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What is Driving the U.S. Electric Vehicle Market?

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Summary

We conduct a detailed metropolitan area-level analysis to assess the drivers for the electric vehicle market in the U.S. We catalogue information on 43 unique promotion activities, consumer incentives, and charging infrastructure to analyze their association with electric vehicle adoption across metropolitan areas in 2016. Several California areas, Seattle, and Portland are the leading U.S. markets, with 2% to 10% of new sales are plug-in electric vehicles. We find that electric vehicle uptake is significantly linked with incentives, public and workplace charging, model availability, carpool lane access, and city activities. We highlight exemplary such policies and programs.

1 Introduction

The global electric vehicle market continues its steady early growth, reaching over 500,000 sales in 2015 and over 750,000 sales in 2016 [1]. Although the global electric vehicle market is 1% of total new vehicle sales, the electric vehicle market is beginning to move beyond the early adopters of the new technology in some markets. For example, local markets in California, Norway, the Netherlands, and China have seen electric vehicle sales shares surpass 5%, 10%, and even 30%, of new car sales [2].

The early and varied electric vehicle market development across the world provides an opportunity to understand what differentiates early leading markets from others. The consumer barriers to the widespread adoption of electric vehicles are complex, including cost, charging convenience, and information. Actions by governments, businesses, and non-profit organizations can help break down such barriers with a series of incentives, regulations, infrastructure, and education campaigns. The large variation of electric vehicle policy and market development across the U.S. makes for an especially rich laboratory for analysis.

The U.S. market represents over a quarter of global electric vehicles sales through 2016 and represents about 17 million automobile sales her year, making the U.S. market second only to China in both respects. The national U.S. electric vehicle market has remained below 1%, and annual sales increased from 115,000 in 2015 to 158,000 in 2016 [3]. Within the U.S. market, California cities have tended to dominate the early market growth, but other markets, including in Georgia, Oregon, Washington, and Colorado have showed major relative growth due to their underlying and diverse support policies [4,5,6,7,8].

This work provides a fresh analysis with updated 2016 data on the U.S. market and a more detailed characterization of the local actions in place to support electric vehicles. The paper describes its data and methods in Section 2, presents the analysis of the various electric vehicle drivers in Section 3, summarizes the statistical analysis of the drivers in Section 4, and provides final conclusions in Section 5.

2 Methodology and data sources

In this research, we assess the relationship between promotion actions and the electric vehicle market. As an initial step, we catalogue the state, city, and electric power utility actions in place to promote electric vehicles. Then we procure data and analyze the electric vehicle market across the U.S. To capture the major markets and broader regions within which people travel and commute, we analyze at the metropolitan area level, which typically includes one (or more) major urban cities and each of the surrounding counties.

For the scope of the analysis, we assess the electric vehicle market across metropolitan areas in the U.S. We focus the analysis primarily on the 50 most populous areas, each of which has over 1.1 million residents and that combined represent 81% of U.S. electric vehicle sales, due to our greater ability to assess local electric vehicle promotion actions in these 50 areas. We also provide some additional analysis for the 200 most populous areas, which represent about 94% of U.S. electric vehicle sales.

To understand the full array of activities underway across local electric vehicle markets, we research state, city, and electric power utility actions for the 50 most populous U.S. areas. In our previous work (see [6]) we analyzed 33 such action areas in 2015. Table 1 shows the updated listing of the 43 electric vehicle actions we catalogued according to their implementation in 2016. In addition, the table provides example programs in place in across states, cities, and utilities.

In addition to identifying which of the 43 electric vehicle promotion activities are in place, we analyze the public electric vehicle-charging infrastructure that is available, across 50 U.S. metropolitan areas. This analysis includes an evaluation of the quantity and type of publically available charging infrastructure, and an indexing of charging infrastructure per population and per vehicle population to normalize the relative charging network. We also include availability of workplace charging. Furthermore, we include a direct monetary quantification of consumer incentives for electric vehicles, which include purchase, operation, and parking incentives, as well as access to high-occupancy vehicle (HOV) lanes. Purchase incentives are available in about 10 states and typically range from $1,000 to $2,500 per electric vehicle. Federal consumer tax credits are also available for new electric vehicle purchases, but are not analyzed in this assessment of differences in local uptake, as they apply equally across all markets.

We analyze the electric vehicle market data in several ways. Starting with vehicle registration data from IHS Automotive at the metropolitan area level, we evaluate the share of new vehicles that are plug-in electric for all the U.S. metropolitan areas. Also from the IHS registration dataset, we estimate the availability of electric vehicle models for sale across the markets.

Table 1: State, local, utility electric vehicle promotion actions catalogued for U.S. metropolitan areas

Level	Action	Example program
State	State ZEV program	• California - Zero Emission Vehicle Program
	State International ZEV Alliance participation	• Multiple - Zero Emission Vehicle Alliance
	State low carbon fuel policy	• California - Low Carbon Fuel Standard
	State BEV purchase incentive	• Colorado - Innovative Motor Vehicle Tax Credit
	State PHEV purchase incentive	• Massachusetts - MOR-EV
	State increased BEV incentive for low-income	• California - Clean Vehicle Rebate
	State increased PHEV incentive for low-income	• California - Clean Vehicle Rebate
	State fee reduction or testing exemption	• Arizona – Reduced Vehicle License Tax
	No state annual electric vehicle fee	• California – Zero-emission vehicle fee beginning 2020
	State private charger incentive, support	• Missouri – Alternative Fuel Infrastructure Tax Credit
	State public charger promotion	• Ohio – Alternative Fuels Transportation Program
	State parking benefit	• Hawaii - Free Parking for Electric Vehicles
	State fleet purchasing incentive	• Massachusetts - Electric Vehicle Incentive Program: Fleets
	State manufacturing incentive	• California – Sales and Use Tax Exclusion Program
	State allows direct sales to consumers	• Maryland - House Bill 235
Local	City electric vehicle strategy	• Portland, Oregon – 2017 City of Portland Electric Vehicle Strategy
	Streamlined EVSE permitting process	• Chicago, Illinois – Drive Electric Chicago
	EV-ready building code	• Denver, Colorado – Municipal building code
	City vehicle purchase subsidy	• Riverside, California – Alternative Fuel Vehicle Rebate Program
	City parking benefit	• Cincinnati, Ohio - Free Parking for All-Electric Vehicles
	City EVSE incentive, support	• Washington, DC – Alternative fuel infrastructure credit
	City carpool lane (HOV) access	• Nashville, Tennessee – HOV Smart Pass
	City-owned EV chargers	• Raleigh, North Carolina – Electric Vehicle Charging Stations
	US DOE EV Project key area	• Multiple – The EV Project
	Workplace charging	• Multiple – Workplace Charging Challenge Progress Update 2016
	City car sharing program link	• Indianapolis, Indiana - BlueIndy
	City informational materials	• Chicago, Illinois – Drive Electric Chicago
	City outreach events	• New Orleans, Louisiana – National Drive Electric Week
	City outreach events in low-income communities	• Watts, California – National Drive Electric Week
	City green fleet target	• Milwaukee, Wisconsin – Smart Fleet
	City electric vehicle fleet target	• New York, New York – OneNYC
	City use of electric buses in public transportation	• Louisville, Kentucky – Transit Authority of River City
Utility	Utility charging pilot or other research	• Birmingham, Alabama – Alabama Power Electric Transportation
	Utility public charging infrastructure	• Kansas City, Missouri – Clean Charge Network
	Utility public charging infrastructure in low-income communities	• San Diego, California – SDG&E to install thousands of EV chargers
	Utility time of use rates offered	• Detroit, Michigan – DTE Energy Rate Options
	Utility preferential EV rates	• Atlanta, Georgia – Georgia Power Plug-in Electric Vehicle Rate
	Utility EV or EVSE incentive, support	• Austin, Texas – Austin Energy – Plug-in Austin
	Utility increased incentives for EVSE at multifamily properties	• Austin, Texas – Austin Energy – Multifamily Properties
	Utility info materials or outreach events	• Baltimore, Maryland – Baltimore Gas and Electric – Electric Vehicles
	Utility EVSE informational materials for multifamily properties	• Seattle, Washington – EV service equipment for multi-family housing
	Utility cost comparison tool	• Dallas, Texas – Oncor – EV Savings Calculator
	Utility electric vehicle fleet	• San Francisco, California – PG&E to Step Up Addition of EVs

Figure 1 illustrates the share of new vehicle registrations that are plug-in electric across U.S. metropolitan areas. The 50 most populous metropolitan areas that are the primary focus of this analysis are labeled. Electric vehicle shares tend to be highest in the major west coast markets. The San Jose area had the highest share at 10%, followed by other California areas at 4% to 6%. The top markets in Colorado, Hawaii, Oregon, Vermont, and Washington had 2% to 4% to lead in other regions. Overall the share of new vehicles that are plug-in electric in these 50 areas is 1.2%, about three times higher than the rest of the United States.

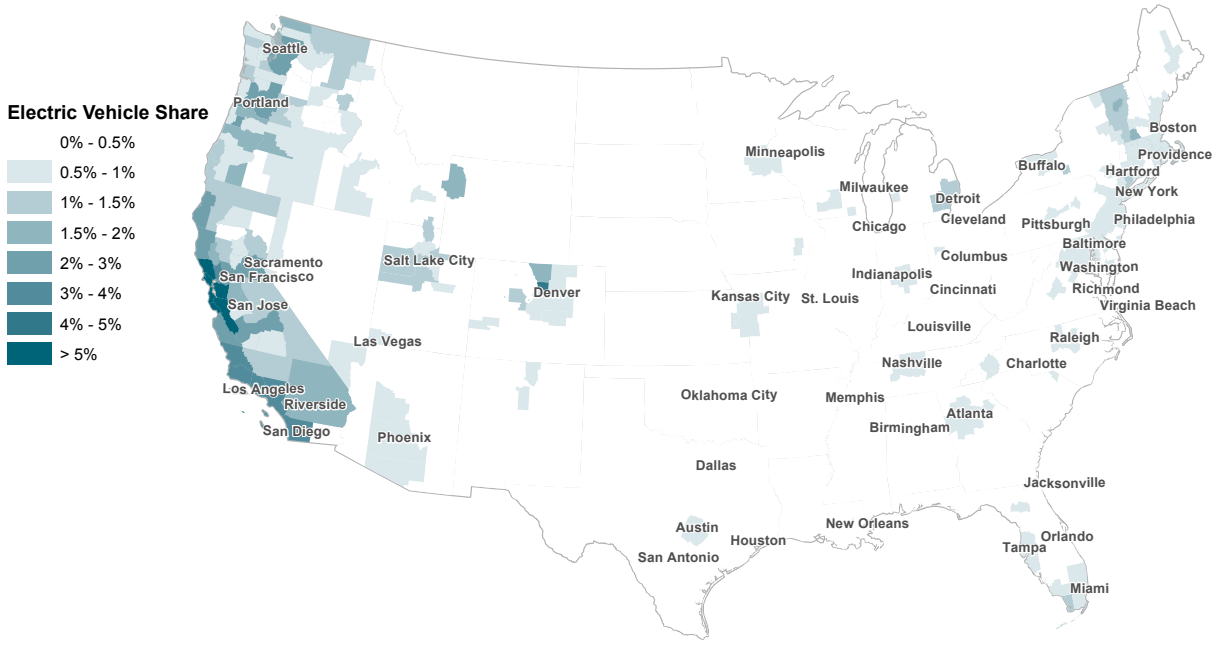

Figure 1: Electric vehicle share of new 2016 vehicle registrations by metropolitan area (new vehicle registration data from IHS Automotive)

To conduct the analysis, hundreds of information sources were collected, reviewed, and analyzed to create a database of the known city, state, and electric power utility actions to promote electric vehicles. The database was first constructed for calendar year 2013 state data [4], then added 2014 local data [5], then updated for 2015 data including increased coverage of more local promotion activities [6]. This paper provides further updates for calendar year 2016, for which additional details on references are available [9].

3 Analysis of drivers

Based on the detailed electric vehicle data at the U.S. metropolitan area level, we assess the link between support actions like consumer incentives, local policy actions, and public charging infrastructure across U.S. markets. This section describes key underlying factors and depicts their relationship with electric vehicle uptake. The subsections are broken down into descriptions of the availability of electric vehicle models, quantifiable value of the consumer incentives, the discrete local policy actions in place, and the charging infrastructure availability.

3.1 Electric vehicle model availability

The availability of a range of electric vehicle models is a key factor for the broader adoption of electric vehicles (e.g. see [10]). Electric vehicle model availability tends to be much lower outside of California [6,11,12]. Since 2012, when there were just several smaller car models on the market, the electric vehicle offerings have greatly expanded. Although the number of non-electric models is in the hundreds, the proliferation of electric models is greatly expanding the market to more prospective customers. As of 2016, there were a variety of available electric vehicle models including smaller cars and hatchbacks (e.g., Smart ForTwo, Fiat 500e, Nissan Leaf), midsize and luxury cars (e.g., Audi A3, BMW i3, Ford Fusion Energi), luxury sport utility vehicles (e.g., Tesla Model X, BMW x40e), and now a minivan (Chrysler Pacifica).

Figure 2 shows the number of available models (bar chart, left axis), electric vehicle share (line, right axis) across the 50 most populous metropolitan areas. The order of the chart is set according to the highest electric vehicle uptake, with San Jose at 10% electric vehicle sales furthest to the left. We analyze model availability as the number of electric models that had at least 20 new registrations in 2016, in order to better distinguish models that were available beyond a few select showroom models with low annual sales. As shown, areas with high adoption, tended to have many available electric models. In addition, the five

leading electric vehicle markets by sales volume, representing nearly half of all 2016 U.S. electric vehicle sales, were also the leading markets in terms of model availability with at least 24 available models.

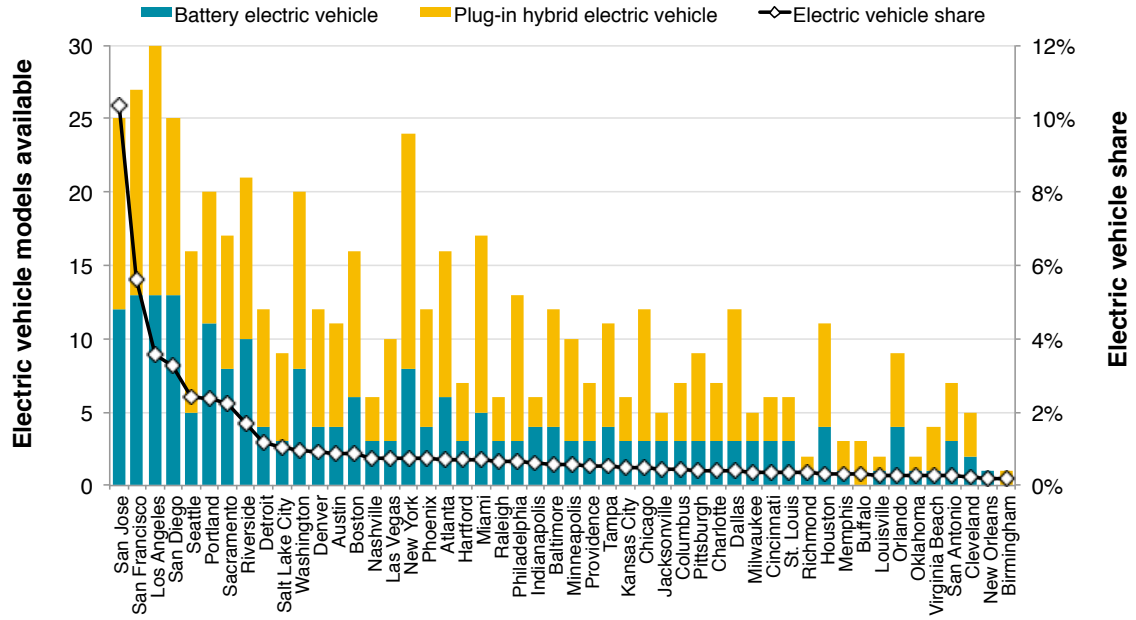

Figure 2: Electric vehicle share of new vehicles and model availability for 50 most populous U.S. metropolitan areas

Also shown in Figure 2, each of the areas with more than 2% uptake (over twice the national average) had 16 or more models available in 2016. Uptake in Portland, San Diego, Los Angeles, San Francisco, and San Jose was between 2.5 times (Portland) and 11 times (San Jose) the national average. Many models were also available in New York City and Washington, D.C., and both are relatively strong electric vehicle markets in sales. As compared to 2015, 43 of the 50 most populous metropolitan areas saw an increase in model availability. The average increase across the 50 cities was about 3 electric vehicle models.

Analyzing across the 200 most populous areas, we find model availability generally quite low across most of the U.S. Based on the 20-electric-vehicle model threshold, 88% of the 200 most populous metropolitan areas had no more than 10 electric vehicle models available to consumers. In terms of population in these areas, about half (48%) of the population was in an area that had 10 or fewer models available in 2016. As shown above, prospective consumers in markets with high electric vehicle uptake had about 2-3 times this availability. Many cities had 5 or fewer models available.

3.2 Electric vehicle consumer incentives

Consumer incentives to promote the adoption of electric vehicles are in place in many U.S. states. Consumer incentives include purchase, operation, and parking incentives, as well as access to high-occupancy vehicle (HOV) lanes. Consumer incentives help overcome key cost and convenience barriers and help to accelerate the early electric vehicle market while technology costs fall and consumers become familiar with the technology. Numerous studies have identified that purchase and other consumer incentives are linked with electric vehicle uptake [4-6,13-17]. Many governments offer one or more consumer incentives, typically with the goals of accelerating the early electric vehicle market, reducing petroleum use, enabling consumer fuel savings, improving local air quality, and reducing climate pollution.

State incentives such as rebates, tax credits, or substantial tax exemptions for the purchase or lease of an electric vehicle were available in 18 of the 50 metropolitan areas in this study. The value of state incentives typically ranges from $1,000 (Utah) to up to $6,000 Colorado). Some of the rebates come and go through the year, depending on state funding availability and political changes. Purchase incentives from local governments are less common and typically of lesser value than state incentives; of the cities in this study, a $500 rebate was available in Riverside, and city and county tax exemptions are available in Seattle. Some states have implemented additional annual fees for electric vehicles, resulting in a disincentive in 9

metropolitan areas, for example in Denver, Colorado; Atlanta, Georgia; and Seattle, Washington. A handful of other states have recently been considering similar legislation [18]. Other research concludes that improved vehicle efficiency has a far greater effect on overall tax revenues than electric vehicles [10,19].

Other perks are also included in our analysis. The use of high-occupancy vehicle (HOV) lanes for eligible electric vehicles provides a major incentive in many markets were there is high congestion during commute times. We estimate the value of HOV access based on previous methodology using applicable data on congestion and available lane miles where the HOV lanes allow electric vehicles [4,20]. Our valuation of HOV access also increased. We estimate that areas where HOV lanes have the highest six-year ownership value are Raleigh, Nashville, San Francisco, Los Angeles, and San Jose (ranging from $1,950 in Raleigh to $3,350 in San Jose). Also, vehicle operation incentives were available in 24 of the 50 metropolitan areas in 2016, including reductions in in-state fees (5 areas) and inspections (23 areas).

A range of state and local electric vehicle parking policies exist that provide benefits to electric vehicle drivers. Two states, Nevada and Hawaii, offer free parking for electric vehicles at eligible parking locations that are metered. Similarly, three cities (Cincinnati, Salt Lake, San Jose) provide free parking at all city parking meters and a limited number of participating garages. Applying our previous methodology [4], we estimate the six-year value of parking incentives. Other examples of local parking support include designated parking for electric vehicles; for example, New York City's 2014 policy requires 25% of new parking be electric-vehicle ready with the proper wiring and panel capacity to handle electric vehicle charging. As a co-benefit to promoting electric vehicles, such policies help to avoid timely and costly retrofits at a future date, estimated at up to nearly $7,000 per charging station [21].

The financial and nonfinancial incentives support electric vehicle market growth by lowering upfront cost barriers and by providing additional convenience during their use. Figure 3 shows the value of consumer incentives (vertical bars, right-axis) across the 50 cities. Also shown is the electric vehicle uptake in 2016 (black line, left-axis). The 50 cities are ordered from left to right based on highest electric vehicle uptake. As shown, incentives include state purchase incentives, city purchase incentives, the estimated value of HOV lane access, and "other" incentives, which include exemptions from state and local fees and emissions inspections. Also shown are additional electric vehicle fees, which generally come in the form of state annual license fees. The incentive values shown are the average of full battery electric and plug-in-hybrid incentives in each area. Incentives and fees that occur for future years after the point of sale are included based on a six-year vehicle ownership period with a 5% annual discount rate.

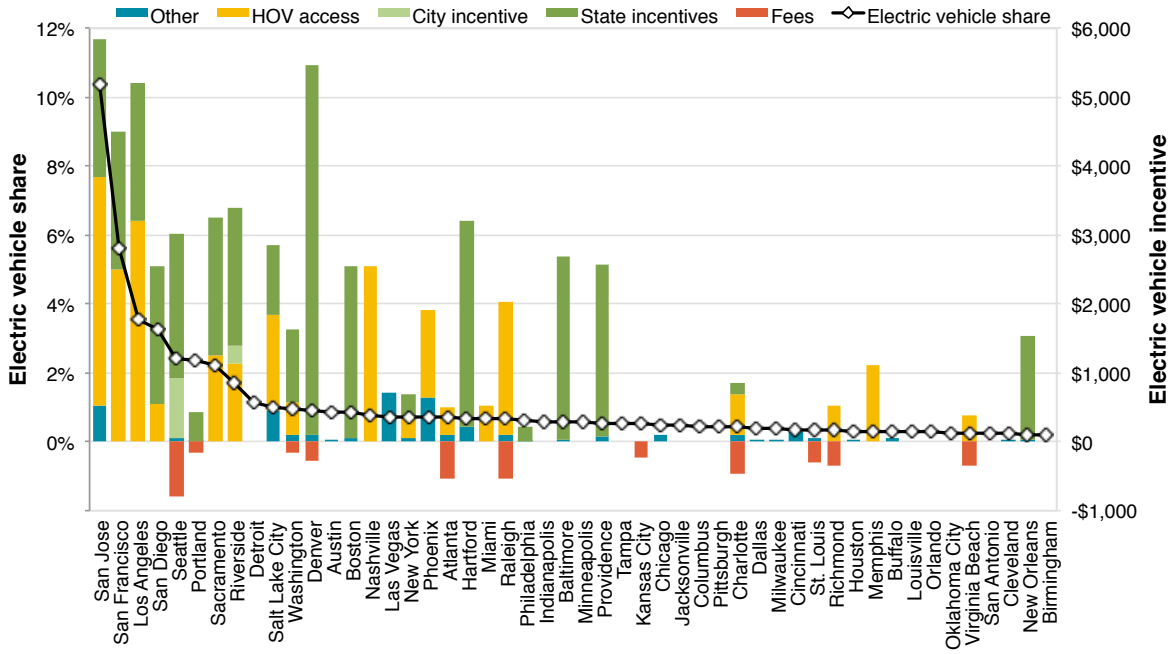

Figure 3: Electric vehicle share of new vehicles and available consumer incentives for 50 most populous U.S. metropolitan areas

The figure shows how most of the areas with high electric vehicle uptake have substantial incentives. For example, electric vehicle drivers in the California cities, Salt Lake City, and Washington D.C. can benefit from incentives and HOV access. Those in Denver can receive purchase incentives, and those in Seattle receive state and city tax credits. There are also other examples with relatively high incentives but low uptake (e.g., Baltimore, Providence, New Orleans), showing that other actions are also important.

The Atlanta case demonstrates the importance of incentives. Through mid 2015 Georgia offered an incentive that was generally valued at $5,000. In 2014, the electric vehicle share in Atlanta was 3.5%, more than four times the national average. Since the suspension of the incentive (and the introduction of a $200 annual fee for electric vehicles), electric vehicle sales have fallen to below the national average of 0.9%.

Counter examples of areas with low incentives and relatively high uptake tend to have several other electric vehicle promotion actions in place to support the market. Electric vehicle drivers in the Portland area, for example, benefit from a broad array of local and utility actions, active outreach and awareness programs, and extensive charging infrastructure. Detroit is another example with relatively high uptake but low incentives. Nearly 95% of the area's electric vehicle registrations in 2016 were PHEVs. Although there is generally a lack of incentives or other promotions there, model availability in the Detroit area is high, and individuals employed by the auto industry benefit from greater awareness and potentially also from employee purchase discounts [7].

3.3 Local policy actions to promote electric vehicles

A comprehensive package of policy and promotion actions by state, local, utility, and other private stakeholders is a key for developing the electric vehicle market [5,6]. Table 1 above lists the actions that we assessed in this work and more details are shown in [9]. We explore the relationship between number of actions and electric vehicle uptake below.

Figure 4 displays the number of state, city, and utility promotion actions in each of the 50 markets (vertical bars, right-axis) as well as the electric vehicle share (black line, left-axis). The areas are ordered from left to right by highest share. As shown in the figure, the eight areas with the highest uptake have adopted 24-36 electric vehicle promotion actions. These areas tend to have a strong mix of state, city, and utility actions. Markets with the lowest uptake tend to have 15 or fewer actions.

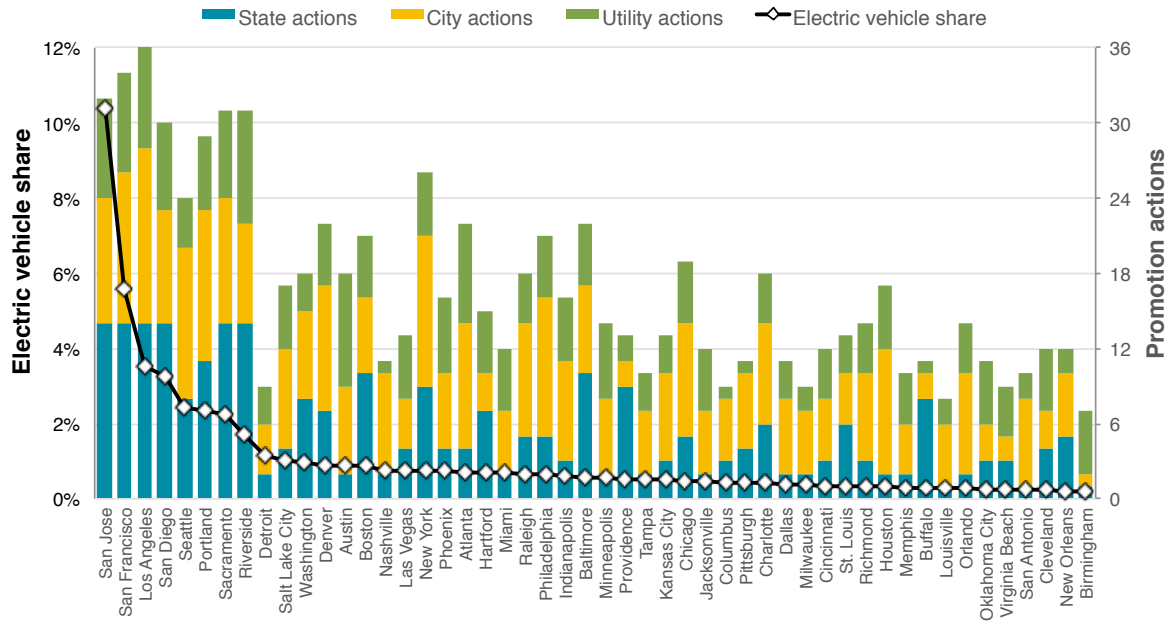

Figure 4: Electric vehicle share of new vehicles and state, city, and utility promotion actions for 50 most populous U.S. metropolitan areas

The relative breakdown of actions in the figure helps to show where markets have a relatively complete, or relatively lacking, portfolio of actions. Areas with the greatest number of city actions include several California cities, Portland, Seattle, New York City, and Philadelphia. Austin has an especially active utility but promotion actions at the state level are generally lacking. State electric vehicle promotion actions are very limited in Michigan, Tennessee, Texas, and Florida. Areas where there are several local actions in place such as Austin, Nashville, Houston, and Orlando, could benefit from greater state support. Utility involvement appears to be limited in Detroit, Nashville, Columbus, Pittsburgh, and Buffalo.

3.4 Electric vehicle charging infrastructure availability

Availability of charging infrastructure at home, the workplace, and at public locations can support the adoption of electric vehicles by helping to overcome range and inconvenience barriers. Drivers of electric vehicles in the United States primarily charge at home, followed by the workplace and public stations [22]. A more extensive charging infrastructure network can increase driver confidence in the vehicle's range and expand the vehicle's operating functionality [10]. Deployment of charging infrastructure can also offer supplemental benefits by increasing visibility and general awareness of the technology.

Multiple studies highlight the importance of home charging [10,23,24]. Workplace charging has been identified as statistically linked with electric vehicle adoption [6,17]. Furthermore, workplace charging has been reported as the most effective non-residential charging investment for increasing electric vehicle adoption [17]. Similarly, the availability of public charging infrastructure is widely considered a key factor to encourage electric vehicle uptake [5,6,8,25,26,27]. Action by governments, utilities, and industry are significantly increasing the charging infrastructure network. Government and utility support includes direct deployment, financial incentives for residential or commercial infrastructure, expedited permitting, and electric-vehicle ready building codes.

We analyze the public and workplace charging infrastructure data from the U.S. Department of Energy Alternative Fuel Data Center and U.S. DOE Workplace Charging Challenge, respectively [28, 29]. Figure 5 shows the public charging availability per million population (horizontal axis) and the corresponding electric vehicle uptake (vertical axis) in the 50 most populous metropolitan areas. The charging data include public direct current (DC) fast charging and Level 2. The sizes of the circles represent the 2016 electric vehicle market size in each area; the largest data circle is Los Angeles with over 30,000 new electric vehicle registrations in 2016. The U.S. average is about 0.9% electric vehicle uptake and 110 public charge points per million population, and the 50 metropolitan area averages are 1.2% electric vehicle share and 140 charge points per million.

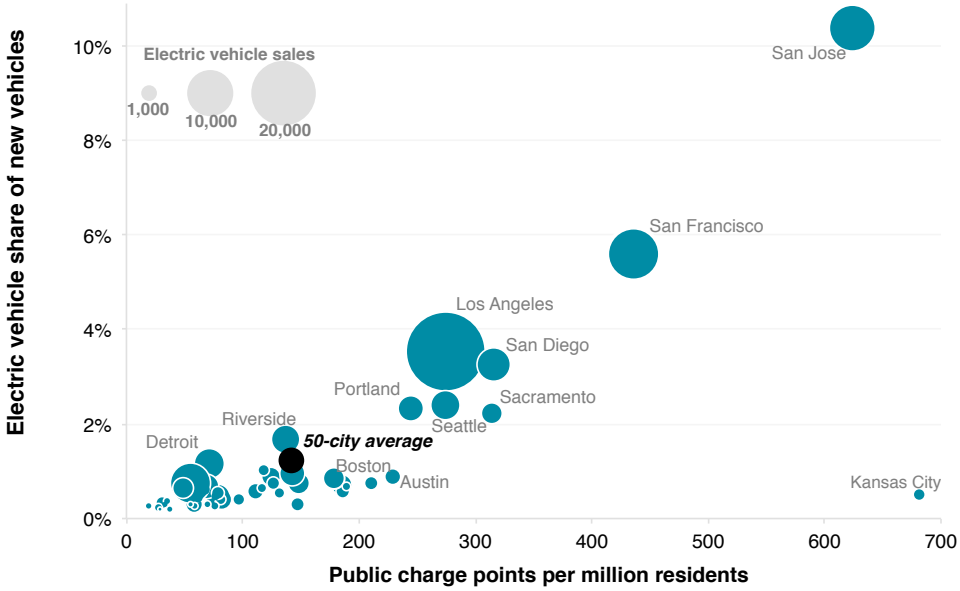

Figure 5: Electric vehicle share of new vehicle sales (vertical axis), public charge points (horizontal axis), and 2016 electric vehicle sales (circle size), for 50 most populous U.S. metropolitan areas

As shown, many areas with the highest electric vehicle shares also had relatively high deployment of public charging infrastructure. Of the 20 areas with the highest electric vehicle shares, 18 had greater-than-average charging availability. Six of the 10 areas with the highest electric vehicle shares had public charging infrastructure availability that was over three-times the national average. Averaging across the 50 metropolitan areas, DC fast accounts for approximately 11% of the total public charging infrastructure; however, the deployment of DC fast and Level 2 charging stations varies greatly across the areas. Although not shown in Figure 5, workplace charging is another metric that separates the U.S. metropolitan areas. Based on limited available data, San Jose had much greater workplace charging availability, with over 1700 charge points, or at least 900 charge points per million population. Other areas with relatively high workplace charging are Detroit, San Francisco, Los Angeles, and Portland.

4 Statistical analysis of drivers and electric vehicle uptake

This section provides a statistical analysis to discern links between the potential electric vehicle market drivers analyzed above and electric vehicle uptake. The statistical analysis is based on the 200 most populous metropolitan areas, where data are available, as well as on the 50 most populous metropolitan areas, for which we have more detailed local data. The 50-area analysis includes additional variables of workplace charging, HOV lane access, and local electric vehicle promotion actions.

The results from the stepwise multivariate statistical analysis are summarized in Table 2, showing relationships between the variables to discern the strongest fits at both the 200- and 50-metropolitan areas level. We report four statistically significant fits, and each column represents a unique statistically significant regression with three or four independent variables (each marked with "X") regressed against electric vehicle share. We conduct the analysis for battery electric vehicles (BEV) and plug-in hybrid electric vehicles (PHEV).

For the regressions of the 200 most populous metropolitan area data, we find statistical fits for BEVs and PHEVs each with four independent variables. Each includes model availability, consumer incentive, Level 2 public charging, and DC fast public charging, and they had adjusted R-squared values of 0.61 and 0.63. For the 50 most populous metropolitan areas, model availability remains significant in the PHEV and EV cases, and public charging infrastructure is significantly linked with shares in the BEV and EV cases. The regressions of the 50 areas also show significant links with workplace charging, HOV access incentives, and city promotion actions. For the four separate statistically significant regressions, all the variables' p-values were less than 0.05. As shown, the statistical fits help explain more of the variability in the 50-metropolitan area regressions (adjusted R-squared of 0.89 and 0.92).

Table 2: Summary of statistically significant independent variables for 200- and 50-metropolitan area statistical regressions on battery electric vehicle (BEV) and plug-in hybrid electric vehicle (PHEV) shares in U.S.

	200 U.S. metropolitan areas		50 U.S. metropolitan areas	
	BEV	PHEV	BEV	PHEV
Model availability, BEV	X		X	
Model availability, PHEV		X		X
BEV consumer incentive	X			
PHEV consumer incentive		X		
Public charging per capita (Level 2)	X	X		
Public charging per capita (DC fast)	X	X	X	
Workplace charging per capita			X	X
High occupancy vehicle lane incentive				X
City electric vehicle promotion actions				X
Regression adjusted R-squared	0.61	0.63	0.92	0.89

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

The statistically significant regressions show links between the independent variables and electric vehicle uptake. The two 200 metropolitan area regressions suggest that incentives, infrastructure, and model availability are key factors for growth in the U.S. electric vehicle market. Greater model availability, consumer fiscal incentives, and more public charging infrastructure availability are likely to be key ingredients to further electric vehicle market growth. The regressions with 50 metropolitan areas are more granular with the collection of additional data on more dimensions, especially on local promotion actions. The 50-area regressions offer more detailed points of interpretation on what is driving electric vehicle uptake in the U.S. Workplace charging, HOV lane access, and city promotion actions are significantly linked with electric vehicle uptake in the 50 metropolitan area regressions.

5 Conclusions

The consumer barriers to the widespread adoption of electric vehicles are complex, including cost, charging convenience, and information. Governments, businesses, and non-profit organizations are working to break down such barriers with a series of incentives, regulations, infrastructure, and education campaigns. The electric vehicle market response across the U.S. has varied. The San Jose area had the highest share at 10%, followed by other California areas at 4% to 6%. Top markets in Colorado, Hawaii, Oregon, Vermont, and Washington had 2% to 4%.

Several factors help make sense of why the markets are each developing at a different pace. Based on the findings from our statistical analysis, electric vehicle shares are linked with the availability of more electric vehicle models, more extensive public charging infrastructure, consumer incentives, city electric vehicle promotion actions, workplace charging, and high-occupancy vehicle lane access.

Growth in the electric vehicle market clearly requires many actions, by many players. Actions by many local, state, and utility stakeholders are key to reducing consumer barriers related to electric vehicle uptake with supporting policy, incentives, infrastructure, and consumer awareness. California, where the Zero-Emission Vehicle regulation catalyzes automaker marketing and model availability, complementary policy incentives, and sustained infrastructure investment, especially embodies this comprehensive action.

Expanded electric vehicle model offerings and greater availability of those models is a prerequisite to market growth. The five leading electric vehicle markets by volume, representing nearly half of all U.S. electric vehicle sales, each had at least 24 available electric vehicle models in 2016. Yet about half of the population has 10 or fewer electric models available, many with very low dealership inventories. Availability of more models across vehicle types, from low-cost to luxury, from subcompact to sport utility vehicle, is an essential precursor to more substantial market development.

Consumer incentives remain key to growing the electric vehicle market. Ten of the top 12 major metropolitan areas with the highest electric vehicle uptake offered significant consumer incentives typically worth $2,000 to $5,000 per electric vehicle. These incentives increase awareness and reduce the initial cost barrier while battery costs keep dropping to enable lower cost and longer electric range vehicles.

Electric vehicle charging infrastructure remains a barrier in many markets. Even though households with dedicated parking and available home charging are common in the U.S., public and workplace charging are key factors for the market. The leading electric vehicle markets tend to have public charging availability that is several times the U.S. average, and most of the U.S. has far lower than leading cities. Greatly expanded public and workplace charging will be needed as the electric vehicle market grows.

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