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Global Assessment of Charging Infrastructure Deployment

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Summary

We analyze electric vehicle charging infrastructure at the metropolitan-area level across hundreds of major electric vehicle markets across Asia, Europe, and North America. We find a statistically significant link between both Level 2 and direct current fast charging availability and electric vehicle uptake, indicating that public charging infrastructure is a key factor in the development of electric vehicle markets around the world. Even among the world's leading electric vehicle markets, the ratio of electric cars to public charge points varies greatly, as general housing and population density affect the exact relationship.

Keywords: EVSE, infrastructure, market development

1 Introduction

Electric vehicle uptake continues to increase in markets around the world, fueled by falling battery prices and political resolve to encourage cleaner, more sustainable transportation. The initial stages of the transition to electric drive have been made possible by the ubiquity of the electrical grid and the ability for many drivers to charge at home or work. However, as the electric vehicle market grows, so too does the need for a robust public charging infrastructure network.

Public and private stakeholders have already made progress in the early build out of charging infrastructure. Some automakers have begun to directly build out their own charging infrastructure networks, while others have engaged in partnerships with charging providers. Many governments have created programs to encourage the construction of charging infrastructure through subsidies, regulations, and partnerships. Nonetheless, there is relatively little consensus about the optimal concentration and distribution of charging stations.

At this stage, governments, auto industry experts, and researchers around the world have many questions about electric vehicle charging infrastructure. Namely, how much public charging infrastructure is required for a mature market, and what types are likely to be needed in the future as electric vehicle technology continues to evolve? What policy frameworks and funding mechanisms can help to ensure that the necessary charging infrastructure is in place for electric vehicles?

This paper seeks to address these questions with a comprehensive review of the current status of public charging infrastructure in major electric vehicle markets in North America, Europe, and Asia. We assess the relationship between charging infrastructure and electric vehicle uptake at a metropolitan area level. Through this analysis, we identify regional trends in charging infrastructure deployment and provide background on major government programs to increase charging infrastructure.

2 Literature regarding charging infrastructure and electric vehicle uptake

Although charging infrastructure is a major priority for governments looking to accelerate electric vehicle adoption, specific relationships between public charging station availability and increased electric vehicle sales have been elusive. Likewise, there are no universally accepted goals or standards for charging infrastructure density, either on a per capita or per vehicle basis. Nonetheless, several studies in the past few years have provided helpful insights into these questions, as described below.

Sierzchula et al. [1] assessed factors influencing electric vehicle adoption across 30 countries in 2012 at a national level. They concluded that "charging infrastructure was the best predictor of a country's EV market share," although there were notable exceptions to this trend. Using a complex model, Harrison and Thiel [2] considered the impact of several factors, including charging infrastructure, on electric vehicle market share in Europe. This model found that electric vehicle market share increases as electric vehicle per charge point ratio decreases between 25 and 5 electric vehicles per charge point. Slowik and Lutsey [3] conducted an analysis on the 50 most populous metropolitan areas in the United States, breaking down charging infrastructure at a regional level. Overall, the study found a significant relationship between public charging (measured in charge points per capita) and electric vehicle uptake, and identified 275 public charge points per million residents as a benchmark in 2016 for leading U.S. markets. Li et al [4]., analyzed 353 U.S. metropolitan areas and found that electric vehicle sales and charging infrastructure create feedback loops that greatly influence the market. They also concluded that subsidizing charging infrastructure in the early market development stage could be more than twice as effective as similar spending in vehicle subsidies. Harryson, Ulmefors, and Kazlova [5] conducted a review of charging infrastructure and supporting policies in eight countries and concluded that more charging stations would boost electric vehicle uptake in Sweden. Finally, Mersky et al. [6] tested the effects of many policies on BEV uptake in Norway, concluding that charging infrastructure availability was a significant predictor of sales shares in Norway's counties and municipalities.

Therefore, there is significant evidence that public charging infrastructure is important to the growth of the electric vehicle market. However, there has been limited research into how much charging infrastructure is needed for a given market and how strongly charging infrastructure is linked to electric vehicle sales. This may be partially due to issues with data availability: in many markets, there is no comprehensive, up-to-date list of charging points. It may also be due to the quickly evolving state of electric vehicle and charging technology. Although this paper cannot fully answer these questions, we hope to provide greater clarity about the relationship between charging infrastructure and electric vehicle sales in major electric vehicle markets.

3 Summary of government programs to promote public charging infrastructure

Since the introduction of modern electric vehicles, many governments at the local and national level have promoted public electric vehicle charging infrastructure in recognition of the necessity of charging stations for a mature market. Table 1 summarizes some of the prominent national-level programs in major electric vehicle markets. These plans vary widely in scope and focus, attesting to the pace of change in this industry and range of government priorities.

Table 1: Summary of national government programs to promote public charging infrastructure

Country	Program	Budget	Mechanisms of support
China	• State Grid national fast charging corridors • Regional investments by automakers • City government-funded construction in pilot cities		• State-owned utility investment • Public-private partnership • Grants to local governments
France	• Funding distributed to 3,000 cities for 12,000 charge points • EDF power company building nationwide DCFC network		• Local governments apply for grants • Rate-based state-owned utility investment
Germany	• €300 million for 10,000 L2 and 5,000 DCFC stations	€300 million	• Subsidies for 60% of costs for any eligible businesses
Japan	• Next Generation Vehicle Charging Infrastructure Deployment Promotion Project • Nippon Charge Service government-automaker partnership	Up to ¥100 billion (~US $1 billion)	• Grants to local governments and highway operators • Public-private partnership
Netherlands	• "Electric Mobility gets up to speed" incentive program • "Dutch Green Deal" – curbside chargers on request	€9 million €33 million	• Subsidies for charge points in focus areas • Contracts tendered to businesses on project-by-project basis
Norway	• Enova grant scheme from 2009 onwards		• Quarterly calls for proposals for targeted projects
United Kingdom	• Curbside stations for residential areas • Highways England construction of stations at rest stops	£2.5 million £15 million	• Municipalities apply for grants, installers reimbursed • Tenders for hardware, operation by state
United States	• Grants and loan guarantees for public charging stations through Department of Energy and Department of Transportation	$15 million	• Matching grants for local governments, loan guarantees, subsidies to businesses

In addition to the programs listed in Table 1, a number of regional governments have also created innovative programs to construct charging infrastructure. For example, the province of Québec, home to half of Canada's electric vehicle stock, has been active: the Electric Circuit network, operated by public utility Hydro Québec, includes over 870 stations and is in the process of expanding into Ontario. The province also provides support for private home, multi-unit residential, and workplace charging, and is working with neighboring U.S. states to create cross-border fast charging corridors. Three U.S. states (California, Oregon, and Washington) are working together to construct fast-charging networks along major highways.

A review of these programs leads to several lessons that can help to maximize the impact of government investment. Naturally, all recommendations must be tailored to fit local political, geographic, and demographic contexts.

It is important to target specific known charging needs. The problem of charging infrastructure availability is complex and changing quickly, and constructing a charging network that appears comprehensive now may not suit future needs. Therefore, it is usually preferable for a government program (especially on the federal level) to focus on one form of charging infrastructure where there is a clear need, e.g. intercity DC fast charging or curbside residential charging.

Clear, easily accessible information on charging programs helps all stakeholders. This includes posting basic information online, requiring only one or two clicks from the primary electric vehicle informational website. Ideally, the most important provisions of the rule for different actors (such as drivers, local governments, and businesses) would be identified, along with links to similar programs at other levels of government.

Competition among charging providers helps grow the market and identify the leading business models. It is generally accepted that the charging infrastructure industry will eventually shift towards the private sector, as greater electric vehicle sales increase the demand for charge points and the profitability of their operation. In the near term, though incentives are needed, regulators can set the stage for robust private sector leadership by promoting competition and innovation through government programs. This could include holding frequent bids for projects (as in the Netherlands), providing additional subsidies for stations with advanced features, or capping the reimbursable price of stations while mandating certain functionality.

4 Global status of public charging infrastructure

The status of charging infrastructure varies greatly from country to country, as well as from city to city, and comparison among local markets can help to elucidate broader trends within the electric vehicle market. This section will present and analyze data on charging infrastructure in major electric vehicle markets. For each market, we use the best publicly available data for charging infrastructure for the end of 2016 (unless otherwise noted). The data is generally presented in terms of charge points per one million residents in each area to allow comparisons between jurisdictions of different populations. We define a charge point as a single outlet or plug – a charging station may have one or more charge points.

At a national level, availability of public charging infrastructure varies widely, as shown in Figure 1. The global leaders in electric vehicle uptake, Norway and the Netherlands, are also leaders in charge point availability, with far more total charge points per million residents than other countries. While the Netherlands has the most Level 2 charge points per population, Norway has the highest concentration of DC fast charge points per capita. Without adjusting for population, China is the clear leader in absolute numbers of charge points with over 100,000 Level 2 charge points and 38,000 DC fast charge points, followed by the United States (36,000 total charge points), the Netherlands (27,000), Japan (18,000), Germany (12,000), and the United Kingdom (11,000).

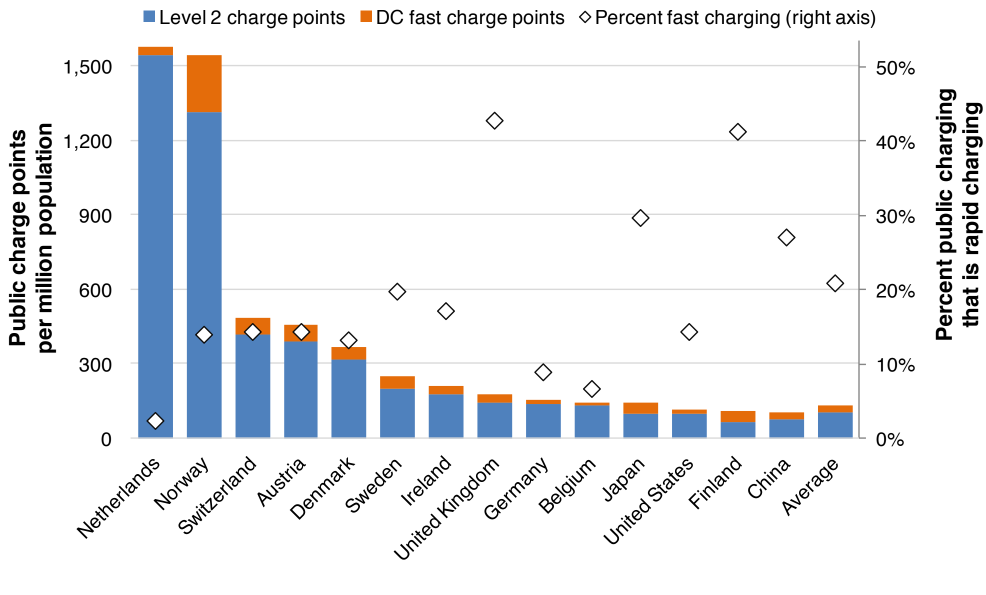

Figure 1: Comparison of electric vehicle charging infrastructure per million population in selected electric vehicle markets around the world

4.1 Metropolitan area-level analysis

Within countries there may be significant variability among cities with regards to electric vehicle uptake and charging infrastructure availability. Furthermore, charging infrastructure is part of a regional ecosystem, where drivers can make use of charging stations in a wide area as they commute and take additional local trips. For these reasons, our primary analysis is focused at a metropolitan area level.

For the following analysis, we include data from 14 countries: Austria, Belgium, Canada (the province of Québec only), China, Denmark, Finland, Ireland, Japan, the Netherlands, Norway, Sweden, Switzerland, the United States, and the United Kingdom. These markets were targeted primarily because they were the highest in electric vehicle uptake, and also because local-level data in these markets were available for both electric vehicle uptake and public charging infrastructure. We estimate that these national markets effectively include about 90% of global electric vehicle sales. The only significant national markets for which we could not find comparable electric vehicle and charging data, and are therefore excluded, are Canada (outside of Québec) and France. In the relationships depicted in Figure 2, Figure 3, and the statistical analysis, we only incorporate metropolitan areas with resident populations of at least 200,000, to remove some of the smaller markets that could have otherwise skewed the results. The data are for 2016, with the exception of China markets, which use some data for 2015 where it is the most recent available data.

Figure 2 illustrates charging infrastructure deployment and electric vehicle uptake in major metropolitan areas around the world. Cumulative electric vehicles registrations (including both BEVs and PHEVs) per million population are plotted on the vertical axis, while public charge points (both Level 2 and DC fast) per million population are plotted on the horizontal axis; the bubble size indicates the number of electric vehicles sold in 2016 in that market (with asterisks indicating 2015 data for select markets in China). Data points are colored according to country. Selected high-electric vehicle uptake markets are labeled.

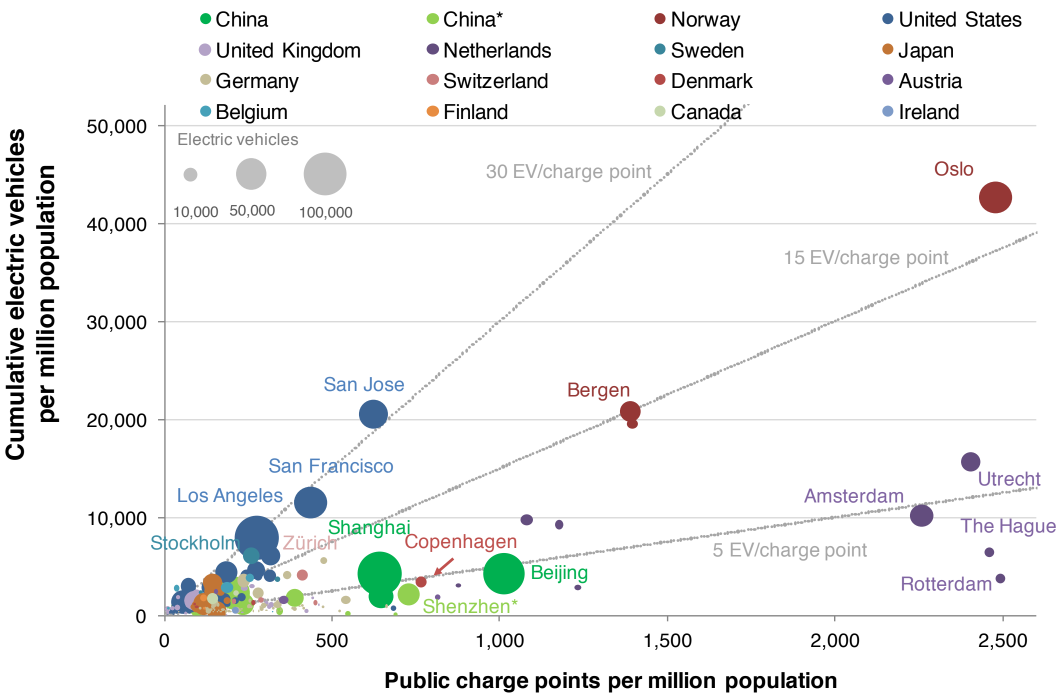

Figure 2: Public charging infrastructure and electric vehicle registrations per million population in metropolitan areas, with size of data points indicating electric vehicle sales volume.

We provide several observations related to Figure 2. As with the above Figure 1 national-level data, the data demonstrate that while there is a rough relationship between electric vehicle uptake and charging infrastructure availability, there is substantial variability across the markets. If the electric vehicle-to-public charger relationship were a clear universal one, the data would line up more along a diagonal line. We overlay three diagonal trend lines within the figure to show three ratios of 30, 15, and 5 electric vehicles per charge point, to help point out how the cities compare. The clustering of most of the data points in the lower left is a clear testament to how early the electric vehicle market development is so far. Most of the markets below 5,000 electric vehicles per million population and less than 400 charge points per million electric vehicles have less than 1% of new vehicle sales that are plug-in electric.

Charging infrastructure and uptake data from the various metropolitan areas within each country show different patterns. The two largest metropolitan areas in Norway, Oslo and Bergen, where about a third of all new vehicle sales were plug-in electric vehicles, each have about 14-17 electric vehicle sales per public charger. The markets in the Netherlands tend to have a lower ratio of electric vehicles per charge point, at 3-6 electric vehicles per charger for the largest electric vehicle markets of Amsterdam, Utrecht, and the Hague. This could be due to the relatively low rate of private garage ownership in these cities. In contrast, the large California markets tend to lie above the other cities with a higher vehicle per charge point ratio, at approximately 25-30 electric vehicles per charge point. This could be due to greater access to private home charging and workplace charging in parts of California. This ratio ranges from 3 to 11 in major cities in China, while these cities typically had the highest percentages of rapid charging.

Over all markets considered in this study, we find an average of approximately 7 electric cars per public charge point. Given the wide variation observed across the markets, including the successful high-uptake markets, it seems clear that this average ratio does not represent a consistent or universal metric for assessing local electric vehicle markets. We further examine this ratio of electric vehicles per point charge point in Section 5 below.

The various electric vehicle markets also vary greatly by their different numbers of Level 2 (normal) and DC fast (rapid) charge points. Figure 3 illustrates these differences, plotting public Level 2 charge points (horizontal axis) and DC fast charge points (vertical axis) per million population for the major metropolitan areas with significant electric vehicle uptake. Again we emphasize that some of the data for China regions (indicated by asterisks) is through 2015 rather than 2016 as for other markets. Selected major markets are labeled. We also overlay three diagonal trend lines to illustrate how the cities compare with respect to 40%, 15%, and 5% of their public charging infrastructure being rapid charging.

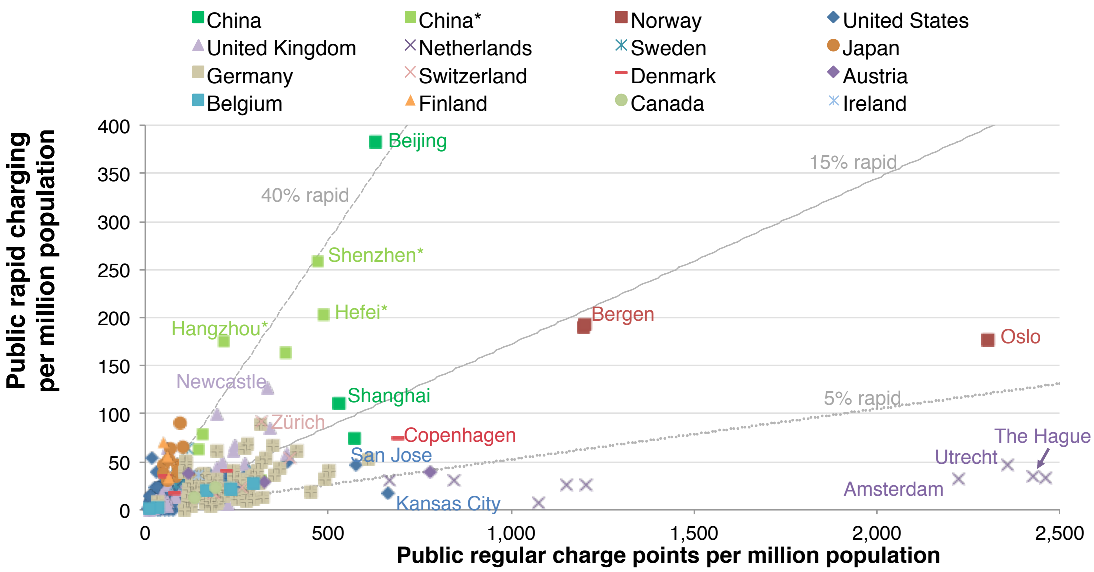

Figure 3: Relative numbers of public Level 2 and DC fast charge points per million population in selected major metropolitan areas.

This data reveals that trends within different markets do not resemble the global average of approximately 20% fast charging, and there appears to be no consistent ratio between Level 2 and fast charge points. The cities in China, to the upper left, tend to have the most, and highest percentage, of fast charge points per million population. Generally, 30% to 40% of the public charging facilities in the China cities was of the rapid charging variety, due at least in part to installations by their major utilities. Cities in the Netherlands generally have high availability of charging overall, but the lowest percentage of rapid charge points at about 2%. The low percentage of fast charge points may reflect the large numbers of curbside charging stations intended for overnight use and the large numbers of plug-in hybrid vehicles lacking fast-charging capability. The highest electric vehicle uptake markets in Norway had high amounts of both regular Level 2 and DC fast charging, and had 6% (Oslo) and 13% (Bergen) of the charging as DC fast charging. The three

U.S. markets with the most electric vehicle sales, Los Angeles, San Francisco, and San Jose, had 7-11% of their charging as DC fast charging.

5 Statistical analysis

As previously noted, public charging infrastructure has often been found to be linked with greater electric vehicle uptake. With the detailed local level data from most major global electric vehicle markets, we sought to test this relationship with a stepwise multiple linear regression to find the best fit among the factors analyzed. In addition to analyzing the link between charging availability and electric vehicle uptake, we sought other data that also might help to partially explain the variation in Figures 2 and 3 above.

Based on the research literature we sought to include housing and demographic data to help control for known major differences across global cities. We were able to collect data on the percent of households that live in multi-unit dwellings, which could serve as a rough proxy for the number of households that are less likely to have their own private parking or garage. In addition, we included population density (residents per land area) in the analysis to account for significant land use and travel pattern differences across the areas. Importantly, we include consumer financial incentives for electric vehicle purchase in the analysis, applying the methodology from Yang et al. [7], considering the strong effect of consumer incentives in other statistical analyses.

The results of this regression are summarized in Table 2 below. The statistical test is for the dependent variable of electric vehicle share of new 2016 vehicle sales, with several different charging, incentive, housing, land use variables as independent variables in different combinations. For the analysis below, we conduct a stepwise multivariate linear regression using StatPlus software to identify the best statistical fits among the factors researched above with electric vehicle uptake. As above we only include metropolitan areas with populations of at least 200,000. For this statistical analysis, we include only a smaller subset of cities for data availability and data quality considerations – metropolitan areas from the United States, Norway, the United Kingdom, the Netherlands, Germany, Denmark, Austria, Finland, Belgium, and Japan were included. The remaining four countries are excluded because we could not find comparable data on housing attributes or electric vehicle incentive policies. The resulting regressions are based on 350 metropolitan areas with populations over 200,000.

We use separate variables for regular Level 2 charging and DC fast to discern whether they were both significant. For the consumer incentives, we include both electric vehicle purchase incentives (tax credits, rebates) and tax incentives (e.g., exemptions from vehicle taxation). As shown in the table, we conducted separate electric vehicle regressions for fully battery electric vehicles (BEV) and plug-in hybrid electric vehicles (PHEV) based on separate data for each type's incentive and uptake. The Table 5 findings indicate the strongest statistical fit among the variables, using an alpha threshold of 0.05. All variables marked with "X" therefore had p-values less than 0.05 and are part of the statistical regression for electric vehicle uptake. For the consumer incentives, we included a weighted incentive between the BEV and PHEV for the general electric vehicle regression. As summarized in the Table 5, we find a significant statistical link between electric vehicle uptake and charging infrastructure, incentives, housing characteristics, and population density (R^2 of 0.78).

Table 2: Summary of results of statistical regression

	Electric vehicle share	BEV share	PHEV share
Level 2 charge points per million population	X	X	X
DC fast charge points per million population	X	X	X
Consumer electric vehicle incentive (weighted	X		
Consumer BEV incentive		X	
Consumer PHEV incentive			X
Percent of households in multi-unit dwellings	X	X	
Population density	X		X
Regression adjusted R-squared	0.78	0.65	0.78

BEV = battery electric vehicle; PHEV = plug-in hybrid electric vehicle; X = significant variable (p-value < 0.05)

Also shown in Table 5, when isolating BEVs and PHEVs the statistical fits are similar, with charging and incentives still significant in each case, but for BEVs the population density was not significant, and PHEVs population density was not significant. In each of these regressions, both Level 2 and DC fast charging are shown to be statistically significant, suggesting they both play a role for electric vehicle drivers. The R^2 values of 0.65-0.78 indicate that there remains substantial unexplained variation in the relationships. This could include the many different national, state, and local policies that affect electric vehicles; model availability; automaker marketing and dealer activities; and other factors that are not analyzed here (e.g., see [3]).

Although it is widely recognized that charging infrastructure will be required to expand the electric vehicle market, there is considerable uncertainty about the precise amount of public charging infrastructure needed to reach a given market penetration. As suggested by the successful early electric markets in the section above, there is no single global answer to this question. It is unlikely that any market has achieved the perfect balance of electric vehicles and charge points, and it would be difficult to know when this is the case. The electric vehicle market and the associated charging infrastructure will grow and coevolve together. The rapid development of the technology means that the situation may be quite different in a few years. Furthermore, local conditions, the availability of private and workplace charging, and the mix of electric vehicle types, could also strongly influence the appropriate level of public charging infrastructure deployment in various markets.

5.1 Ratio between electric vehicles and public charge points

Several organizations have attempted to set benchmarks for the amount of charging infrastructure required to support an electric vehicle market. A notable example is the European Union's directive on the deployment of alternative fuels infrastructure in 2014, which stated that "appropriate average number of recharging points should be equivalent to at least one recharging point per 10 cars, also taking into consideration the type of cars, charging technology and available private recharging points" [8]. The government of China advocates at least one public charging station for every 8 electric cars in their pilot cities and one station per every 15 cars in other cities [9]. The International Energy Agency's Electric Vehicle Initiative calculated a global average of one charge point per every 8 electric cars in 2015 [10], and then per 15 electric cars in 2016 [11]. These ratios help to inform on international trends, but it is not yet clear whether these ratios represent benchmarks for future market development or how useful they might be for national or local decision-makers planning their charging infrastructure to match electric vehicle deployment.

Based on the data presented above, we provide an additional summary chart to explore trends in the electric vehicle-to-public charge point ratio shown in the local data. Figure 4 shows the distribution of electric vehicle sales within the metropolitan areas analyzed here (again only for areas with at least 200,000 residents) according to their electric vehicle-to-charge point ratio. This distribution shows that, within each country, there tends to be some grouping related to the relationship between electric vehicle sales and number of charge points. For example, the ratio in the Netherlands ranges from 0 to 10, while in the United Kingdom it generally ranges from 15 to 25. However, as shown above, this ratio varies by more than a factor of 10 among leading cities worldwide, for example from 1.5 (Rotterdam, Netherlands) to 33 (San Jose, United States). We examined how this ratio has changed from 2014 to 2016 in select markets in the United States, Norway, Sweden, and Germany; in general, the same national relationships shown in Figure 2 and Figure 4 were consistent over this period. With this limited sample of time-series data, we found no clear trend that would indicate that either electric vehicle stock or public charging infrastructure tends to grow at a faster rate or that the ratios are shifting in any clear way.

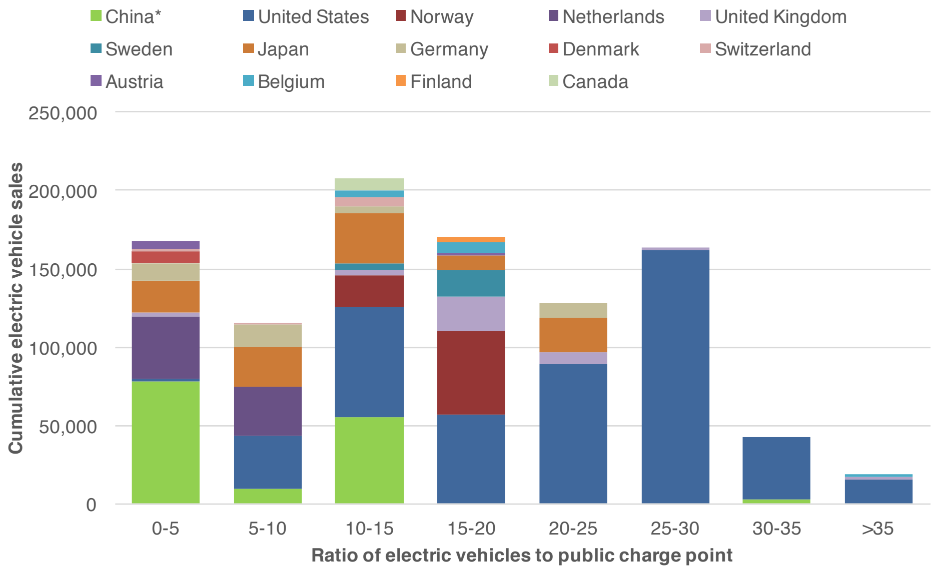

Figure 4: Distribution of cities by ratio of electric vehicles to public charge points.

(2015 data for China markets, 2016 for all other markets)

We note that this global comparison and the above statistical analysis of public charging infrastructure availability at the local level is a novel contribution to the research literature and that there are a number of additions that could strengthen this type of research. Firstly, our study only covers select countries with high electric vehicle uptake. Secondly, some of the data may be incomplete for particular local markets. Integration of privately-held charging point data with the data compiled here may result in more accurate estimates and relationships. Finally, there are many additional factors that influence electric vehicle uptake, such as model availability, income, fuel and electricity costs, and workplace charging availability. Accounting for these variables in a statistical regression may lead to a more accurate estimate of the relationship between charge points and uptake. Certainly, this is a rich area for further research as the market evolves and more data become available.

6 Findings and Conclusions

Based on our analysis of major electric vehicle-uptake markets that make up about 90% of global electric vehicle sales, we find that the availability of public charging is generally linked with electric vehicle uptake. As illustrated in Figure 5, national vehicle markets with higher electric vehicle uptake tend to have more publicly available charging infrastructure. Norway and the Netherlands, which lead the world in electric vehicle sales and stock shares, each have over 1,500 charge points per million population, which is 3 to 13 times higher than most other leading electric vehicle markets. The basic national statistics in the figure show a large variation across the different electric vehicle markets, suggesting that there are key differences among the markets. The figure indicates the need to build charging stations as the market develops, but also shows that there are underlying differences among countries that produce different outcomes.

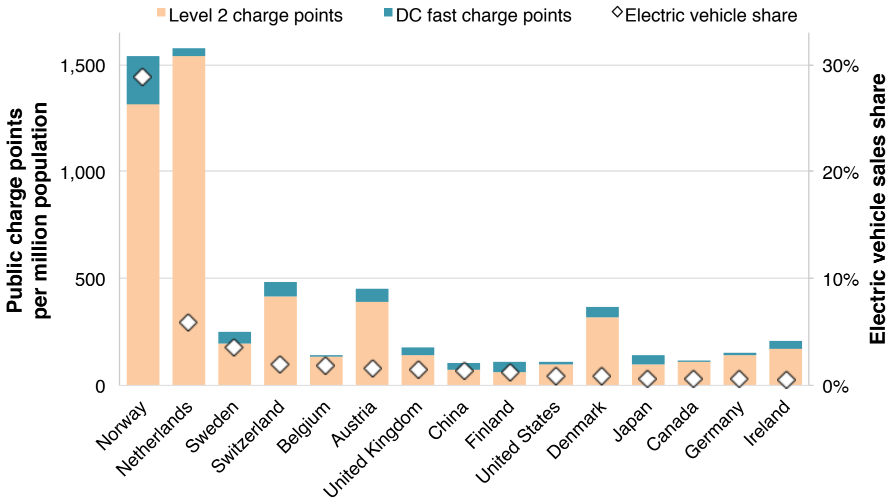

Figure 5: Electric vehicle sales shares and public charge points per million population in major electric vehicle markets.

The variation across national markets led us to analyze the differing local charging infrastructure characteristics, and underlying factors, that have emerged through 2016. When analyzing local-level data, we find that different patterns are emerging among the top global electric vehicle markets. Figure 6 compiles some of the results from this paper's analysis to depict electric vehicle uptake and numbers of public charge points. The figure shows the metropolitan areas with the highest electric vehicle shares in Norway, China, the Netherlands, California, and Sweden. The China data are from 2015 (the latest available data for local level electric vehicles uptake and charging infrastructure), while the others are for 2016. These markets are among the highest electric vehicle shares among major metropolitan areas around the world, with electric vehicle shares from 3% in Gothenburg up to 36% in Bergen. To give a sense of the scale of these markets, cumulative electric vehicle sales in Oslo, Shanghai, Beijing, San Francisco, and Los Angeles each number over 50,000.

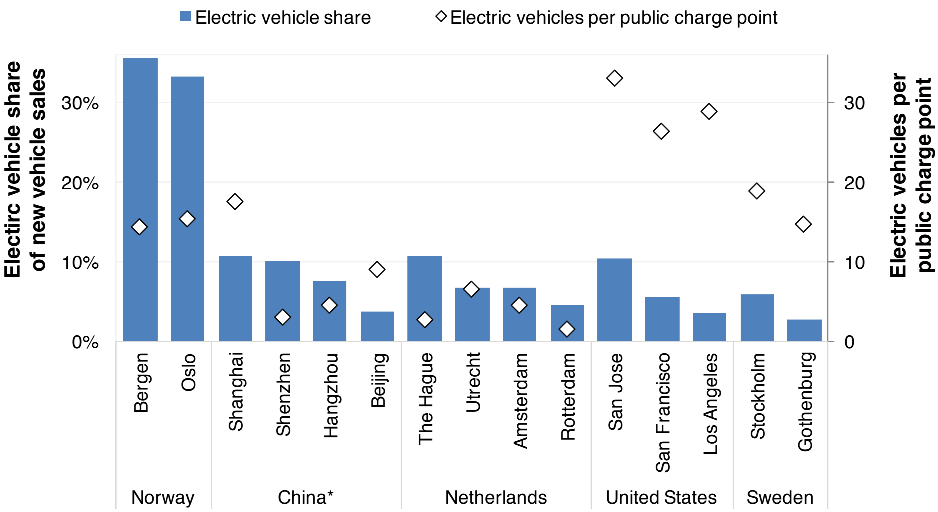

Figure 6: Electric vehicle share of new vehicle sales and public charge points per electric vehicle in major electric vehicle markets.

Based on these findings, it is difficult to provide definitive, universal conclusions about such a quickly moving industry with so many differences across the various markets. However, we do offer several high-level conclusions on the status of charging infrastructure and exemplary practices that help point toward the path forward.

Certain regions and metropolitan areas typically lead in both electric vehicle uptake and charging infrastructure availability. We identify an average of one charge point for every 7 electric vehicles, with about 1 in every 5 charge points a DC fast charger. However, as shown in Figure 6, the electric vehicle-to-charge point ratio varies by a factor of 10 even among the leading global markets. This variability may stem from the differing roles of public charging in different city contexts. For example, in the Netherlands cases, public charging appears to effectively take a role that is more like residential or workplace chargers elsewhere. In other cases, more often in California, public charging supplements home and workplace charging.

Even through there is no simple benchmark or global thresholds for required charging, we do find that public charging infrastructure is a key to growing the electric vehicle market. This work corroborates other research that indicates the importance of developing charging infrastructure in unison with electric vehicle deployment. In our analysis, both standard and direct current fast charging infrastructure are statistically linked to electric vehicle uptake, as are consumer purchase incentives and factors like population density and the prevalence of multi-unit dwellings. The leading electric vehicle markets of Norway and the Netherlands have more than ten times as many public charge points per capita than average markets, and leading markets such as California and China had 3 to 5 times the average. However, there is also significant unexplained variability in our statistical analysis that goes beyond charging infrastructure availability. As routinely indicated in other studies, consumer incentives, vehicle policy, and consumer awareness campaigns are also key components to develop electric vehicle markets. Although there is no single ideal global ratio or benchmark for charging, comparisons of similar markets still offer an instructive way to understand where and how charging is relatively insufficient.

Multi-faceted and collaborative approaches have been most successful in promoting early charging infrastructure buildout. Governments at the local, regional, and national levels around the world have employed varied strategies to promote public and private charging infrastructure. In leading markets, programs have engaged many stakeholders by integrating driver feedback, distributing funding to local governments, creating public-private partnerships, and consulting with utilities to minimize grid impacts and limit costs. To address changing needs in this growing market, leading governments have created and provided consistent funding for separate programs to target several difficult market segments, such as curbside charging stations, multi-unit dwellings, and inter-city fast charging stations. In all cases, it is important to make programs transparent and easily accessible for electric vehicle owners and industry stakeholders.

As with the broader electric vehicle market, charging infrastructure is changing quickly. Nonetheless, it is important that governments and the private sector coordinate their deployment activities to ensure that convenient, affordable, and reliable public charging infrastructure is available to all electric vehicle drivers. There is still more work to do, but cities, national governments, public utilities, and the private sector are making great strides towards a robust charging infrastructure network is in place, setting the foundation for the transition to electric mobility.

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Dr. Nic Lutsey directs the ICCT’s electric vehicle and fuels work and co-leads its U.S. activities. Nic manages the ICCT’s role as the Secretariat for the International Zero-Emission Vehicle Alliance. He has co-authored 19 peer-reviewed journal articles and dozens of reports on technology potential, regulatory design, and policy cost-effectiveness. In 2015, he received the SAE International Barry D. McNutt Award for Excellence in Automotive Policy Analysis. Previously, with the California Air Resources Board, he participated in the regulatory development of the 2004 and 2012 greenhouse gas emission regulations for automobiles. He received a B.S. in Agricultural and Biological Engineering from Cornell University and a Ph.D. in Transportation Technology and Policy from the University of California, Davis.