FI = Finland, DE = Germany, SE = Sweden, PT = Portugal, NL = Netherlands).

Figure 6 also reveals variations in total electric passenger car registrations among the leading 20 European rural areas, which range between 9 (Åland, Finland) to over 2,800 in Møre og Romsdal (Norway). Total BEV registrations generally outpaced those of PHEVs in the leading rural regions of Denmark, Germany, the Netherlands, Norway, and Portugal, corresponding to the national trends. An exception was the rural region of Douro in Portugal where more PHEVs than BEVs were registered. In two of the four Swedish regions shown above, total PHEV registrations outpaced those of BEVs (Darlanas and Kronobergs), similar to the national registration trend in Sweden, while in the other two regions, BEV registrations were higher.

## Electric vehicles uptake in rural regions and public charging infrastructure deployment

The share of BEVs compared to PHEVs also influences public charging infrastructure deployment and requirements. In general, the lack of a comprehensive public charging infrastructure network is considered a main barrier in electric vehicle adoption. Figure 7 plots new electric passenger car registration shares in 2019 against normal (up to 22 kW) and fast charging points (higher than 22 kW) the same year. Based on data availability, results are shown for 192 rural NUTS 3 regions of nine European countries, including Austria, Belgium, Germany, Finland, Norway, Sweden, Switzerland, the Netherlands, and the United Kingdom. The figure reveals that there is no general trend in terms of availability of normal and fast charging points per 100,000 inhabitants and electric passenger car registrations shares in rural regions. In the nine countries analyzed, almost half of the rural regions had less than the average 85 public normal and fast charging points per 100,000 inhabitants and an electric passenger car registration share below the European average of 3.6%. The figure also illustrates that electric passenger car registration shares could be above the European average despite a below-average concentration of public chargers, such as in Åland, Finland and Kronobergs in Sweden. On the contrary, there were regions with registration shares below the European average despite an above average number of normal and fast public charging points per 100,000 inhabitants, such as in the Orkney Islands (United Kingdom), Gotlands and Jämtlands (Sweden), and Lungau (Austria).

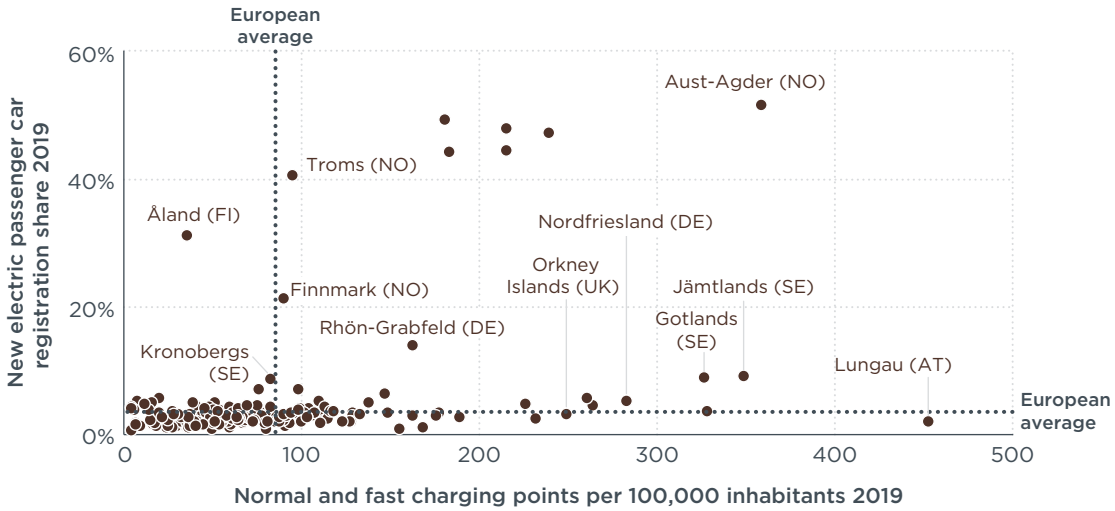


**Figure 7.** New electric passenger car registration shares and normal and fast charging points per 100,000 inhabitants in rural regions of select European countries in 2019 (AT = Austria, FI = Finland, DE = Germany, NO = Norway, SE = Sweden, UK = United Kingdom).

While no general trend can be observed if plotting electric passenger car registration shares against the concentration of public charging points, other factors are likely to influence electric passenger car adoption. These include the housing stock (i.e. the share of one- and two-family homes and potential access to home charging), the vehicle mix (ratio of BEVs vs. PHEVs), the amount of fast charging points, driving patterns, the economic status of a region and its population, and national and local policies.[9] These factors can partially explain why there is no clear correlation between the density and electric passenger car registrations shares.

## Electric vehicle uptake in rural regions and gross domestic product (GDP) per capita

The economic situation of a region and its population can also give an indication about the uptake of electric passenger cars. We choose the regional Gross Domestic Product (GDP) per capita to identify potential trends. The GDP per capita can also help in policy making by taking into account different preconditions in wealthier versus less prosperous rural regions. Figure 8 plots the 2019 electric passenger car registration shares for the 334 rural regions by rural regional clusters against the GDP per capita for the year 2016, reflecting the most recent data covering all regions. Regional GDP data is based on Eurostat[10] and the Swiss Federal Statistical Office.[11] The figure suggests no general trend, particularly when leaving out Norwegian regions with GDPs and electric passenger car registration shares above the European average. Of the rural regions, 63% can be considered less wealthy, as the GDP per capita is below the EU-28 average of €29,000 (shown as the black dashed line), and 37% can be considered wealther regions. Of the rural regions, 267 (80%) had an electric passenger car registration share below the 3.6% European average, of which 71% had a GDP per capita below the European average and 29% above. Twenty percent of rural regions, or 67, recorded passenger car registration shares equal to or above 3.6%, 33% where the GDP per capita was below and 67% where the GDP was above European average.

9 Dale Hall and Nic Lutsey, *Electric vehicle charging guide for cities*, (ICCT: Washington, DC, 2020), https://theicct.org/sites/default/files/publications/EV_charging_guide_03162020.pdf

10 Eurostat, "Gross domestic product (GDP) at current market prices by NUTS 3 regions," (6 September, 2020), https://appsso.eurostat.ec.europa.eu/nui/submitViewTableAction.do

11 Federal Statistical Office, "Graubünden," (2020), https://www.bfs.admin.ch/bfs/en/home/statistics/regional-statistics/regional-portraits-key-figures/cantons/graubuenden.html

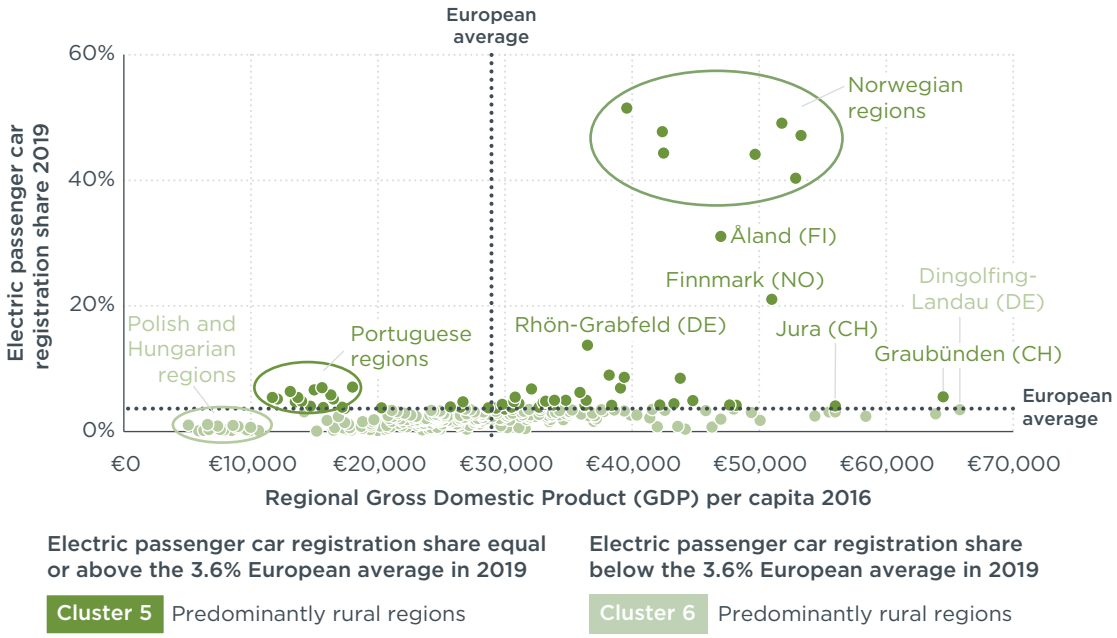


**Figure 8.** Electric passenger car registration share and GDP per capita for rural regions in Europe.

Figure 8 also illustrates that all eight Norwegian rural regions had a GDP per capita above the European average and, at the same time, electric passenger car registration shares significantly above the 3.6% European threshold in 2019, ranging between 21.0% and 51.5%. The two rural Swiss regions with the highest (Graubünden) and fifth highest (Jura) GDP per capita among all 334 rural regions recorded above European average electric passenger car registrations in 2019. On the contrary, the 36 rural regions with the lowest GDP per capita, i.e. equal or below €10,000, also recorded some of the lowest passenger car registrations shares, ranging between 0% and 1.0%. These regions were located in Hungary (6 rural regions) and Poland (30 rural regions). Some regions experienced above European average electric passenger car registrations shares despite a below European average GDP, with most located in Portugal (14 out of its 16 rural regions).

An assessment of charging infrastructure deployment and the economic situation indicates that there are no general trends which could explain the uptake of electric vehicles in rural regions in 2019. In the following section, we therefore highlight select leading rural regions by electric passenger car registrations shares with focus on policy actions and measures taken at local and national levels which might have helped to spur electric vehicle adoption.

## Analysis of leading rural electric vehicle regions

To analyze why some rural regions may have been successful in electric vehicle adoption based on electric passenger car registration shares in 2019, we chose nine rural regions. The selection is based on countries where at least one rural region experienced an electric passenger car registration share equal to or above the 2019 European average of 3.6%. This applies to ten out of the 17 countries assessed: Austria, Denmark, Finland, Germany, Norway, Portugal, Spain, Sweden, Switzerland, and the Netherlands. Of these ten countries, we select the rural region with the highest share of BEV and PHEV registrations in 2019 for a more detailed evaluation of policy actions. For Finland, we choose the rural region with the second highest uptake of BEVs and PHEVs, Etelä-Pohjanmaa. Åland, an autonomous island region of Finland, had a higher uptake but registered fewer than ten new electric cars in 2019. We did not consider the rural region El Hierro, one of the Spanish Canary Islands, which also recorded fewer than ten electric passenger cars registrations in 2019. Based on these criteria we analyze policies in nine rural regions in more detail (Figure 9): Aust-Agder (Norway), Rhön-Grabfeld (Germany),

Jämtlands (Sweden), Região de Leiria (Portugal), Zeeuwsch-Vlaanderen (Netherlands), Graubünden (Switzerland), Etelä-Pohjanmaa (Finland), Tiroler Unterland (Austria), and Vest- og Sydsjælland (Denmark).

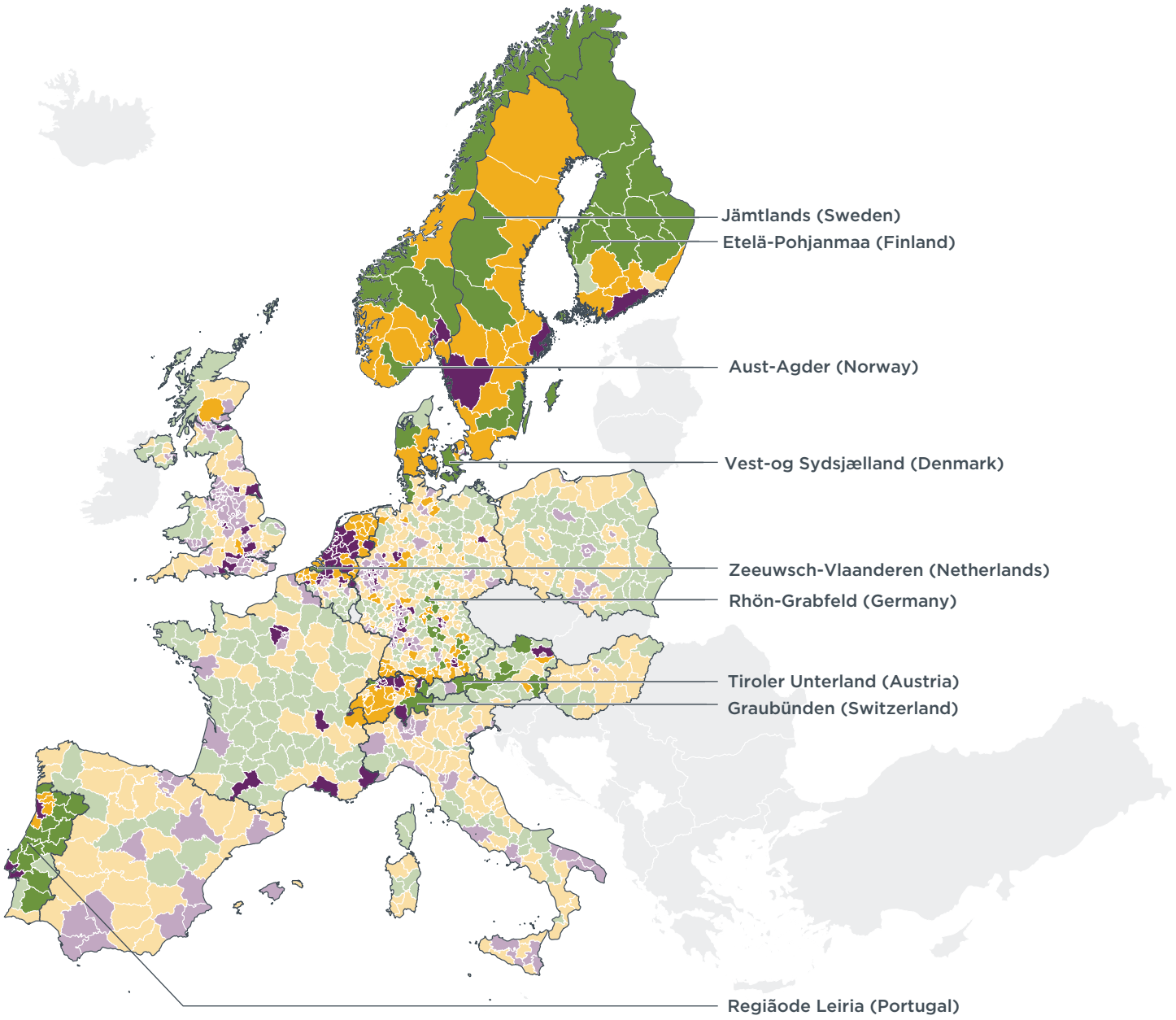


**Figure 9.** Rural regions selected for the analysis.

For the analysis of local electric vehicle promotion actions and measures it is important to note that, concerning the nine rural regions selected, there are wide variations in terms of area size, population and population density, and the size of the largest cities (detailed information in Table A1, Appendix). The areas of the nine rural NUTS 3 regions selected range from 877 km$^2$ (Zeeuwsch-Vlaanderen, Netherlands) to 53,752 km$^2$ (Jämtlands, Sweden). The populations range from 80,000 in Rhön-Grabfeld, Germany, to 587,000 in Vest- og Sydsjælland, Denmark, and the population density ranges from 3 persons/km$^2$ (Jämtlands, Sweden) to 142 persons/km$^2$ (Zeeuwsch-Vlaanderen, Netherlands). For the selected regions, the largest cities have a population of 50,000 to 64,000 inhabitants. As a consequence of the differing preconditions, electric vehicle promotions actions are usually scattered over different locations in the relevant regions. For the analysis of local policies, we therefore focus mainly on policies adopted in the larger communities of these regions.

## Electric passenger car market in leading rural regions

All rural regions selected experienced electric passenger car uptakes above the European average, ranging between 4.3% in Vest- og Sydsjælland (Denmark) and 51.5% in the Norwegian rural region of Aust-Agder (Figure 10). Differentiated by total new BEV and PHEV registrations, the rural regions in Austria, Germany, Norway, Portugal, Sweden, Switzerland, and the Netherlands experienced a higher uptake of BEVs compared to PHEVs, while in Etelä-Pohjanmaa (Finland) and Vest- og Sydsjælland (Denmark) PHEV registration dominated. By total numbers, the least number of new electric cars were registered in Zeeuwsch-Vlaanderen, the Netherlands (just over 90 BEV and PHEV registrations) and the highest with over 1,500 in the Norwegian region of Aust-Adger.

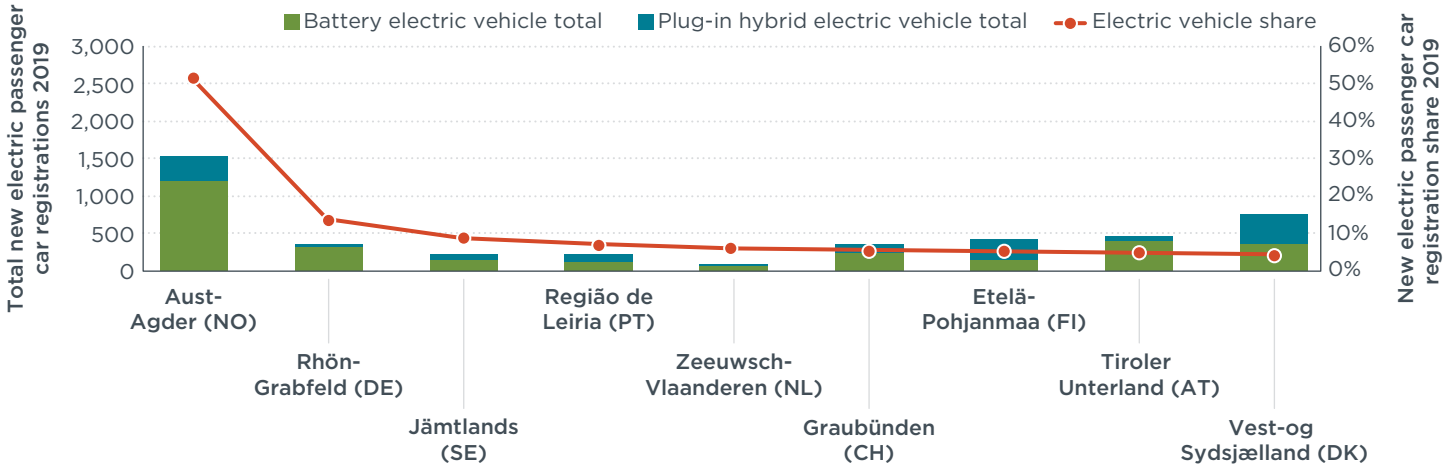


**Figure 10**. New electric vehicle registrations in leading rural electric vehicle regions (NO = Norway, DE = Germany, SE = Sweden, PT = Portugal, NL = Netherlands, CH = Switzerland, FI = Finland, AT = Austria, DK = Denmark).

The share of new electric passenger car registrations was usually lower in the leading rural region than its country average. The share was 51.5% in Aust-Agder (Norway 58.0%), 5.4% in Etelä-Pohjanmaa (Finland 6.9%), 8.9% in Jämtlands (Sweden 11.0%), and 6.2% in Zeeuwsch-Vlaanderen (the Netherlands 7.0%). In three rural regions, the shares exceeded the national averages. In Região de Leiria the share was 7.0% compared to 5.7% in Portugal; in Rhön-Grabfeld the share was 13.7% versus 3.0% in Germany; and in Tiroler Unterland it was 4.9% versus 3.6% in Austria. In the Swiss canton of Graubünden, 5.5% of all passenger cars registered were a BEV or PHEV, similar to the average in Switzerland of 5.6%.

The dominance of BEVs or PHEVs in registrations in the selected rural regions generally reflected national trends. This applied to the leading rural electric vehicle regions in Austria, Finland, Norway, Portugal, and Switzerland. For example, in Aust-Agder new BEV registrations were over three times higher than of PHEVs, similar to the pattern in Norway. In Rhön-Grabfeld new BEV registrations were 10 times higher than PHEV registrations while it was less than twice as high for Germany. In Zeeuwsch-Vlaanderen, BEV registrations were 3 times higher than of PHEVs versus 12 times higher at the Dutch national level. In Jämtlands, Sweden, more new BEVs than PHEVs were registered, contrary to the national trend where more PHEV registrations were recorded. This is similar to Vest- og Sydsjælland (Denmark) where more new PHEVs than BEVs were registered, differing from the national trend with higher BEV registrations.

## Public charging infrastructure network in leading rural electric vehicle regions

In parallel to the uptake of electric passenger cars, the public charging infrastructure network has been rolled out successively. Figure 10 shows that of eight regions analyzed

in more detail, the total number of public charging points varied widely.[12] The highest number of public charging points were installed in Graubünden, Switzerland (over 500), followed by Jämtlands, Sweden with about 450 public chargers, and Aust-Agder, Norway with over 400 publicly accessible charging points available across the region. In contrast, less than 50 charge points were available in the Finnish rural region of Etelä-Pohjanmaa, yet more than half of them were fast chargers. In Aust-Agder, one-fourth of all public chargers were fast chargers. In the other rural regions, normal chargers dominated with the share between 85% in Vest- og Sydsjælland, Denmark and 99% in Zeeuwsch-Vlaanderen, the Netherlands.

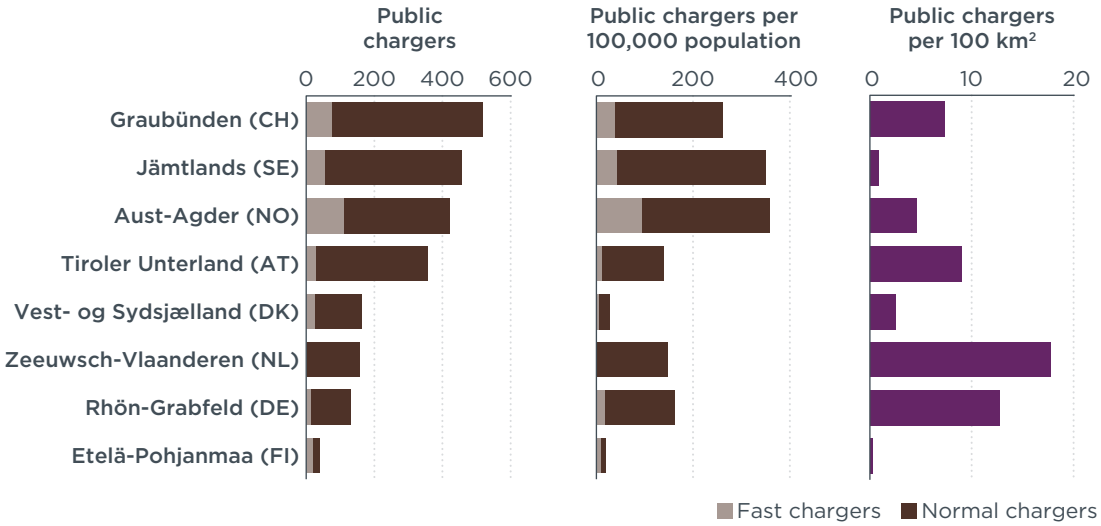


**Figure 11.** Public chargers across selected rural regions (CH = Switzerland, SE = Sweden, NO = Norway, AT = Austria, DK = Denmark, NL = Netherlands, DE = Germany, FI = Finland).

The three rural regions with the highest total number of public charging points also accounted for the most by 100,000 inhabitants. Public charging points per 100 km² ranged between 1 and 18, with Zeeuwsch-Vlaanderen in the Netherlands having the highest density, followed by Rhön-Grabfeld in Germany with 13 public charging points per 100 km², and Tiroler Unterland with 9 public charging points per 100 km².

Comparing public charging points per 100 km² in the selected rural regions with the country averages, the difference was most pronounced in the Netherlands. While in the Netherlands there were more than 120 public charging points per 100 km², there were 18 per 100 km² in the rural region of Zeeuwsch-Vlaanderen. In contrast, in the selected rural regions of Austria, Finland, Germany, and Sweden, the average concentration of public chargers per 100 km² versus the national averages was almost balanced.

The number of public chargers per 100,000 inhabitants was over three times higher in the rural regions of Switzerland and Sweden compared to the national deployment, and was two and a half times higher in Rh.n-Grabfeld compared to Germany. it was and one and a half times higher in the Tiroler Unterland compared to Austria, and one and a half times higher in Aust-Agder compared to Norway (Figure 12). In contrast, in the rural regions of Vest- og Sydsjælland in Denmark and Zeeuwsch-Vlaanderen in the Netherlands public charging points per 100,000 inhabitants were below national figures, by about half. In Finland and one of the leading rural electric vehicle regions, the concentration was almost balanced.

12 No regional charging infrastructure data was found for Região de Leiria, Portugal.

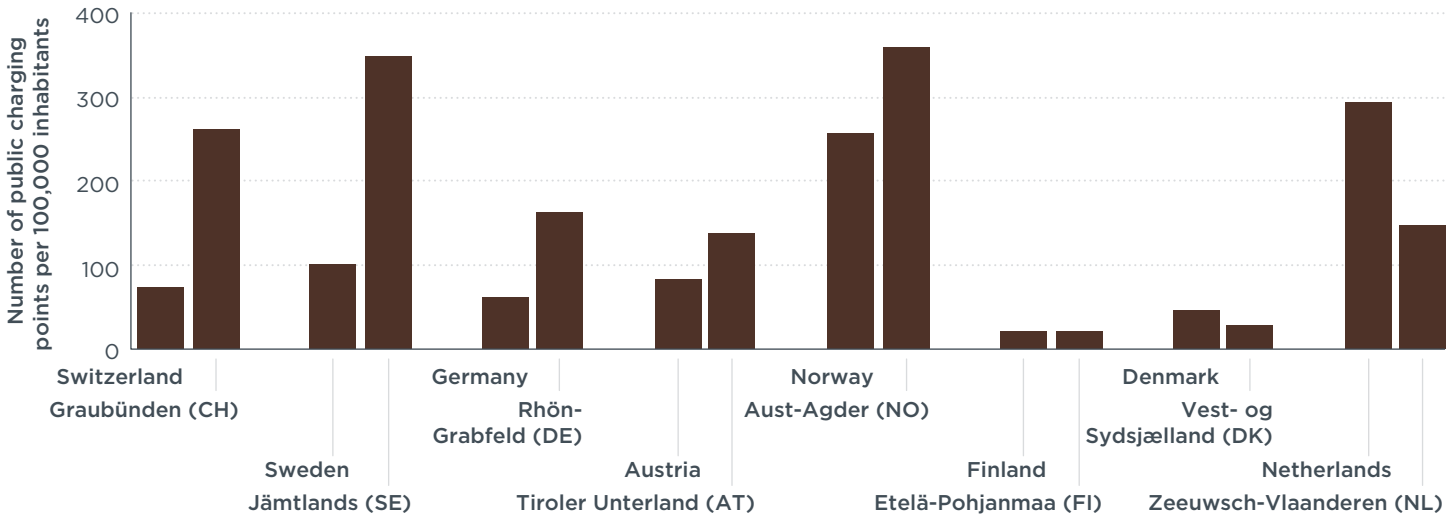


**Figure 12.** Comparison of number of public charging points per 100,000 inhabitants of selected rural regions versus national figures (CH = Switzerland, SE = Sweden, DE = Germany, AT = Austria, NO = Norway, FI = Finland, DK = Denmark, NL = Netherlands).

Due to the longer distances commonly traveled in rural compared to intermediate and urban regions, fast charging, particularly along corridors, can help to accelerate electric vehicle adoption in rural areas. Figure 13 shows the percentage of public charging points that are fast charging and compares the leading rural electric vehicle regions with the country percentages. The figure illustrates that the share of public fast charging is higher in the leading rural regions of Denmark, Finland, Norway, Switzerland, and Germany compared to the share at country levels. It is up to two times higher in Vest- og Sydsjælland, Denmark and Etelä-Pohjanmaa, Finland. In the leading rural electric vehicle regions of Sweden and Austria, the share of public fast charging points is about equal to the country shares. Zeeuwsch-Vlaanderen in the Netherlands is the only rural region of the eight regions assessed where the national public fast charging share is higher.

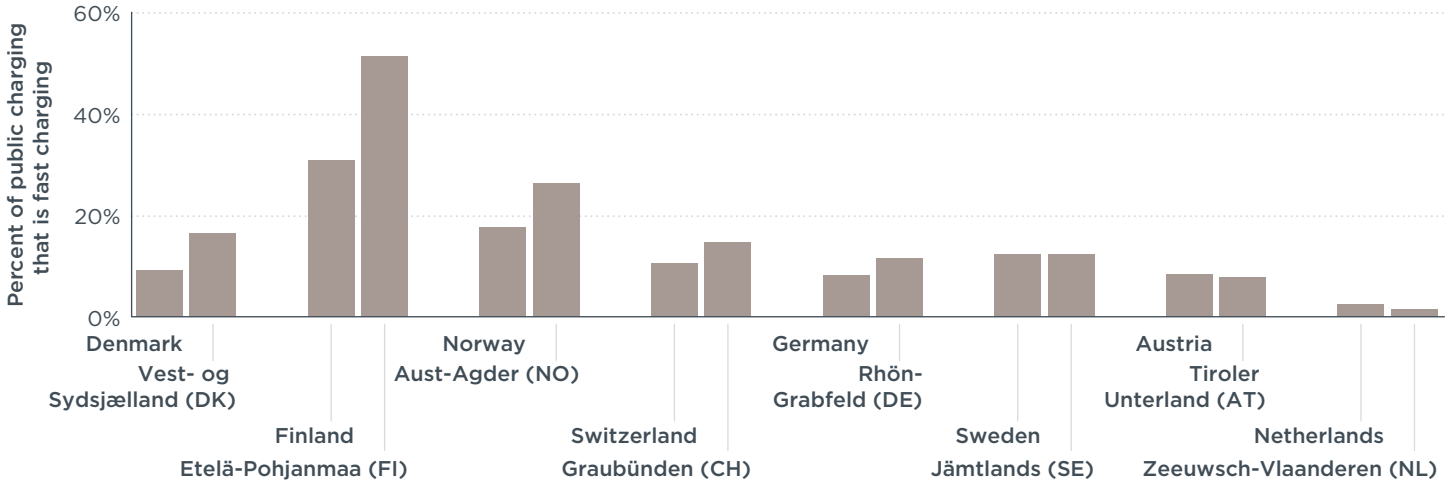


**Figure 13.** Percentage of public charging that is fast charging (DK = Denmark, FI = Finland, NO = Norway, CH = Switzerland, DE = Germany, SE = Sweden, AT = Austria, NL = Netherlands).

The comparison of leading rural electric vehicle regions versus national trends in terms of selected public charging infrastructure metrics shows that the concentration and potential access in some of those regions is higher than the national values.

We find that for public charging facilities in all rural regions analyzed, a certain proportion of the rural population also has potential access to home charging. For

example in Rhön-Grabfeld, Germany, over 90% of the population live in residential buildings with one- or two-apartments.[13] In Zeeuwsch-Vlaanderen, the Netherlands, 85% of people live in single-family houses and 15% in multi-family buildings.[14] In Graubünden, Switzerland, 60% of the population live in single-family homes, ranging by community between 17% and 96%[15] and in the state of Tirol, 47% of the inhabitants live in buildings with one or two apartments.[16] These conditions in the selected rural regions suggest that a certain percentage of the rural population would rely on public charging beyond those who have the possibility of home charging.

## Policy actions and measures in leading rural electric vehicle regions

National and local policies are an important factor in driving the electric vehicle market. To understand which policies might have driven the uptake, national and local policies selected for the analysis include incentives and benefits for electric vehicle purchase and operation, charging infrastructure funding and privileges, and local policy actions such as electric vehicle sales goals and their integration in fleets. Policy actions evaluated commonly refer to the year 2019 to best reflect electric passenger car registrations analyzed for that same year. The focus is on policies adopted for passenger cars. Policies highlight incentives for electric vehicles rather than disincentives for conventional cars. Yet, shifting to polluter-pay policies that impose high taxes on high polluting vehicles can also help to durably fund the transition to zero-emission vehicles in the long-term.[17]

### *Electric vehicle purchase and operation*

Financial policies for electric vehicle purchase and operation at national and local levels play an important role in bridging the cost gap or making them more attractive in terms of cost compared to conventional cars.

Of the nine markets analyzed, five offered national *BEV and PHEV purchase incentives* in 2019. The German government granted the highest amount for the acquisition of a zero-emission vehicle, i.e. BEV or fuel cell electric vehicle (FCEV), at a maximum of €6,000, while purchasers of a PHEV received €4,500. Sweden granted €5,700 for a new zero-emission vehicle and between €900 and €5,600 for a PHEV, depending on the vehicle's carbon dioxide ($CO_2$) emissions. In Austria, the maximum purchase grant for a zero-emission car or van was €3.000 and €1.250 for a PHEV.[18] Finland and Portugal granted assistance with the acquisition of a zero-emission vehicle only. The maximum aid amount in Finland was €2,000 and in Portugal, private purchasers of a zero-emission car or van could benefit from a €3,000 bonus. Companies benefit from the same amount in case of a van, and a reduced rate of €2,000 applied for the acquisition of a zero-emission car. Denmark, Norway, Switzerland, and the Netherlands offered no purchase incentives for electric vehicles in 2019.

13 Bayerisches Landesamt fuer Statistik, "Statistik kommunal 2018, Landkreis Rhön-Grabfeld [Statistic communally 2018, district Rhön-Grabfeld]," (2019), https://www.statistik.bayern.de/mam/produkte/statistik_kommunal/2018/09673.pdf

14 Stec Groep, "Woningkwaliteit- en woningmarktonderzoek Zeeland 2019 (KWOZ) [Housing quality and housing market research Zeeland 2019]," (2020), https://www.zeeland.nl/sites/zl-zeeland/files/woningkwaliteit-_en_woningmarktonderzoek_zeeland_2019_kwoz.pdf

15 Canton of Graubünden, "Buildings and apartments," (2020), https://www.gr.ch/DE/institutionen/verwaltung/dvs/awt/statistik/Bau-_und_Wohnungswesen/Seiten/Gebaeude_und_Wohnungen.aspx#:~:text=Gem%C3%A4ss%20Geb%C3%A4ude%2D%20und%20Wohnungsstatistik%20(GWS,aus%20der%20Zeit%20vor%201960.

16 Amt der Tiroler Landesregierung, Landesstatistik, "Tirol, Regionsprofil [Tirol, regional profile]," (2020), (https://www.tirol.gv.at/fileadmin/themen/statistik-budget/statistik/downloads/Regionsprofile/Stat_profile/Land/Tirol.pdf

17 Peter Slowik, Dale Hall, Nic Lutsey, Michael Nicholas, and Sandra Wappelhorst, *Funding the transition to all zero-emission vehicles*, (ICCT: Washington, DC, 2019), https://theicct.org/sites/default/files/publications/Funding_transition_ZEV_20191014.pdf

18 Kommunalkredit Public Consulting, "Private individuals environmental subsidies," accessed 12 February, 2021, https://www.umweltfoerderung.at/privatpersonen/foerderungsaktion-e-mobilitaet-fuer-private-2019-2020/navigator/fahrzeuge-1/foerderungsaktion-e-mobilitaet-fuer-private-2019-2020.html; Kommunalkredit Public Consulting, "Companies environmental subsidies," accessed 12 February, 2021, https://www.umweltfoerderung.at/betriebe/e-ladeinfrastruktur/navigator/mobilitaetsmanagement/foerderungsaktion-e-ladeinfrastruktur.html

A few of the countries studied offer tax incentives, as opposed to direct grants, for the purchase of electric vehicles. In Norway, the 25% Value Added Tax added to the vehicles base price is waived for zero-emission cars. For example, the purchaser of a medium-sized Volkswagen e-Golf, the second best-selling BEV in Norway in 2019, would be exempt from paying an additional €8,000 beyond significant tax reductions when first registering a new BEV.[19] In 2020, the Dutch government introduced a bonus for used and new zero-emission cars and vans (€4,000 for a new and €2,000 for a used BEV)[20] and in response to the COVID-19 outbreak, Austria and Germany increased the bonus amounts for BEV and PHEV purchases as recovery measures to the pandemic.

Six out of the nine markets analyzed did impose registration taxes on vehicle purchase, and all of those countries also provided one-time *BEV and PHEV registration tax benefits*. In Denmark and Portugal, tax deductions on registration applied to both BEVs and PHEVs. In Austria, Finland, Norway, and the Netherlands, only purchasers of a zero-emission vehicle could benefit from favorable tax breaks. Germany, Sweden, and Switzerland did not impose taxes on a vehicle's first registration. In addition to registration tax liabilities, *BEV and PHEV ownership tax benefits* can help to further reduce the cost for owning a vehicle. The national governments of all nine markets offered exemptions or reduced tax rates on vehicle ownership taxes in 2019. In Denmark and Portugal, tax breaks applied to both BEVs and PHEVs. Austria, Finland, Germany, Norway, Sweden, and the Netherlands offer favorable tax breaks for owners of a zero-emission vehicle. In the canton of Graubünden (Switzerland), reduced tax rates applied for low-emission vehicles in 2019 including BEVs and PHEVs.[21]

Next to private ownership, company cars play an important role in European markets. Many governments provide *BEV and PHEV company car tax benefits* for employees. With the exception of Switzerland, all countries provide exemptions or tax breaks on income tax for employees privately using an electric company car. In Austria, Finland, Norway, and the Netherlands, these tax breaks applied to only zero-emission company cars in 2019. In Denmark, Germany, Portugal, and Sweden, users of a PHEV also benefited from preferential tax breaks on income tax.

Other financial incentives for electric vehicles include *toll, bridge, or ferry discounts* which can further reduce the operating cost compared to conventional vehicles. Austria, Portugal, and Norway impose national road tolls for passenger cars. Only Norway grants discounts for drivers of a zero-emission vehicle.

Typical financial incentives at local levels include *electric vehicle parking privileges* in the form of discounts on parking fees or free parking. The municipalities of Arendal and Grimstad (Aust-Agder, Norway), both provide parking privileges for owners of an electric vehicle. In Arendal, BEVs and FCEVs park for free for a limited amount of time in public parking spaces in the city center and at the local hospital.[22] In Grimstad, parking a BEV and FCEV was also free of charge up to March 2020, but drivers now pay the normal fare in all public car parks.[23] Beyond these areas, no other local communities in the rural regions selected had parking privileges for electric vehicle drivers in place in 2019.

19 Based on the price for a Tesla Model S Performance.

20 Government Gazette of the Kingdom of the Netherlands, "Regulation of the State Secretary for Infrastructure and Water Management, of 25 May 2020, no. IENW / BSK-91099, containing rules for stimulating the purchase and lease of electric passenger cars by private individuals (Subsidy scheme for private electric passenger cars)," (25 May, 2020), https://zoek.officielebekendmakingen.nl/stcrt-2020-28162.html

21 Kanton Graubünden, "Verordnung zum Einführungsgesetz zum Bundesgesetz über den Strassenverkehr (RVzEGzSVG) [Ordinance on the Introductory Act to the Federal Road Traffic Act (RVzEGzSVG)]," (1 January, 2020), https://www.gr-lex.gr.ch/app/de/texts_of_law/870.110/versions/3006

22 Arendal Kommune, "Electric car," (27 August, 2020), https://www.arendal.kommune.no/tjenester/vei-parkering-og-havn/parkering/elbil/

23 Grimstad Kommune, "Electric car – parking and charging points," https://www.grimstad.kommune.no/tjenester/vei-parkering-og-havn/parkering/elbil/

Non-financial incentives for the use of an electric vehicle adopted include *speed limit privileges.* The Austrian government is the only one of the nine markets which allows different speed limits for zero-emission and combustion engine cars on its motorways. Since mid-2019, zero-emission cars registered in Austria are allowed to drive 130 km/h in certain sections of the national motorway network while the maximum speed for combustion engine cars is 100 km/h.[24]

### *Charging infrastructure policies*

A comprehensive public and private charging infrastructure network is an important precondition to comply with the increasing electric vehicle market and growing user needs. In rural areas where a higher number of people live in houses compared to urban regions, the access and support of home charging facilities bears high potential. Yet, in the transition to electric vehicles, a nationwide public charging network is likewise important to provide equal access and not leave less populated regions behind in the transition to electric vehicles. Some national, state, and local governments have therefore set targets for the deployment of public and private charging facilities and are pursuing a variety of measures for the successive roll-out, including funding programs and charging privileges.

*Public charging infrastructure funding programs* have been adopted at different governmental levels. National governments such as Germany, Austria, Sweden, Finland, Norway, and the Netherlands provided funding for the extension of the public charging infrastructure network in 2019.[25] In Germany and Austria, the state governments of Bavaria[26] and Tirol[27] made additional funding available for installation of a charging point. In Switzerland, some communities in the canton of Graubünden could also benefit from funding in 2019 from the city of Zurich electricity provider.[28] Beneficiaries of the funding programs for public charging infrastructure included local authorities, associations, commercial organizations, companies, tourism and leisure facilities, or shopping centers.

*Private charging infrastructure funding programs* were available in Austria, Finland, and Sweden in 2019. The Swedish government provides SEK 90 million (€8.7 million) to support private individuals with up to 50% or SEK 10,000 (€960) for the hardware and installation of home chargers. The Finnish government grants financial aid for housing co-operatives, condominiums, and similar organizations for building charging points for their residents, allowing 35% or up to €90,000 for the purchase and installation of charging points. Austria also subsidizes the installation of private charging points when purchasing an electric car.[29] In 2020, Germany announced plans to invest €500 million for the establishment of private charging points.[30]

*Charging privileges* analyzed include measures such as tax breaks for the installation of charging points, the installation of public charging points, and free charging. In the Netherlands, many local governments offer to install a nearby public charging point for

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24 Bundesministerium für Klimaschutz, Umwelt, Energie, Mobilität, Innovation und Technologie, "Elektroautos [Electric cars]," accessed 12 February, https://www.bmk.gv.at/themen/klima_umwelt/luft/luft/recht/e_autos.html

25 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/sites/default/files/publications/EV_city_policies_white_paper_fv_20200224.pdf

26 Bayerisches Staatsministerium für Wirtschaft, Landesentwicklung und Energie, "Ladeinfrastruktur für Elektrofahrzeuge in Bayern [Charging infrastructure for electric vehicles in Bavaria], accessed 12 February, 2021, https://www.stmwi.bayern.de/service/foerderprogramme/ladeinfrastruktur/

27 TINETZ-Tiroler Netze GmbH, "Charging infrastructure funding", accessed 12 February, 2021, https://www.tinetz.at/kundenservice/ladeinfrastrukturfoerderung/

28 Swiss eMobility, "Funding measures in Switzerland", (2018), https://www.swiss-emobility.ch/de/elektromobilitaet/Foerdermassnahmen/

29 Wappelhorst, Hall, Nicholas, and Lutsey, *Analyzing policies to grow the electric vehicle market in European cities*

30 Bundesministerium für Verkehr und digitale Infrastruktur, "The starting shot for wallbox funding / charging infrastructure masterplan is consistently implemented," (23 November, 2020), https://www.bmvi.de/SharedDocs/DE/Pressemitteilungen/2020/065-scheuer-startschuss-fuer-wallbox-foerderung.html#:~:text=privater%20Ladeinfrastruktur%20gef%C3%B6rdert.-,Ab%20dem%2024.,daf%C3%BCr%20200%20Millionen%20Euro%20bereit.

owners of an electric car if they cannot charge at private premises. This also includes municipalities in the district of Zeeuwsch-Vlaanderen.[31] In addition, companies in the Netherlands benefit from favorable tax breaks when investing in the installation of charging points.[32] Other privileges, such as charging an electric vehicle free of charge are available in selected communities outside the city of Östersund (Jämtlands, Sweden).[33]

In an effort to expand the charging infrastructure network, a number of markets have also set specific *charging infrastructure goals.* In 2019, the German government set the target to build 1 million publicly available charging points by 2030.[34] The state of Tirol in Austria aimed for 1,000 public charging points by 2020 as outlined in their 2017 electric mobility action program. For 2030, the state aims for a state-wide, comprehensive network, including fast charging infrastructure at important traffic junctions and appropriate charging infrastructure availability at all locations of social interest and with a longer duration of stay.[35] Some markets have also assessed their charging infrastructure needs without setting a defined target. The Netherlands predicts that 1.74 million charging points will be needed by 2030 to serve a fleet of 1.9 million electric passenger cars on the road. This would include 77,000 private, 39,000 public, 56,000 semi-public, and 9,700 fast charging points. For the district of Zeeuwsch-Vlaanderen, over 40,000 charging points are estimated to be needed, including about 9,500 public charging points.[36] To increase the number of public charging points, the region is working together with municipalities, network operators, and market parties.[37] Graubünden in Switzerland published a masterplan charging infrastructure in 2017 which estimates the canton's needs at between 4,500 and 8,800 public charging stations for 2035.[38]

### *Local planning and fleets*

Setting goals for the electrification of the passenger car fleet is in important step also for local and regional governments to set the path towards electric vehicle adoption and to outline and implement the relevant policy measures. In addition, integrating electric vehicles into local fleets can help to raise awareness about new vehicle technologies.

Three of the regional governments have formulated *100% electric vehicle stock goals.* The county of Jämtlands (Sweden) has set a goal to become fossil-free in 2030 and to convert the vehicle fleet to 100% renewable fuels.[39] The region of Aust-Agder (Norway) aims to electrify the entire transport sector by 2030.[40] The district of Zeeuwsch-Vlaanderen (the Netherlands) aims for all mobility to be emission-free by 2040, with all passenger cars emission-free by 2035 and public transport 100% emission-free by

31 Municipality of Middelburg, "Charging points for electric transport," accessed 12 February, 2021, https://www.middelburg.nl/oplaadpunten-elektrisch-vervoer?origin=/Inwoners/Verkeer_en_vervoer/Oplaadpunten_voor_elektrisch_vervoer

32 Netherlands Enterprice Agency, "MIA and Vamil," (1 May, 2020), https://english.rvo.nl/subsidies-programmes/mia-and-vamil

33 Östersunds kommun, "Electric cars," accessed 12 February, 2021, https://www.ostersund.se/trafik-och-infrastruktur/biltrafik/elbilar.html

34 Die Bundesregierung, "Masterplan Ladeinfrastruktur der Bundesregierung [Masterplan charging infrastructure of the government]," (2019), https://www.bmvi.de/SharedDocs/DE/Anlage/G/masterplan-ladeinfrastruktur.pdf?__blob=publicationFile

35 Amt der Tiroler Landesregierung, "Aktionsprogramm E-Mobilität 2017-2020 [Action program e-mobility 2017-2020]," (2017), https://www.tirol2050.at/uploads/tx_bh/aktionsprogramm_e_mob.pdf

36 Elaadnl, "Factsheet – Nationale Agenda Laadinfrastructuur (NAL) [Factsheet – National agenda charging infrastructure (NL)]," (2020), https://www.elaad.nl/uploads/files/Factsheets-NAL/Factsheet-NAL-Nationale-Agenda-Laadinfrastructuur-ElaadNL.pdf

37 Provincie Zeeland, "Your charge Zeeland: expansion of charging stations in Vlissingen," (15 September, 2020), https://www.zeeland.nl/actueel/zeeland-laad-je-op-uitbreiding-laadpalen-vlissingen

38 Kanton Graubünden, "Masterplan Ladeinfrastruktur E-Mobilität Kanton Graubünden [Masterplan charging infrastructure e-mobility canton Graubünden]," (2017), https://www.gr.ch/DE/institutionen/verwaltung/diem/aev/dokumentation/EnergieeffizienzDokumente/Masterplan_Ladeinfrastruktur_E-Mobilitaet_Graubuenden.pdf

39 Jämtlands län, Jämtland Härjedalen, "Energi– och Klimatstrategi 2020–2030 JÄMTLANDS IÄN [Energy and Climate Strategy 2020-2030 Jämtlands län]," (2019), https://jht.se/wp-content/uploads/2019/04/Remissversion-Energi-och-klimatstrategi-2020-2030.pdf

40 Agder fylkeskommune, "Regionplan Agder 2030 [Regional Plan Agder 2030]," accessed 12 February, 2021, https://agderfk.no/_f/p1/i4d721a77-52f4-49e3-ba9e-42cb0c5a8b4e/regionplan-agder-2030.pdf

2025.[41] The state of Tirol (Austria) aims for 5% of the total car stock to be electric in 2020 and for 40% in 2030.[42]

One measure to integrate electric vehicles into fleets are through local carsharing programs. *Electric carsharing initiatives* have been established in some communities of the Tiroler Unterland (Austria) and Zeeuwsch-Vlaanderen (the Netherlands). In the Tiroler Unterland, electric carsharing is offered in three local communities with funding by the European Regional Development Fund and additional national and state financing.[43] The municipal utility of the city of Wörgl, in cooperation with the Transport Association of Tirol, offers about 50 electric carsharing vehicles in more than 20 municipalities of the region as of September 2020.[44] In Zeeuwsch-Vlaanderen, the Zeeland Sustainable Mobility Foundation offers about ten electric shared cars throughout the region, targeted at businesses and private customers likewise as of the end of 2020.[45]

## Summary of policy actions and measures

Figure 14 summarizes the selected policy actions and measures implemented by leading European rural electric vehicle regions in descending order of the number of policies adopted. Most policies among the nine rural regions selected have been adopted in Tiroler Unterland, Austria, with ten out of 16 adopted if accounting for actions at multiple levels separately. Those actions have been implemented at local, regional, and national levels. The rural regions Jämtlands (Sweden), Aust-Agder in Norway, and Zeeuwsch-Vlaanderen (the Netherlands) all had eight of the 16 analyzed measures in place in 2019. In all three regions, we find a mix of national, regional, and local level policy actions, with most being implemented at the national level. The least number of policies had been implemented in Graubünden in Switzerland in 2019. Here, apart from ownership tax benefits, only some communities could benefit from local public charging infrastructure incentives. Yet, the GDP per capita was the second highest among all 334 rural regions analyzed, indicating that other aspects beyond policies, such as the prosperity of a region and its population, might have driven the uptake.

41 Provincie Zeeland, "Sustainable mobility," accessed February 12, 2021, https://www.zeeland.nl/energie-en-klimaat/duurzame-mobiliteit

42 Amt der Tiroler Landesregierung, "Aktionsprogramm E-Mobilität 2017-2020 [Action program e-mobility 2017-2020]," (2017), https://www.tirol2050.at/uploads/tx_bh/aktionsprogramm_e_mob.pdf

43 Stadtwerke Kufstein, "Sharing instead of owning: E-car sharing with Beecar," (2020), https://www.stwk.at/produkte-leistuharngen/e-carsing/

44 Stadtwerke Wörgl, "floMOBIL - eCarsharing from Tyrol," (2020), https://flo-mobil.com/?gclid=EAIaIQobChMI0q6wyM3h6wIVi94YCh35AAHdEAAYASAAEgL2rvD_BwE; ORF, "VCÖ mobility award for car sharing in Tyrol," (18 September, 2020), https://tirol.orf.at/stories/3067339/

45 Duurzame Mobiliteit Zeeland, "Platform for sustainable mobility initiatives in Zeeland," accessed 12 February, 2021, https://www.duurzame-mobiliteit-zeeland.nl/

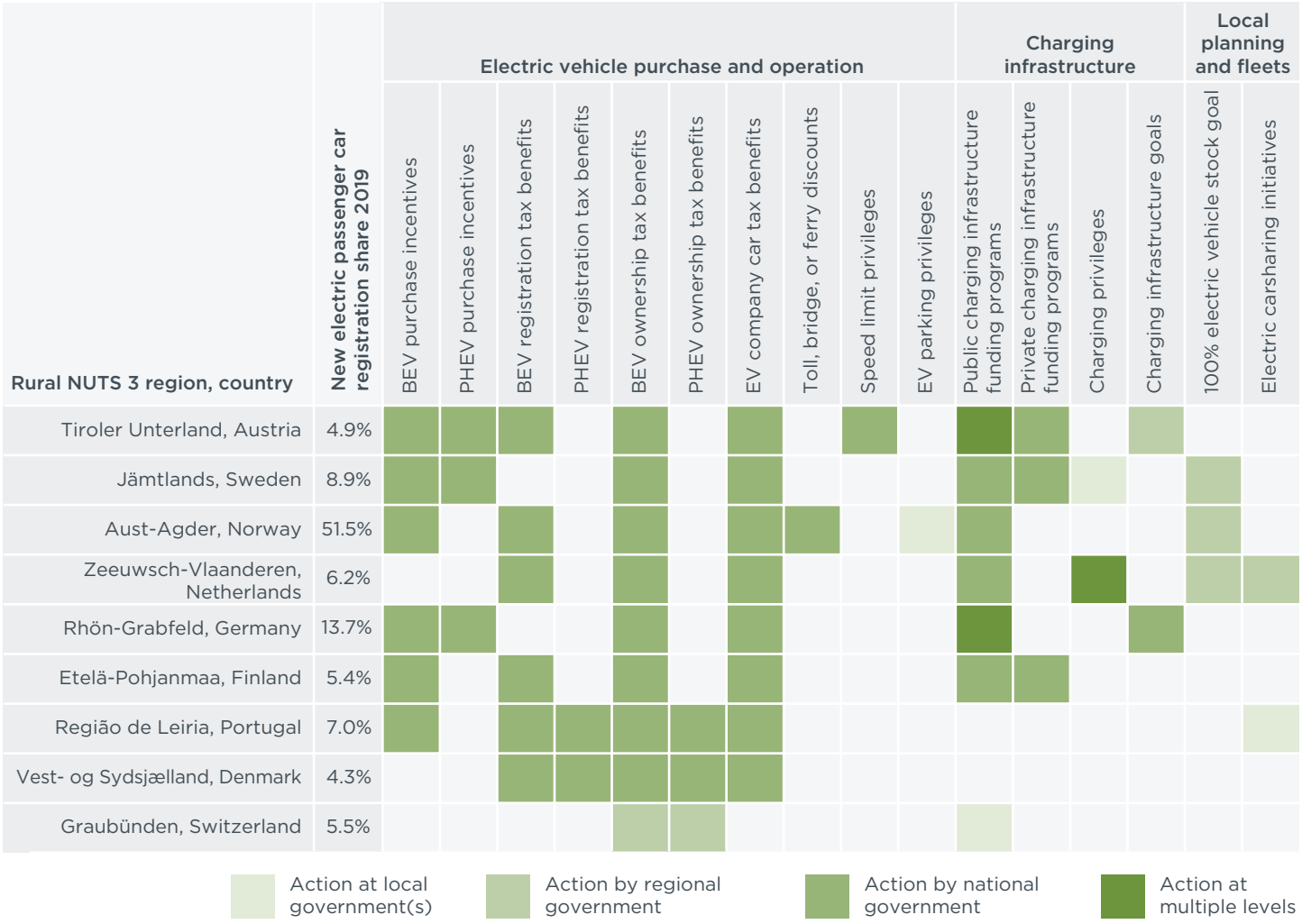


**Figure 14.** Selected policies implemented in leading rural electric vehicle regions.

Figure 15 compares the leading rural regions in terms of electric vehicle registration share, purchase incentives for BEVs, number of public charging points per 100,000 inhabitants and per 100 km$^2$, as well as the number of policies adopted based on the analysis above.

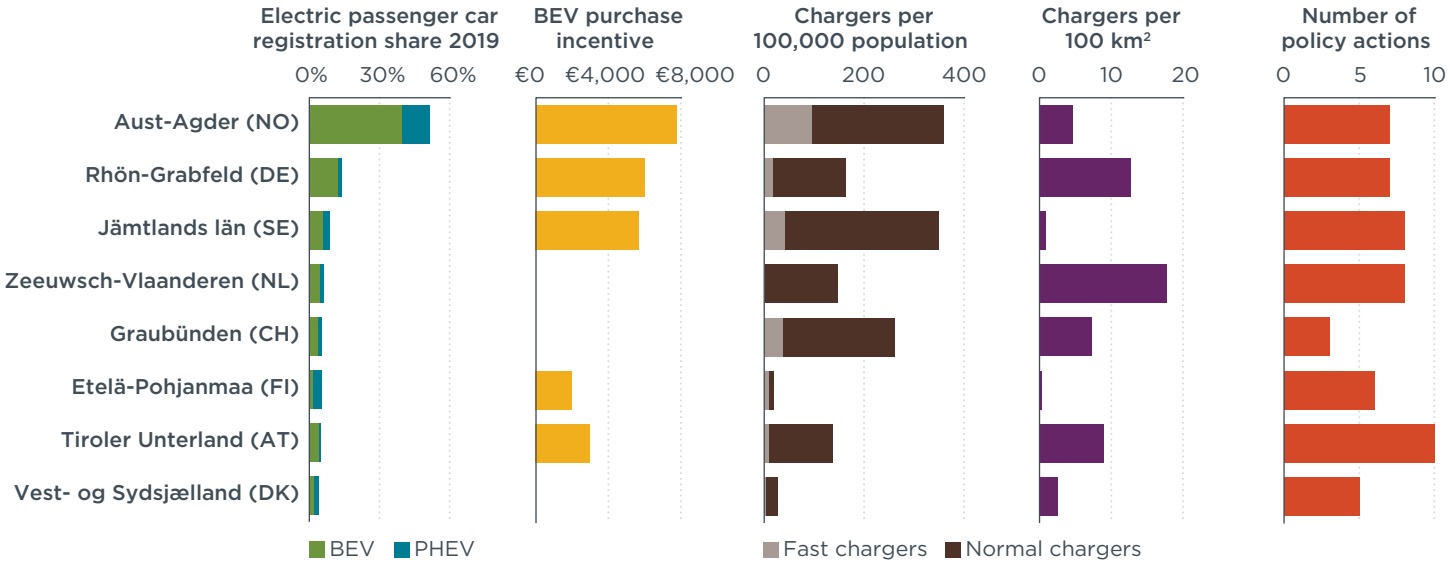


**Figure 15.** Electric passenger car registration share, BEV purchase incentive, number of public charging points per inhabitants and area, and number of policy actions in selected rural electric vehicle regions in 2019 (NO = Norway, DE = Germany, SE = Sweden, NL = Netherlands, CH = Switzerland, FI = Finland, AT = Austria, DK = Denmark). Note: No regional charging infrastructure data was found for Região de Leiria, Portugal.

The figure reveals that the leading rural electric vehicle regions benefit from or apply a mix of national, regional, and local measures which have contributed to a high electric vehicle uptake. In Norway, purchasers of a BEV benefit from significant tax savings including a 25% Value Added Tax waiver which can be worth several thousand Euros depending on a new vehicle's base price. Despite a comparably low density of five public charging points per 100 km² in the region of Aust-Agder, the number of charging points per 100,000 inhabitants is the highest among the leading rural regions selected. In Germany, purchasers of a BEV could benefit from a maximum €6,000 one-time bonus in 2019 and in Rhön-Grabfeld drivers could charge at 13 charging points per 100 km², the second highest density of public chargers among the eight rural regions shown above for comparison. Beyond the policies analyzed, the uptake in Rhön-Grabfeld has been influenced by activities implemented as part of a funding program starting in the district's city in 2010, which has helped to increase awareness across the region. In addition, the establishment of educational facilities and various companies related to electric mobility have helped the rural region of Rhön-Grabfeld remain the leading electric vehicle region in Germany by registration shares for many years.

Figure 15 also indicates that there is no general trend or formula that can explain high electric passenger car registrations shares in the leading rural electric vehicle regions, likely due to varying structural preconditions. For example, in Vest- og Sydsjælland (Denmark) electric passenger car registration shares were above the European and Danish average despite a low concentration of public charging points. National policies on electric vehicle purchase and operation or other aspects may have been sufficient to drive the uptake.

## Further community level electric vehicle promotion actions

Beyond the policy actions outlined above, there is a variety of additional activities adopted in individual communities which include measures to increase awareness and extend knowledge transfer. For example, in 2017, the Polytechnic of Leiria (Região de Leiria, Portugal) started a new course on electric and hybrid vehicles with the aim to train professionals able to maintain, diagnosis, and repair electric vehicles and their

components.[46] In the city of Bad Neustadt an der Saale (district of Rhön-Grabfeld, Germany), the state of Bavaria founded an Electromobility Technology Transfer Center in 2012 with research focusing on electrical energy technology, drive technology, and electromobility. Also, the city of Bad Neustadt an der Saale received state funding from the Bavarian ministry of economics with the aim to also spur electric mobility in rural regions. Since 2010, the region has pursued various activities to spur electric mobility and raise awareness. This includes a yearly electric mobility fair and a membership organization to promote electric mobility across the region and connect interested stakeholders from businesses, administration, and institutes.[47] Moreover, one of the local car dealers has been one of the flagship and award-winning companies by electric car sales since the early 2010s, helping to raise awareness about electric vehicles in the region and beyond.[48]

Further local government activities include strategic plans and goals to electrify the local vehicle fleet. An example is the municipality of Östersund (Jämtlands län, Sweden), which aims to increase the share of electric vehicles in the municipal fleet, extend the number of charging stations, and provide at least 25% of parking spaces for municipal housing with charging infrastructure in an effort to become fossil free by 2025.[49]

Despite the specific national, regional, and local contexts, the leading rural electric vehicle regions can serve as an example for other rural regions to enhance electric vehicle adoption.

## Conclusions

The analysis of electric passenger car uptake in rural regions points to complex, interdependent factors which affect electric vehicle adoption. Rural regions can differ significantly by area, population size, and population density, as well as their economic power. As there is slower uptake of electric vehicles in rural areas compared to urban and intermediate regions by total numbers, on a per capita basis, and by average shares, it is important to not leave rural regions behind in the transition to electric vehicles. There is a significant opportunity to electrify the passenger car fleet in rural regions, as dependency on private cars is much higher due to a less comprehensive public transport system compared to urban regions. In addition, potential access to home charging is generally higher in rural areas due to a high share of one- and two-family homes. Despite the complexity of electric vehicle adoption in rural regions, the following high-level conclusions can be made:

***The electric vehicle market is slowly evolving in rural regions.*** This study shows that electric passenger car registrations in 2019 were, on average, the highest in Europe's urban regions. In rural regions, average electric passenger car registration shares, total registrations, and total registrations per capita are lagging behind. Yet, in ten out of the 17 countries assessed, some rural regions exceeded the 2019 European average electric passenger car registration share of 3.6%. This included rural regions in Austria, Denmark, Finland, Germany, Norway, Portugal, Spain, Sweden, Switzerland, and the Netherlands. In Austria, Germany, and Portugal, some rural regions experienced higher electric passenger car registration shares than the national averages. This applied to 33%

46 Politécnico de Leiria, "TeSP of electric and hybrid vehicles", accessed 12 February, 2021, https://www.ipleiria.pt/cursos/course/tesp-de-veiculos-eletricos-e-hibridos/

47 Bad Neustadt Modellstadt Elektromobilität, "Bad Neustadt ist Modellstadt für Elektromobilität. Was heißt das genau? [Bad Neustadt is model city for electromobility. What does that mean?]," accessed 12 February, 2021, https://www.m-e-nes.de/de.html

48 Autohaus, "Electromobility: Award for Renault Vorndran," (7 January, 2015), https://www.autohaus.de/nachrichten/elektromobilitaet-auszeichnung-fuer-renault-vorndran-1661543.html

49 Östersunds kommun, "Klimatstrategi för ett fossilfritt och energieffektivt Östersund 2019-2023 [Climate strategy for a fossil-free and energy-efficient Östersund 2019-2023," accessed 12 February, 2021, https://www.ostersund.se/download/18.73a7c412170befc82eb1f2e/1597991290784/Popul%C3%A4rversion%20klimatstrategin.pdf

of the rural regions in Austria, 32% in Germany, and 31% in Portugal. In countries such as Germany and Spain, a rural region recorded the highest share of new electric passenger car registrations in 2019 with a share of 13.7% and 3.6% of all passenger car registrations, respectively. These trends indicate that electric passenger cars are evolving in some less populated areas beyond major cities.

Several rural regions with high electric passenger car shares have set a 100% electric vehicle stock target, an important step to spur electric vehicle policy measures and make the transition to an all-electric vehicle fleet. Jämtlands (Sweden) and Aust-Agder (Norway) are aiming to convert the vehicle fleet to 100% renewable fuels or electrify the entire transport sector, respectively, by 2030. The region of Zeeuwsch-Vlaanderen in the Netherlands targets a 100% emission-free public transport fleet by 2025, with passenger cars to follow suit by 2035, and all mobility by 2040. The actions in these regions can serve as examples of good practice for other rural regions as they translate their ambitions into policy actions.

***Providing equal access to electric vehicles in rural areas is crucial in the early transition phase.*** Almost two-third of the rural regions across the 17 European countries analyzed can be considered as less wealthy based on their regional GDP per capita. These regions and their population face a higher likelihood of lagging behind in the transition to electric vehicles due to the lower financial capability of their population to acquire a new electric car. Yet, the example of Portugal and its rural regions shows that electric vehicles can succeed despite less favorable economic conditions. All national or regional governments of the nine leading rural electric vehicle markets analyzed provide purchase incentives, tax breaks on registration and for owning a car, or a combination. In 2019, aid amounts were as high as €6,000 in Germany and €5,700 in Sweden in case of a new zero-emission car purchase. Norway offered the highest financial support. The country's 25% Value Added Tax waiver when buying a new BEV can be worth more than €20,000 if purchasing a Tesla model S, the best-selling car in Norway in 2019. In addition, all national governments, with the exception of Switzerland, levied favorable tax breaks on income tax for employees privately using a company car in 2019. Beyond incentives for electric vehicles, Sweden levies high taxes on high-emitting vehicles as part of its bonus-malus tax system, a measure that can help to fund the transition to electric vehicles. The Netherlands is the only of the assessed countries which introduced support for used electric vehicles, issuing a one-time bonus in mid-2020. This is an important measure to guarantee equal access to electric vehicles in rural regions considering that a high proportion of rural regions are less prosperous.

Alternative mobility options, such as public transport or electric shared transportation, are less developed in rural regions compared to urban regions due to generally lower utilization and higher financial cost for operators. Municipal electric carsharing initiatives can be one option for these areas. In Tiroler Unterland (Austria) and Zeeuwsch-Vlaanderen (the Netherlands), electric carsharing initiatives provide an alternative mobility option in the absence of a comprehensive public transport network and beyond car ownership. To fund alternative mobility options such as electric carsharing in rural areas, the aforementioned municipal schemes are supported by EU, national, and state funding or offered by municipal utilities, transport operators, or foundations.

***The extension of charging facilities is key to growing electric car adoption in rural regions.*** The analysis shows the public charging infrastructure network in the majority of the selected leading rural electric vehicle regions is well established. In the leading rural electric vehicle regions of Austria, Germany, Norway, Sweden, and Switzerland, public charging points per 100,000 inhabitants exceed national values by up to more than three times. The governments of Austria, Finland, Germany, Norway, Sweden, and the Netherlands are supporting the extension of the public charging infrastructure network throughout their countries with national funding programs. This is partially matched

with funding by state governments by Tirol in Austria and Bavaria in Germany. Local policy actions in the leading rural electric vehicle regions include the free installation of a public charging point, a common measure in the Netherlands, or free charging, as in some parts of Jämtlands, Sweden. As indicated in some of the region's strategic plans and estimations, future public charging infrastructure needs are predicted to remain high as the electric vehicle market evolves. To fund public charging infrastructure in rural areas, the Netherlands and the region of Zeeuwsch-Vlaanderen provide a good example in how municipalities, network operators, and market parties work together to fund this transition. Co-operations and funding beyond governmental support appears important in the transitions towards electric.

The paper also indicates that commonly a high percentage of the rural population lives in residential buildings with one or two dwellings with potential access to home charging. The national governments of Austria, Finland, and Sweden grant financial aid for home charging facilities and in 2020, the German government also adopted a specific funding scheme. These policies can further help to accelerate the transition towards electric vehicles in rural areas where we find higher motorization rates compared to intermediate or urban regions.

Charging requirements differ in rural compared to intermediate and urban regions due to commonly higher access to home charging and longer distances traveled. The extension of a fast charging infrastructure network along corridors in rural areas can therefore further advance electric vehicle adoption. In the leading rural electric vehicle regions of Norway and Finland, fast charging points make up one quarter to one half of all public charging points, exceeding national percentages. Other leading rural electric vehicle markets in Denmark, Germany, and Switzerland also exceed the share of fast charging compared to national percentages.

Overall, the study shows that due to varying preconditions in less populated areas, there is no policy set that can easily be adopted across all rural regions to speed up the transition to electric vehicles. However, the analysis of leading rural electric vehicle regions indicates that financial incentives to support electric vehicle purchase and use provided by national governments, national and state programs, and local incentives for the extension of the public and private charging infrastructure network can help to expand adoption. In addition, local activities such as community-based electric carsharing initiatives, information, and awareness campaigns can help to spur the electrification of the rural vehicle fleets beyond major cities. The leading rural regions by electric passenger car registrations shares show that a transition to electric vehicles is also possible in less populated, rural regions. Yet, continuous efforts are necessary to guarantee equal access and not leave certain regions and population groups behind.

## Appendix

The following figure and tables provide detailed information on electric vehicle uptake, structural conditions, and policy actions taken in the nine rural regions selected for the analysis.


**Figure A1.** Electric vehicle uptake by territorial typology, regional clusters, and countries.

**Table A1.** Structural framework conditions of the nine rural regions selected for the analysis.

| NUTS 3 region[a] | New electric passenger car registration share, 2019 | Area size[b] | Population[c] | Population density[d] | Largest cities (inhabitants) |
|---|---|---|---|---|---|
| **Aust-Agder, Norway** | 51.5% | 9,158 km² | 118,000 | 14 persons/km² | Arendal (45,000)<br>Grimstad (24,000) |
| **Rhön-Grabfeld, Germany** | 13.7% | 1,022 km² | 80,000 | 78 persons/km² | Bad Neustadt an der Saale (15,000)<br>Bad Königshofen im Grabfeld (6,000) |
| **Jämtlands, Sweden** | 8.9% | 53,752 km² | 130,000 | 3 persons/km² | Östersund (54,000) |
| **Região de Leiria, Portugal** | 7.0% | 2,449 km² | 285,000 | 117 persons/km² | Pombal (17,000)<br>Leiria (15,000)<br>Marinha Grande (11,000) |
| **Zeeuwsch-Vlaanderen, Netherlands** | 6.2% | 877 km² | 105,000 | 142 people/km² | Terneuzen (55,000);<br>Middelburg (50,000) |
| **Graubünden, Switzerland** | 5.5% | 7,105 km² | 198,000 | 28 persons/km² | Chur (38,000)<br>Davos (11,000) |
| **Etelä-Pohjanmaa, Finland** | 5.4% | 13,999 km² | 94,600 | 14 persons/km² | Seinäjoki (63,000)<br>Kurikka (21,000) |
| **Tiroler Unterland, Austria** | 4.9% | 3,973 km² | 260,000 | 65 persons/km² | Kufstein (20,000)<br>Wörgl (14,000)<br>Schwarz (14,000) |
| **Vest- og Sydsjælland, Denmark** | 4.3% | 6,415 km² | 587,000 | 93 persons/km² | Næstved (44,000)<br>Slagelse (34,000)<br>Holbæk (29,000) |

a Area definition valid for the year 2019. Does not take into account territorial reforms in 2020 as applicable e.g., for Norway.

b Eurostat, "Area by NUTS 3 region," (25 August, 2020), https://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=demo_r_d3area&lang=en

c Eurostat, "Population on January 1st by age group, gender and NUTS 3 region," (14 May, 2020), https://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=demo_r_pjangrp3&lang=de

d Eurostat, "How closely do people live together in your region?," (30 April, 2020), https://ec.europa.eu/eurostat/web/products-eurostat-news/-/DDN-20200430-1

**Table A2.** Highlighted electric vehicle promotion actions.

| Policy area | Selected region | Policy description |
|---|---|---|
| **BEV purchase incentives** | Aust-Agder, Norway | The Norwegian government waives 25% Value Added Tax on the purchase price of a BEV or FCEV. |
| **PHEV purchase incentives** | Jämtlands, Sweden | The Swedish government offers a PHEV purchase incentive up to €5,600. |
| **BEV registration tax benefits** | Zeeuwsch-Vlaanderen, Netherlands | In the Netherlands, purchasers of a zero-emission vehicle are exempt from paying registration tax. |
| **PHEV registration tax benefits** | Zeeuwsch-Vlaanderen, Netherlands | In the Netherlands, purchasers of a PHEV pay a reduced registration tax compared to conventional combustion engine cars. |
| **BEV ownership tax benefits** | Rhön-Grabfeld, Germany | The German government waives annual ownership taxes for owners of a BEV or FCEV. |
| **PHEV ownership tax benefits** | Etelä-Pohjanmaa, Finland | In Finland, owners of a PHEV pay lower ownership taxes compared to conventional cars with higher $CO_2$ emissions. |
| **EV company car tax benefits** | Região de Leiria, Portugal | In Portugal, employees pay no additional amounts on personal income tax for privately using a zero-emission company car. |
| **Toll, bridge, or ferry discounts** | Aust-Agder, Norway | In Aust-Agder, drivers of a BEV or FCEV benefit from a 50% discount on the region's toll roads. |
| **Speed limit privileges** | Tiroler Unterland, Austria | In Austria, zero-emission cars registered in the country are allowed to drive 130 km/h in certain sections of the national motorway network while the maximum speed for combustion engine cars is 100 km/h. |
| **EV parking privileges** | Aust-Agder, Norway | In the municipality of Arendal, BEVs and FCEVs park for free in regulated public paid parking spaces in the city center and at the local hospital. |
| **Public charging infrastructure funding programs** | Rhön-Grabfeld, Germany | The state of Bavaria subsidizes 40% of the cost for normal public charging (up to a maximum of € 3,000 per charging point), and 40% of the grid connection cost per location with a share of 40%. |
| **Private charging infrastructure funding programs** | Jämtlands, Sweden | The Swedish government grants private individuals up to 50% or SEK 10,000 (960 Euros) for the hardware and installation of home chargers. |
| **Charging privileges** | Zeeuwsch-Vlaanderen, Netherlands | Municipalities in Zeeuwsch-Vlaanderen offer owners of an electric car installation of a public charging point in their area if they cannot charge at private premises. |
| **Charging infrastructure goals** | Rhön-Grabfeld, Germany | The German government targets 1 million publicly-available charging points across Germany until 2030. |
| **100% electric vehicle stock goal** | Zeeuwsch-Vlaanderen, Netherlands | The district of Zeeuwsch-Vlaanderen aims to have passenger cars drive 100% emission-free by 2035 and public transport be emission free by 2025. |
| **Electric carsharing initiatives** | Tiroler Unterland, Austria | Several municipalities of the Tiroler Unterland benefit from municipal electric carsharing offers. |