Change in Motion: Infrastructure Adoption for Plug-In Electric Vehicles

Electric vehicles (EV) create a need for a close-knit network of public EV charging stations (EVCS) throughout the United States. Since this network is not growing traditionally by independent stations as seen in traditional gas stations, there are hinderances to continuous adoption, despite clear trends of sustained growth in EV and plugin hybrid electric vehicles (PHEV). An under coverage of EVCSs could indicate a market failure due to the range limitations of EV needing a unilateral network. The benefits of rapid adoption can reduce the number of 6.5 million deaths per year linked to air pollution, mostly in urban environments. This raises the question:

What population dynamics influence developing trends in Electric Vehicle (EV) adoption and EV Charging Station (EVCS) coverage in the United States?

In particular:

I. What are the trends in EV market development?

II. What is the development of EVCS covered areas?

    A. Which areas are under-covered?

        1. What are the characteristics of under-coverage?

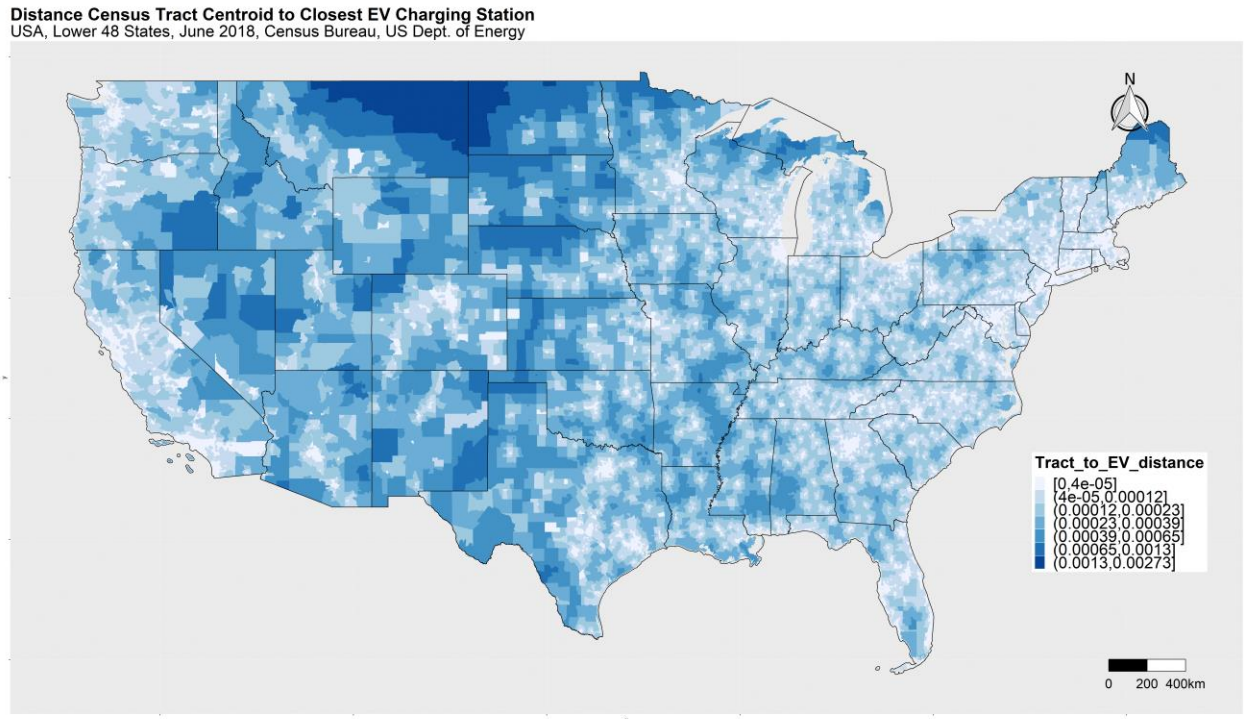
III. What patterns are identifiable?

    A. Are there access discrepancies regarding income?

    B. Are there access discrepancies regarding population density?

    C. Are there access discrepancies regarding states/regions?

To answer this question, a preliminary look at the distribution shows that, when using census tracts, there are significant differences in distances to the next station. When using Jenks Breaks to show the differences between distances of census tract centroids and the nearest publicly accessible station, the resulting map looks like this:

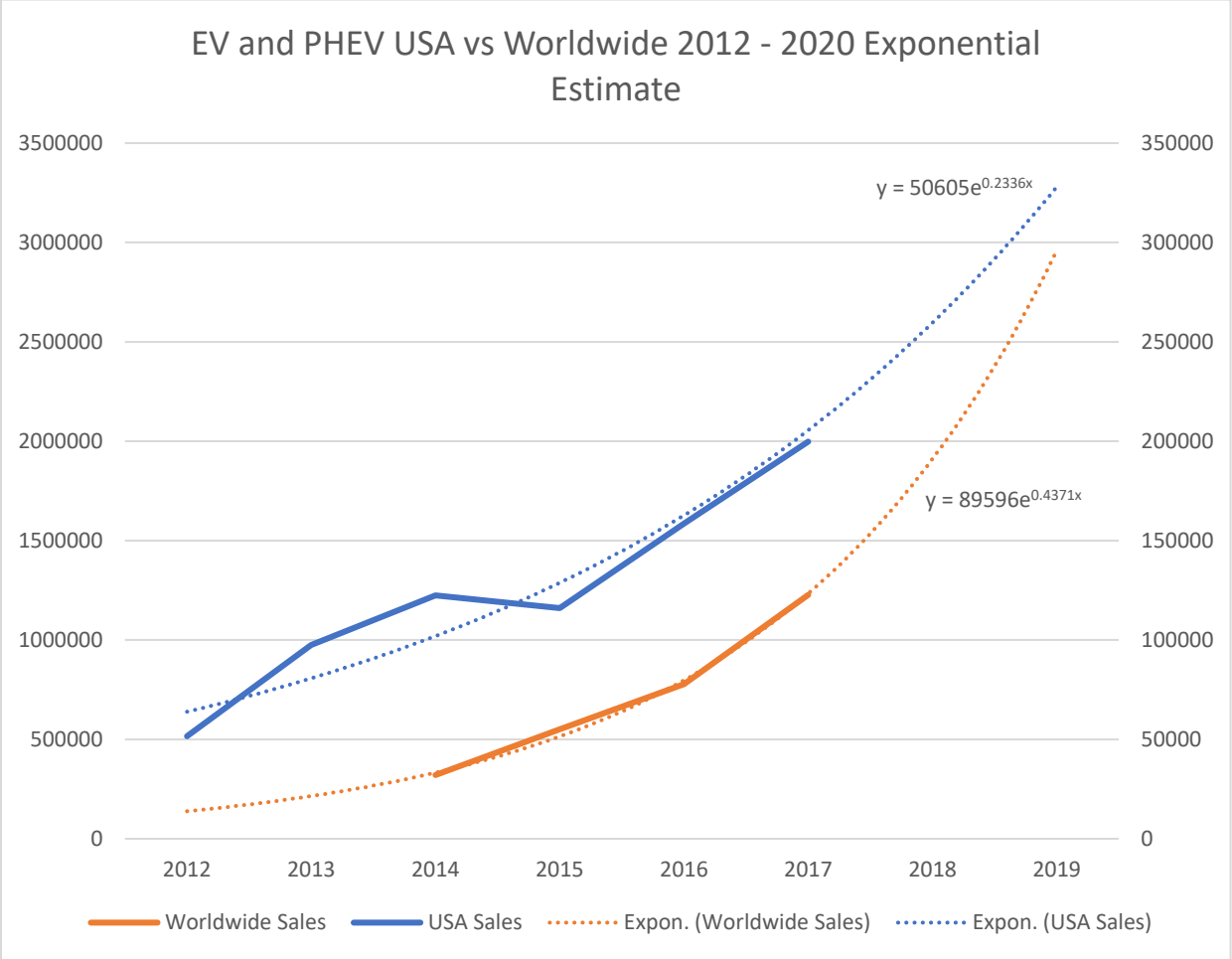


Given that markets are targeted unevenly by EV producers due to the relatively high initial price for most vehicles, it can be suspected that the distribution of EVCS is skewed towards the primary market. However, this can constitute several problems: Given that more and more vehicles will enter the secondary (used) car market, a larger number of consumers would be able to afford them. However, if the access to a station is limited, certain populations will be deterred to choose an EV. For example, there are almost no apartment complexes offering EV charging spaces. Furthermore, rural areas might have less access and given that distance travel needs a reliable network even for people that charge their car at home and/or at work, it makes an alternative to EV necessary to reach certain destinations or makes it

necessary to alter the route from the most efficient in terms of distance and time to one that presents enough opportunities to recharge – especially in the current state of technology that requires long charging times. In the later case, an under-coverage is not only given if there are no EVCS at or around the consumers' residences but also of the areas 200-350 miles away are not covered with EVCS.

A preliminary projection of vehicles sold in the U.S. suggests this is likely becoming a growing issue:

EV and PHEV USA vs Worldwide 2012 - 2020 Exponential Estimate



Left y-axis shows worldwide estimates, right y-axis shows U.S. estimates.

Estimates (dotted lines) are based on year 2012 = 1 for the exponential formulas. Solid lines show available estimated data from Table 3.

USA formula for exponential growth estimate: $y = 50605e^{0.2336x}$

World formula for exponential growth estimate: $y = 89596e^{0.4371x}$