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EV Charging Station Incentives

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Introduction

Electric vehicle (EV) adoption has taken off and is expected to represent as much as one-third of the world's motor fleet within 20 years (Morsy 2018). As EV adoption grows, the distribution and deployment of charging infrastructure becomes of critical importance. New issues arise and new policy and regulation must be developed to support this build-out. Financial incentives are one of the policy tools being used to support the deployment of EV charging infrastructure to meet the growing demand. In this paper, I will analyze the deployment of EV charging infrastructure over time and the related financial incentives. The aim of our analysis is to answer how have financial incentives for charging infrastructure influenced charging infrastructure deployment? Do incentives favor the deployment of fast-charging infrastructure over slower options?

BACKGROUND

Most literature addresses incentives for electric vehicles themselves and how those incentives affect electric vehicle adoption and market penetration. Vehicle adoption is positively correlated with financial incentives and charging infrastructure (Narassimhan and Johnson 2018; Sierzchula et al. 2014). The most effective policy solution to increasing electric vehicle adoption is prioritizing investment in charging infrastructure (Nie et al. 2016). Investment in public charging infrastructure also provides one of the largest benefit-cost ratios for battery electric vehicle incentives (Jin, Searle, and Lutsey 2014).

Literature on electric vehicle charging stations emphasizes the optimization and planning of infrastructure (Dong, Liu, and Lin 2014; Liu, Wen, and Ledwich 2013; Sadeghi-Barzani, Ghahnavieh, and Karegar 2014), charging behavior and patterns (Morrissey, Weldon, and O'Mahony 2016), economics and business models for charging stations (San Román et al. 2011; Schroeder and Traber 2012; Zhang et al. 2018), and assessing the current and future demand for charging infrastructure (Department of Energy 2017; Gnann et al. 2018; Nicholas, Hall, and Lutsey 2019). The literature does not adequately address the effectiveness of financial incentives and policies to increase the number of charging stations deployed.

METHODS/DATA COLLECTION

Data on charging incentives was compiled from lists of incentives published by members of the private and public sector (Chargepoint 2019; ClipperCreek 2018; Department of Energy 2019c). The study was limited to incentives pertaining to nonresidential electric vehicle charging infrastructure. The incentives were cataloged by state; type of incentive–rebate, grant program, tax credit, financing, or other; start date; type of charger—Level 2, fast charger, or not specified; and level of jurisdiction—offered by state or offered by utility, county, or municipality. In total I identified 94 incentives available in 33 of 50 states.

Data on nonresidential electric vehicle charging stations was obtained from the Alternative Fuels Data Center (Department of Energy 2019b). The data includes the location of the charging stations, number of outlets of each type, and the open date—the year the station first offered electric vehicle charging. The dataset contains information on 23,590 charging stations, but only provides an open date for 10,919 stations. The large gap in data can be attributed to limitations in the Department of Energy's (DOE) data collection process. Open dates are not available for stations that are imported to the Alternative Fuels Data Center's Station Locator through the use of a network API. These station records are obtained directly from the network data available from AeroVironment, Blink, ChargePoint, EVgo, Greenlots, and SemaConnect (Department of Energy 2019a). Furthermore, the data is limited in that there is no indication if and when stations are upgraded or additional charging outlets are added.

CHARGING INCENTIVE TRENDS

Rebates are the most commonly offered type of incentive, followed by grant programs and then tax credits; financing-based incentives are the least common (Figure 1). Local incentives—those offered by utility, county, or municipality—outnumbered state incentives 50 to 44 (Figure 2). Approximately 30 percent of the available incentives specifically mention fast-charging technologies, 22 percent specifically mention Level 2 charging technologies but don't mention fast-charging, and the remaining 48 percent are not technology specific (Figure 3).

Figure 1: Incentive Type

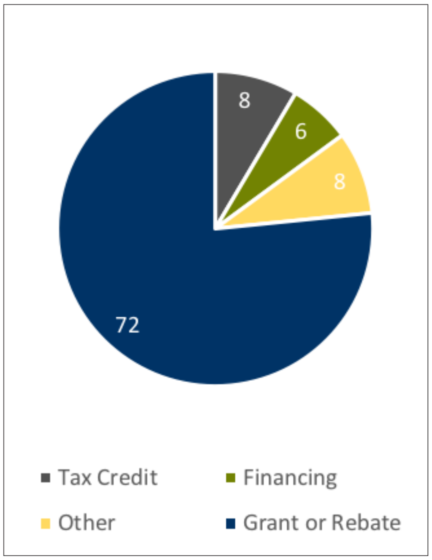


Figure 2: Jurisdiction

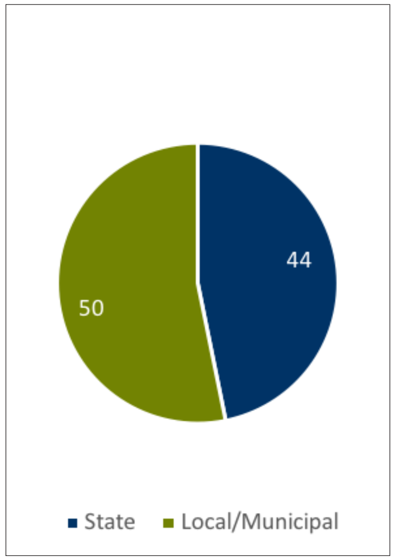
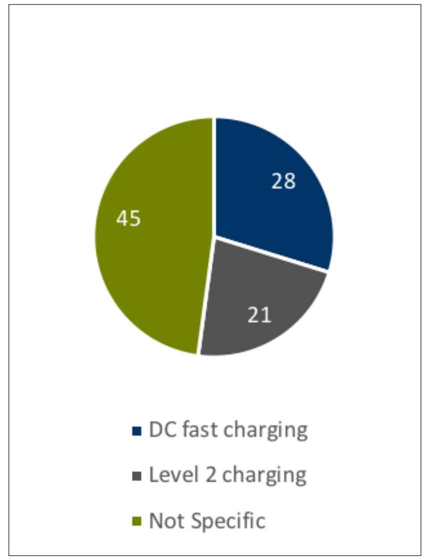


Figure 3: Type of Charger



The start dates of the 94 incentives ranges from 1980 to 2019, but a significant spike in the number of policies introduced each year can be seen from 2015 onwards (Figure 4). A comparison of the subsets of state incentives and local incentives demonstrates that the bulk of state action incentivizing EV charging infrastructure preceded local actions. Most state incentives were enacted after 2004, whereas most local incentives were enacted after 2013 (Figure 5). Incentives that apply specifically to fast-charging and Level 2 charging technologies were first introduced 2009 and 2013, respectively (Figure 6).

Figure 4: Number of Incentives Enacted Per Year

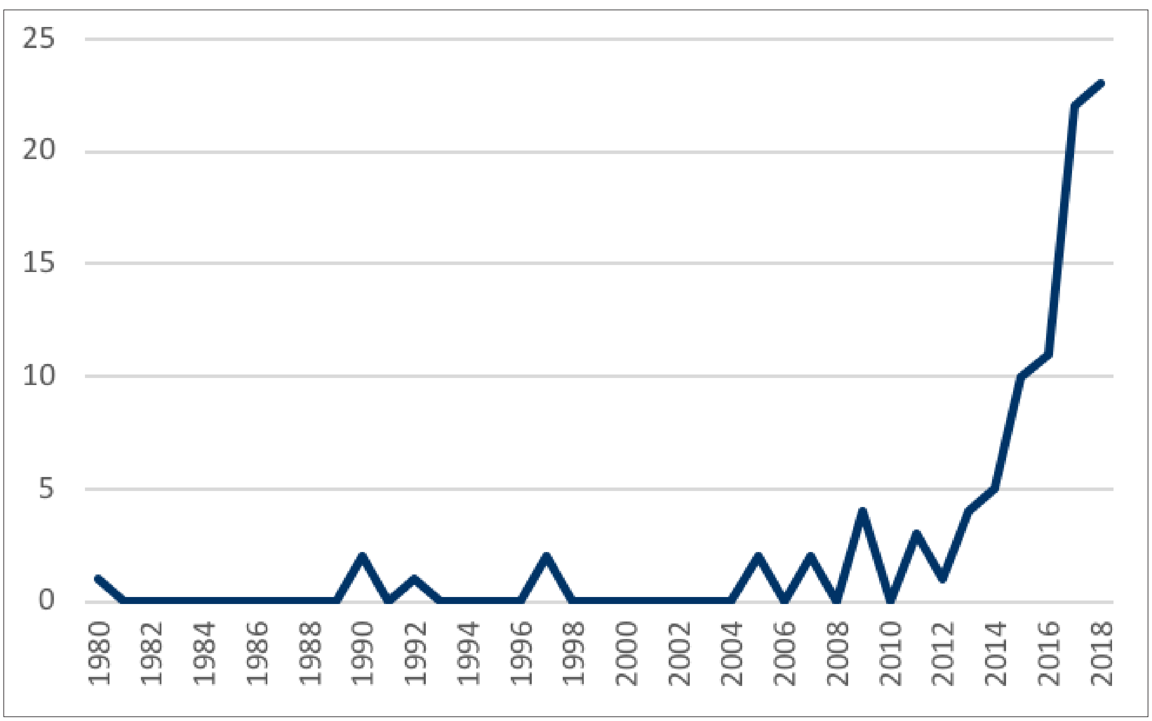


Figure 5: Incentives by Jurisdiction

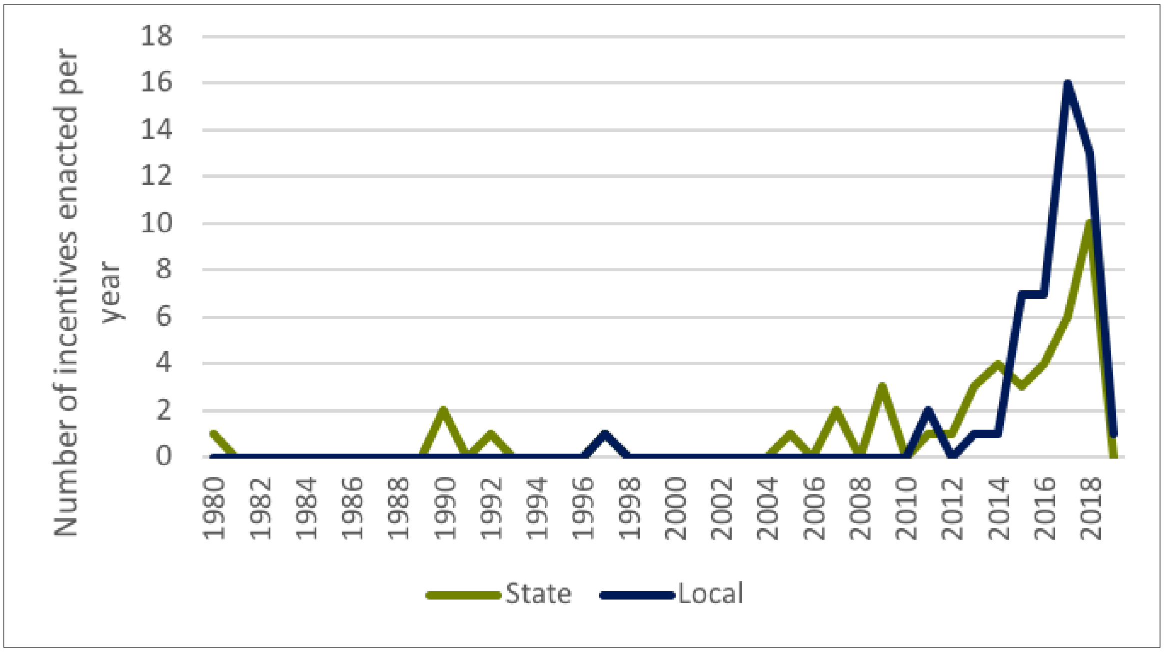
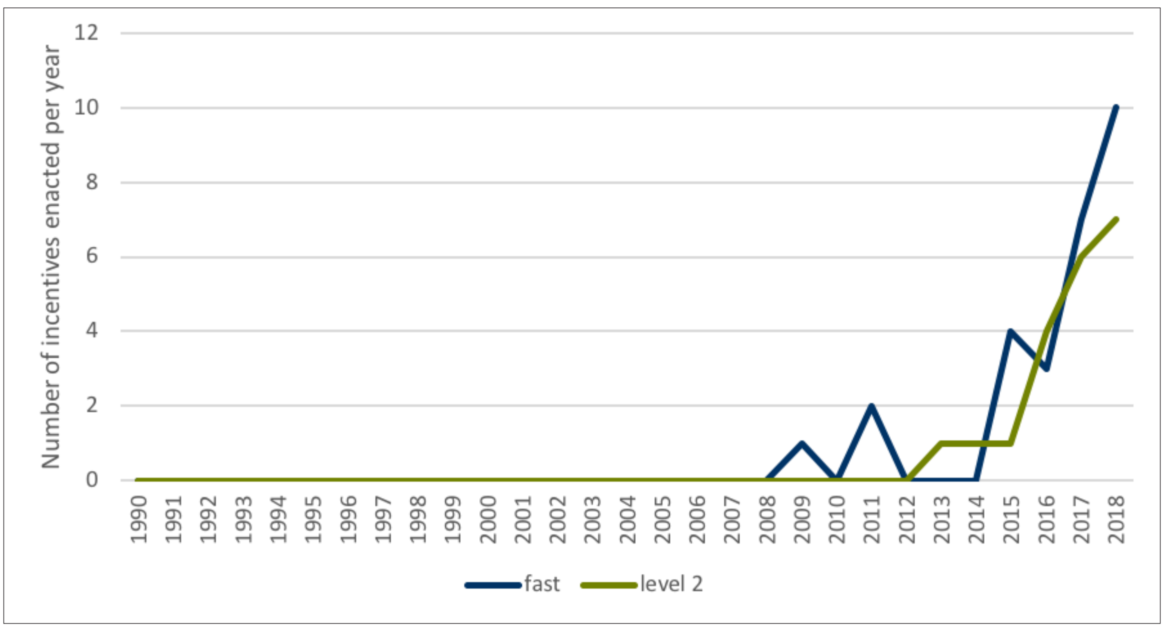


Figure 6: Incentives by Charger Technology

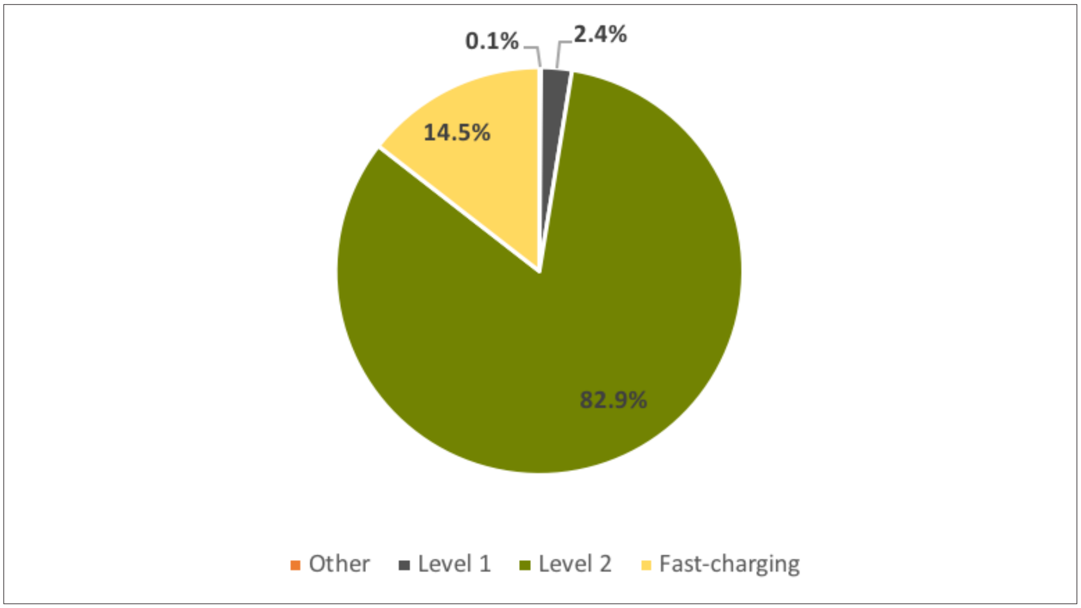


CHARGING STATION DEPLOYMENT TRENDS

Several charging stations employ multiple charging technologies and many offer multiple charging outlets allowing for multiple vehicles to charge simultaneously. The dataset identifies 23,590 electric vehicle charging stations in the United States, which provide 67,271 EV charging outlets.[1] Nationally, 82.9 percent of outlets utilize Level 2 technology, 14.5 percent utilize fast charging technology, 2.5 percent employ Level 1 technology, and 0.1 percent employ other technologies (Figure 7). From a charging station perspective, Level 2 charging is the most widely deployed technology; available at 93 percent of charging stations. Only 11 percent of stations offer fast-charging and 3 percent offer Level 1 or other types of charging, i.e., inductive charging (Department of Energy 2019b).

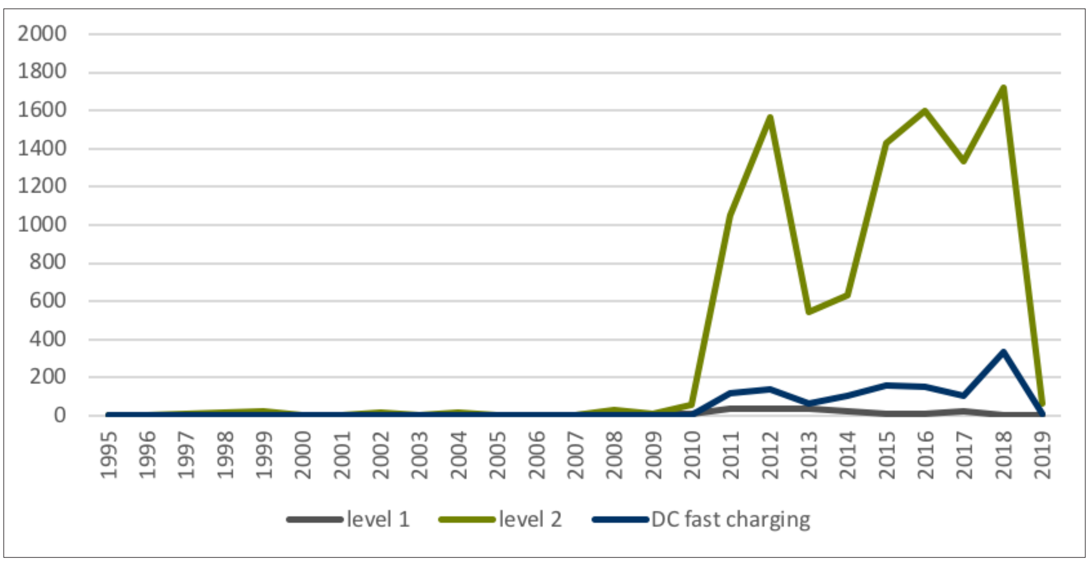
[1] The data set was downloaded and is current up to January 29, 2019.

Figure 7: Number of Outlets by Charging Technology



The open dates for EV charging stations range from 1995 to 2019. However, the open date is only available for 10,919 of 23,590 charging stations; approximately 46 percent. Within the subset of stations that have open dates, more than 95% of stations have opened after 2009. This more recent increase in deployment can be seen across all types of chargers, although deployment of Level 1 charging technologies has declined over the last five years (Figure 8).

Figure 8: Number of Charging Stations Opened Each Year



COMPARING FINANCIAL INCENTIVES AND DEPLOYMENT

California has the most incentives for EV charging stations and significantly outnumbers the other states with 26. Massachusetts and New York are second, with five. Florida, Pennsylvania, and Vermont round out the top end of the table, each having four incentives. In addition to leading in the number of incentives, California ranks first amongst states for infrastructure deployment. Florida and New York also appear on the top of the list of infrastructure deployment, ranked second and third, respectively (Table 1). Both Washington and Oregon appear in the top ten of incentives and deployment, as well. California is also ranked first in fast-charging incentives and fast-charging infrastructure deployment. Florida and Washington are the only other states that make the top ten of both lists (Table 2).

Table 1: Top Ten States by Number of EV Stations/Incentives

Rank	State	Number of Stations	State	Number of Incentives
1	CA	5682	CA	26
2	FL	1270	NY	5
3	NY	1251	MA	5
4	TX	1231	PA	4
5	WA	965	VT	4
6	GA	831	FL	4
7	CO	724	OK	3
8	OR	684	OH	3
9	MD	669	OR	3
10	NC	661	WA	3

Table 2: Top Ten States by Number of Fast-Charging EV Stations/Incentives

Rank	State	Number of Fast-Charging Stations	State	Fast-Charging Incentives
1	CA	674	CA	7
2	FL	128	MA	2
3	GA	124	FL	2
4	OR	116	RI	2
5	TX	113	PA	1
6	WA	110	OK	1
7	NY	85	OH	1
8	MD	85	WA	1
9	VA	80	ID	1
10	NC	78	UT	1

STATE-LEVEL CASE STUDIES

In addition to looking at the relationship between the number of charging stations and the number of incentives, I compared the start dates of specific policies to the number of EV charging stations opened each year. In order to overcome the limitations of the partial completeness of the open date field, an analysis at the state level was conducted. Seven states were selected based on the completeness of their datasets and the availability of charging incentives (Table 3). The number of charging stations opened each year in the selected state was then plotted as a time series and vertical lines were overlaid on the graph to represent the start date of a policy incentive for charging infrastructure.

In all of the case studies, no significant increases in charging station deployment occurred until after the federal tax credit for alternative fuel infrastructure was increased in 2009 to provide 50 percent of the cost of the project not to exceed $50,000. The original credit, released as part of the Energy Policy Act of 2005, which only provided a credit of $1,000, demonstrated no noticeable impact on the study cases (Department of Energy 2019c). A lag can be seen following the introduction of the national tax credit; deployment spikes do not occur until one to two years later.

Several state and utility incentives were introduced in 2018, so their full impacts cannot be accurately assessed. The final complete year available in the charging station deployment dataset is 2018, but many policies start part-way through the year and policies often demonstrate a lag in deployment. For example, the state rebate in Pennsylvania, offered as part of the Driving PA Forward program, didn't begin accepting applications until September 20, 2018 and is accepting applications until December 31, 2019. Many projects approved under this program were not completed in 2018, the program's start year (Pennsylvania Department of Environmental Protection 2019).

In New York, Idaho, Maine, and Connecticut, increases in deployment occur after the introduction of state and local incentives for electric vehicle charging infrastructure. In New York the lag proceeding the state tax credit is longer than that preceding the rebate and grant programs offered by Idaho, Maine, and Connecticut (Figure 9). This three-year lag period suggests that the spike in 2016 might not be a result of the state tax credit and could be tied to the states high EV adoption numbers—ranking third out of all states in 2016, second in 2017, and second in 2018—and increased demand for charging infrastructure (Auto Alliance 2019). The incentives in Idaho, Maine, and Connecticut precede increased station deployments. In Connecticut, the spike occurs between the grant program's start date, in 2013, and end date, in 2018. In both Idaho and Maine, the deployment spike occurs the year after the introduction of grant programs (Figure 9). The shorter lag times between the program start dates and the deployment spikes suggest these increases may be the result of the state and local incentives.

Table 3: Selected Case Studies

State	Number of Stations	Percentage with Open Date	Number of Incentives
NY	1250	0.549	5
PA	475	0.596	4
OK	74	0.811	3
OH	471	0.669	3
ID	87	0.828	2
ME	168	0.917	1
CT	385	0.764	1

Figure 9.1: Charging Station Deployment by State

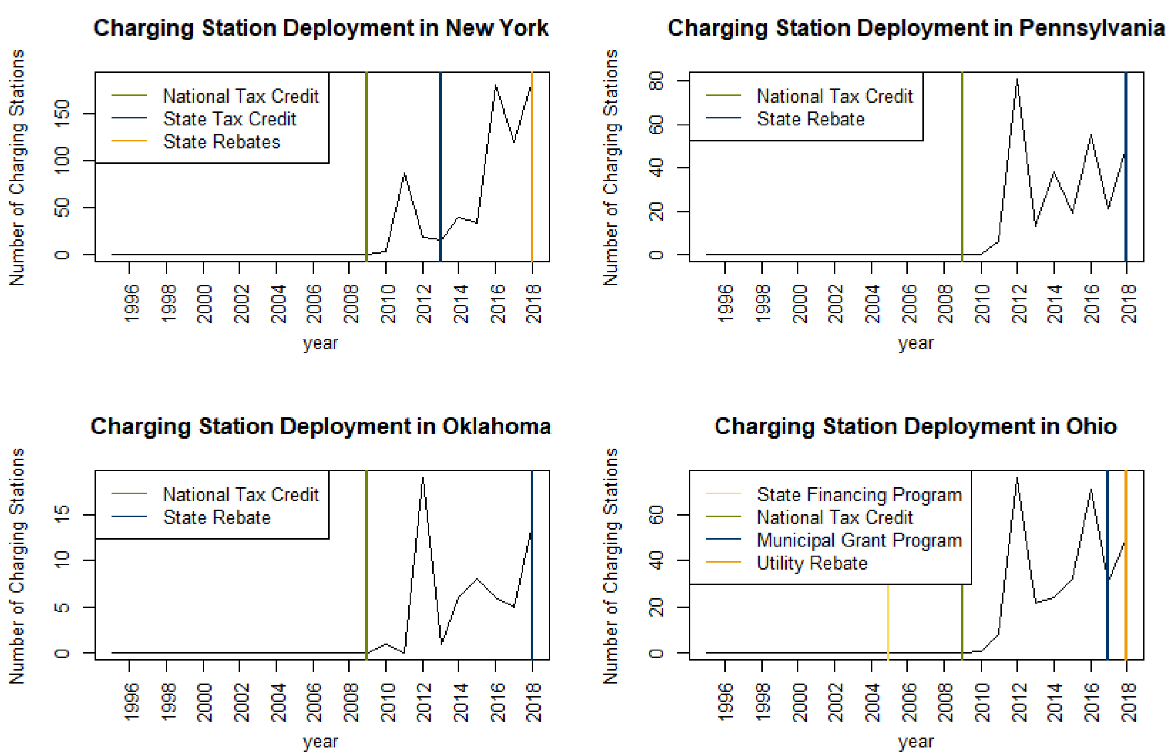
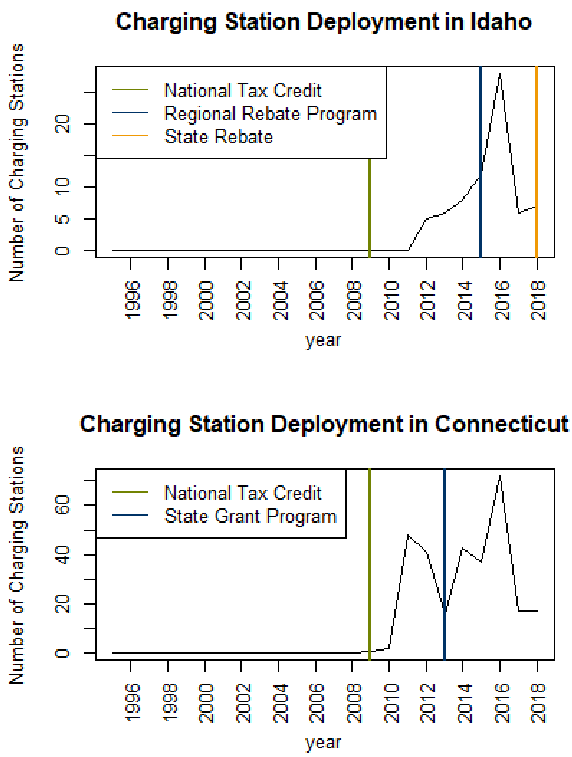


Figure 9.2: Charging Station Deployment by State



CONCLUSIONS

Financial incentives play a clear role in increasing the deployment of EV charging infrastructure. Analysis of the data suggests a possible correlation between the number of incentives available in each state and the number of charging stations in each state, however, more robust statistical analysis should be done in the future, with a larger and more consistent dataset. The time series for the selected case studies tends to support this notion, with the spikes that were observed aligning with the start dates of incentive programs. Currently, there seems to be limited distinction between incentives for fast charging and other charging technologies. The majority of incentives available are not technology specific and 25 of the 28 incentives available for fast-charging also incentivizing Level 2 chargers. In the last few years there have been more incentives offered for fast-charging, which may signal an upcoming trend of incentives favoring fast-charging technologies.

DISCUSSION/LIMITATIONS

The study has been limited by the availability of data on the deployment of charging infrastructure. A more complete dataset with open dates for all stations and a way to track the upgrades to stations would allow us to provide more robust conclusions regarding the effectiveness of incentives for EV charging infrastructure. The study also is unable to account for how the adoption of electric vehicles is influencing the deployment of electric infrastructure. Studies incorporating both charging infrastructure incentives and EV adoption data may be able to better distinguish or reflect the individual contributions of each factor.

Despite the limitations of the study, the analysis provides insight on the types of charging incentives that are being utilized by different states and local actors. The academic literature has not been addressing the topic of incentives for charging infrastructure. More attention should be given to the topic as EV adoption is specifically linked to charging infrastructure deployment (Narassimhan and Johnson 2018; Sierzchula et al. 2014). If a timely transition to electric vehicles is to come to fruition, then effective incentives for infrastructure deployment will be necessary.

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