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Review of New York State Electric Vehicle Charging Station Market and Policy, Finance, and Market Development Solutions

Final Report

New York State Energy Research and Development Authority

October 2015

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Final Report

Prepared for:

New York State Energy Research and Development Authority

Albany, NY

Adam Ruder
Program Manager

Prepared by:

Coalition for Green Capital

Washington, DC

Reed Hundt
CEO

Jeffrey Schub
Executive Director

With support from:

Yale School of Forestry & Environmental Studies
and
Yale School of Management

New Haven, CT

Eitan Hochster
Marissa Galizia

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Acronyms and Abbreviations

BEV	Battery-electric vehicle, or all-electric vehicle, are vehicles that are purely powered by a battery-powered electric motor with no secondary gasoline-power internal combustion engine
EV	Electric vehicles, a general term to describe to describe all types of plug-in electric vehicles
DCF	Discounted cash flow, a kind of financial analysis that estimates the future revenue and expenses streams, and discounts those values to present value to calculate the expected net-present value of an investment
DCFC	Direct current fast charger, also sometimes referred to as a Level 3 charger
EVSE	Electric vehicle supply equipment, a technical term to generally describing electric vehicle charging stations
EVSP	Electric vehicle charging service provider, a secondary party that owns, operates, maintains and/or finances a charging station located at host location
HOV	high occupancy vehicle
ICE	Internal combustion engine, a traditional gasoline-power vehicle
kW	kilowatt
kWh	Kilowatt-hour, the standard unit of energy consumption measurement used by utilities
NPV	Net-present value, the sum value in today's dollars of future cash flows
NYS	New York State
OEM	Original equipment manufacturer, used to describe electric vehicle manufacturers
PHEV	Plug-in hybrid electric hybrid vehicle. Like a traditional hybrid, PHEV have both an electric motor and an internal combustion engine. PHEV differ from traditional hybrids because the electric motor can be charged directly by plugging the car into an outlet, so the car can operate without gasoline using only the electric motor.
TCO	Total cost of ownership, represents the combined lifetime expenses of owning and operating a vehicle. Includes the upfront cost of the car, as well as lifetime fuel and maintenance costs.
VMT	Vehicle miles travelled, a measure of total volume of driving, as measured by distance
ZEV	zero emission vehicle

Summary

This report finds that increased private and public financing for an efficiently designed charging network are essential for accelerating the deployment of electric vehicle charging stations, as financing can reduce barriers to station adoption. This report also finds that more robust electric vehicle (EV) market growth can be achieved if charging station financing solutions described herein are combined with measures taken by New York State (NYS) to simultaneously provide financial support for EV adoption. Together, these approaches can minimize public expenditure while maximizing EV adoption and usage in New York State. NYS has established specific targets for increased adoption of EVs and broader installation and availability of public charging stations to support those vehicles. Under State-specific goals, NYS must grow from 12,000 to 40,000 EVs in four years, and install another 2,000 public charging stations.

Through the adoption of California's Zero Emission Vehicle regulations, NYS has committed to a total of approximately 800,000 EVs by 2025. Achieving these goals will necessarily increase the share of vehicle miles travelled (VMT) driven by electric vehicles. Currently nearly 100% of VMT in NYS are driven by internal combustion engines (ICE). EVs represent an alternative transportation technology that can displace a significant portion of NYS' fossil fuel consumption. Almost 40% of NYS' greenhouse gas emissions come from the transportation sector, so maximizing EV VMT as a share of total state VMT will reduce a major State contributor to climate change.

However, EVs are currently more expensive than comparable ICE vehicles. In addition, because the technology is new and relies on a nascent network of EV charging stations, limited infrastructure has been installed to support new drivers that must refuel when away from the home. Limited infrastructure translates into the market as a significant additional cost borne by early adopters of EVs. Much like how the very first cell phone adopter had to buy the phone *and* cover the cost of each cell phone tower, early EV adopters have to pay for the vehicle and a network of charging stations. The concept of range anxiety is a symptom of this fundamental price problem, and again is similar to the classic difficulties that stall early adoption of other technologies that rely on network effects to be cost effective and successful.

This pricing problem has led to underinvestment in charging stations and slow adoption of EVs. Charging stations specifically prove to be poor economic investments because of low utilization and relatively high upfront cost, especially for DC fast charging (DCFC) stations. Through quantitative cash flow modeling, this report finds that under current market conditions charging station installation is not an attractive investment, with modest payback periods and positive net-present values (NPVs) only coming with high electricity prices charged to drivers and significant increases in charging station utilization. The payback period on a Level 2 station at today's utilization rates is over 20 years. To reduce payback period to a point where private investors may be interested in financing stations would require charging station usage to quadruple from today's level, with customers paying a significant premium on electricity above retail utility rates. Level 2 chargers can be NPV positive, but only under these favorable future conditions and over a long period of time. DC fast chargers, due to high installation cost, are even less likely to attract private investors. These market conditions suggest that the public sector will to need to act to increase the availability of financing for charging stations – either through direct lending support or by offering credit enhancements to private lenders. No matter the tool, public sector support will be necessary to build out the charging station network potential drivers need to avoid the inherent pricing problem of new network expansion.

As EVs and charging stations are complementary goods, NYS may need to establish market development policies for both vehicles and stations that are integrated and aligned toward the same objective. Therefore, this report also finds that NYS may need to incentivize both EV adoption and incremental EV driving as well as supporting the build out of an efficiently designed public charging station network.

This report includes a review of NYS' current policies to support EV market growth, and compares them to the leading EV markets in California and Georgia. This review finds that NYS' EV policies do not create as robust an EV and EV charging station environment as those other states. The review also finds that other states subsidize EV ownership, which NYS does only through marginal benefits like reduced tolls, but also that those states specifically support EV adoption, not EV VMT specifically. These states also demonstrate that increased EV usage may drive charging station installation, and not the other way around. This report also includes a deep analysis of the fundamental barriers to adoption of EV and EV charging stations, the dynamics between EV and charging station adoption and a set of strategies specifically directed at methods for increasing public EV installation. Then through qualitative and quantitative analysis, this report explores the role of financing for EV charging stations and how financing on certain terms can increase the attractiveness of station installation.

This market analysis paired with the EV goals established by Governor Andrew M. Cuomo points to a set of financing and subsidy solutions that can help NYS achieve its EV and EVSE goals at least cost. First, to meet the objective of maximizing EV VMT per public dollar, this report proposes an auction-based program designed to incentivize installation of public charging stations at geographically efficient locations. NYS can work with private parties to identify an optimal charging station network in various regions around NYS. By placing charging stations at the most heavily trafficked and populated locations, NYS can minimize the number of charging stations needed to support the growing EV market while making each of those stations economically viable. Rather than build the network itself, NYS can auction licenses to private parties to build and operate the network, with bidders selected based on the least amount of public money needed to build the market. NYS can then offer financing in that amount to the winning bidder, improving the economics of network ownership. This option also minimizes the cost to NYS for building the network, as financing is far less expensive than paying directly for charging stations. Under this auction mechanism, all other private market activity would still be entirely open and unrestricted. But only the auction winners installing charging stations at the identified, efficient locations could access the benefit of public financing. Also, NYS would not dictate preferred technologies or network partners.

In addition to the auction-based system, NYS can encourage private lending more broadly into EVSE markets by offering credit enhancements for lenders will to lend at certain terms. These kinds of public-private partnership structures are used by NY Green Bank, and are a proven tool for “crowding-in” private capital that is otherwise hesitant to enter the markets. As discussed in this report, EVSE are only economically viable with greatly increased utilization, and adding on financing costs will only erode that marginal economic viability. Therefore, any private lending would need to be offered at modest rates and long tenors. NYS will need to collaborate with private lenders to identify credit enhancements terms that both facilitate private investment and resulting station owner economics that are still attractive in the long run.

Although this report focuses on private financing solutions for EVSE, this report also finds that the current economic condition of EVSE markets is such that attracting financing will be exceptionally difficult without greater EV penetration, and resulting EVSE utilization. Therefore, the public sector may need to supplement private activity in the EVSE sector with public support directly for EVs. To push drivers toward those public charging stations and allow NYS to meet its lofty EV goals, NYS may need to subsidize both adoption and usage of electric vehicles. This can be done by rewarding drivers based on usage of their EV, with a subsidy based on the use of charging stations. NYS can optimize this subsidy structure, across varying market segments to provide the lowest subsidy needed to maximize EV VMT. This subsidy plan is complementary to the public charging network financing, as EV drivers will actively seek out public charging stations. Potential host sites will then draw customers who must wait for their car to charge, pushing down the amount of public money that site requires through the auction in order to make the station economical. Although this is not a purely private sector solution, this report's analysis finds that meaningful and fast EV market growth may require such support (as demonstrated by some, but not all, state EV markets).

This set of proposed solutions are guided by New York State's EV goals, the objective of reducing public expenditure per EV VMT and a desire to implement an efficient, least costly public charging network to reduce costs to consumers. The solutions also defer to private sector leadership and market choice. Finally, this report summarizes a set of regulations and policies based on those used in other states that can create a favorable EV and charging station environment. In combination, the financing, subsidy and market development structures outlined in this report can help the EVSE markets overcome poor economics, and help NYS meet its goals and create a self-sufficient EV ecosystem in NYS as quickly as possible.

1 Introduction

New York Governor Andrew M. Cuomo established specific short-term and long-term goals for EV adoption and electric vehicle charging station installation in NYS. Naturally, the goals carry a significant cost that must be invested from some mix of sources. In NYS' current EV market, based on the current levels of charging station expense and utilization, the cost of station investment exceeds the economic value. Stations do not earn a return, on a stand-alone basis, that is attractive enough to draw in the necessary amount of private investment to build a robust and efficient network. Therefore, NYS has an important role to play in facilitating private investment in charging station deployment.

1.1 EV Market Challenges and New York State's Goals

Starting in 2010, major auto manufacturers around the world began producing and mass marketing electric vehicles. Since that time, over 285,000 EVs have been sold in the United States. That number still represents less than 1% of total new vehicle sales, but the increased variety of EVs on the market, declining technology costs and increasing driving range all create the opportunity for far greater market penetration of EVs in the near future.

However, Chapter 3 details several barriers exist that slow consumer adoption of EVs. One frequently cited barrier to greater EV adoption is the lack of charging infrastructure that drivers need to ensure their cars are adequately charged when away from home. ICE drivers have the comfort of ubiquitous gas stations, longer ranges, and short refueling time, but no such infrastructure exists for EV drivers. Therefore, greater installation of public EV charging stations, also known as electric vehicle supply equipment (EVSE), is a critical lever for allowing consumers to adopt EVs without fear of running out of power.

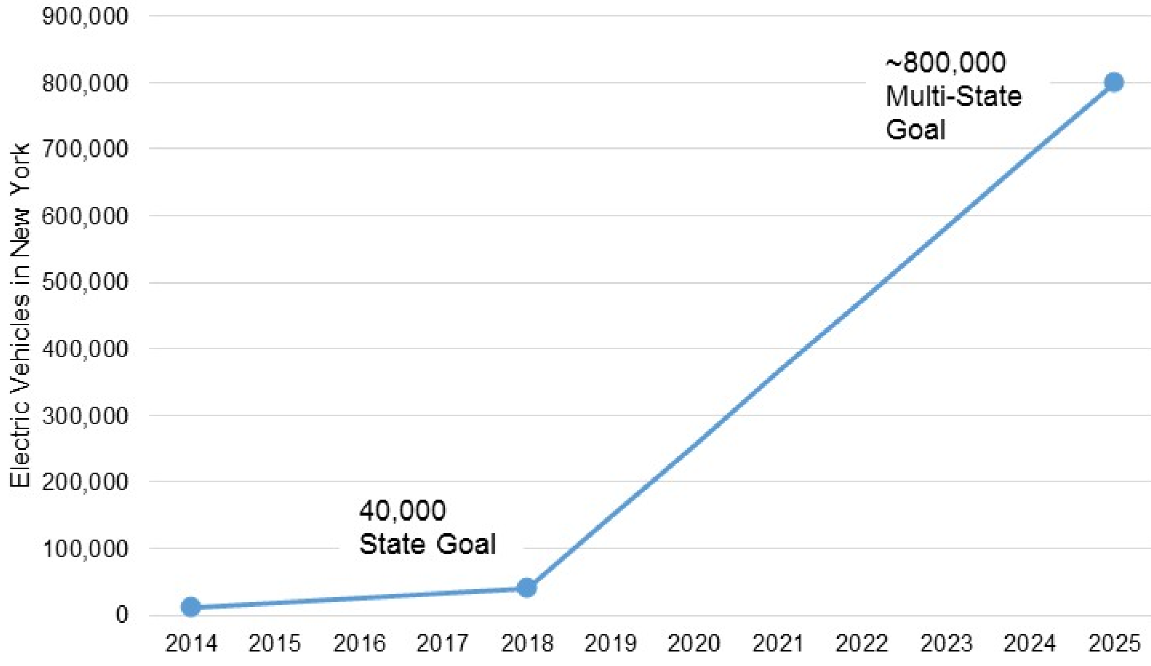
NYS, therefore, must increase both the attractiveness of driving EVs and installing EVSE. Private investment in charging stations is critical, but businesses, property managers and investors are hesitant to purchase and install expensive charging equipment without greater certainty that the EVSE will actually be used. This situation reflects the pricing problem inherent to growing a network. An EVSE owner must make a significant payment upfront for a charging station and hope to earn a return on that investment through revenue generated by that station. But without enough EVs on the road, the station may not be used enough and the revenue generated by the station may never be enough to cover the cost of the initial investment, much less make a return.

The transportation sector is responsible for 28% of total greenhouse gas emissions (GHG) in the United States, and 39% of emissions in NYS.[1] Therefore substituting EVs for gasoline-fueled cars (with internal combustion engines) presents an opportunity for a significant reduction in GHG emissions. Governor Cuomo established the dual goals of 40,000 electric vehicles and 3,000 public electric vehicle charging stations in NYS by the end of 2018. At the end of 2014, approximately 12,000 electric vehicles were on the road and 1,000 public and workplace charging stations were available in NYS. Therefore, to meet NYS goals, NYS needs 7,000 EVs per year for the next four years, and 500 public charging stations per year over that same period.

In addition to the specific goals set by the governor, NYS is also a signatory of the Multi-State ZEV Action Plan, through which eight states have committed to having 3.3 million EVs on the road by 2025 based on the CA ZEV regulations. This point can then be added to NYS' goal. The 3.3 million EV goal is not specifically broken down by state, but based on a per capita allocation across participating states, NYS is responsible for 25% of that amount, or approximately 800,000 EVs. Figure 1 shows that Governor Cuomo has established a goal of increasing state EVs from 12,000 to 40,000 in four years and 800,000 in 10 years. Assuming an average EV price of $30,000 per vehicle, $840 million needs to be invested in EVs in the next four years, with an additional $22.8 billion in the following 7 years leading to the 2025 goal. Assuming the average ICE car is $20,000 per vehicle, the incremental cost will be $7.6 billion.

[1] NYSERDA, 2012 New York State Energy Fast Facts.

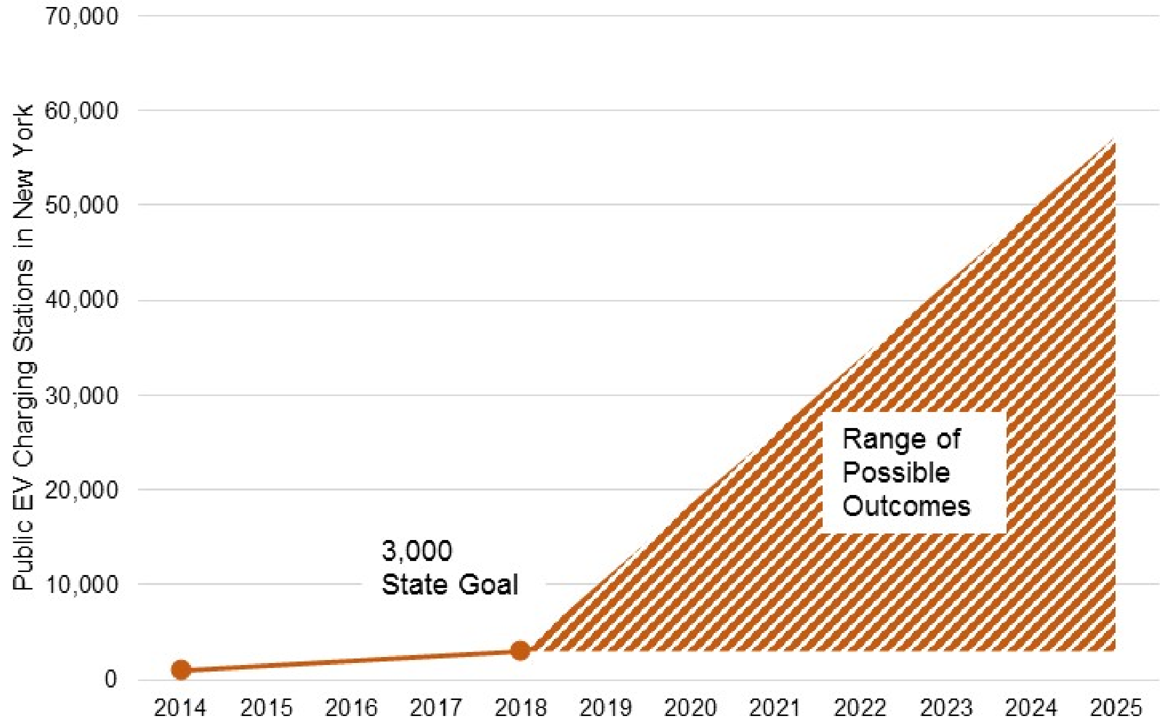
Figure 1. New York State EV Adoption Goals



In the EVSE market, over the next four years an additional 2,000 public EVSE are needed to meet the governor's goal. These stations will likely be mostly Level 2 chargers, with some Level 3 DC Fast chargers, with an average cost of perhaps $10,000 per L2 charging port. Therefore, in four years $20 million will need to be invested in public charging stations. In addition, the market has shown to date that nearly every single EV purchaser also installs a charger at their home or base location. (For this analysis, it is assumed PHEV owners do not install in-home chargers, so the need is two chargers per three total EVs.) Therefore, approximately 18,667 additional EV chargers are needed in the next four years. These installations are typically cheaper, at roughly $1,000 per station, creating a total investment need of an additional $19 million.

The trajectory and need for public charging station beyond 2018 to support the 2025 EV goal, though, is unknown. An optimally designed network configuration could conceivably be installed to meet the 2018 goal and will be 100% sufficient to support the additional 800,000 EVs on the road by 2025. On the other end of potential outcomes, public charging stations could possibly be needed at a ratio exactly equal to that implied by the 2018 goals. Figure 2 shows this broad range of potential EVSE needs going forward.

Figure 2. New York State EV Charging Station Goals and Potential Trajectory



Aside from the public charging needs, in home charging installations will likely continue at a 2-to-3 vehicle ratio between 2018 and 2025, meaning approximately an additional 500,000 home installations will be needed, at a cost of $500 million. Across EVs, public charging stations and home charging stations, NYS has laid out a set of goals that will require approximately $24.2 billion in total investment. These numbers are summarized in Table 1.

Table 1. Investment Needed to Meet New York State EV and Charging Goals

Target Year	Marginal Vehicles Needed	Marginal Vehicle Investment	Marginal Public Chargers Needed	Marginal Public Charger Investment	Marginal Home Chargers Needed	Marginal Home Charger Investment	Total Investment Needed
2018	28,000	$840,000,000	2,000	$20,000,000	18,667	$18,666,667	**$878,666,667**
2025	760,000	$22,800,000,000	?	?	506,667	$506,666,667	**$23,306,666,667**
Total	**$788,000**	**$23,640,000,000**	**2,600+**	**$78,000,000+**	**$525,333**	**$525,333,333**	**$24,185,333,333**

This report assumes that the goals will be met through purchases by individuals, companies or fleet operators. This report will not address what exact segment of the market should be targeted and who is likely to make the billions of dollars of purchase decisions needed to meet the goal (though, given the sheer scale of the need, individuals will likely account for the majority of purchases). However it should be noted that different policy decisions will inherently tilt the purchasing decisions for or against different segments of the purchasing market.

Understanding who will purchase EVs is important, though, because different market segments of EV purchasers will require different kinds of EV charging networks. A fleet of taxis will require multiple charging stations at a specific location in order to cycle through and charge multiple vehicles simultaneously. A grocery store, however, may only need to install one or a small number of chargers based on expected demand. The actual picture of the EVSE network varies according to the market segments that purchase EVs.

The exact market segment of EV drivers will determine what the optimal charging station network looks like, *and* the opposite is also true. The configuration of EV chargers depends on the EV drivers and EV purchase decisions will be based on the EV charger configuration. This report finds that, ultimately, NYS may want to consider the market development for these complementary goods simultaneously.

This report investigates and identifies solutions that NYS can adopt to increase EV and EV charging station investment to meet NYS' goals with maximum efficiency. EV charging station industry analysis and discussion of driver-charging dynamics illuminate paradigms that must be understood to design an efficient policy around charging. A description of the barriers to EV adoption and EVSE investment provide greater clarity on what policies and tools will be most effective at moving the market. And an exploration of market development and financing partners shows natural interdependencies in the EV and EVSE market that NYS can foster to create a robust EV environment in NYS.

This report also finds that meeting NYS' significant EV and EV charging goals without public financial support will be very difficult because of the poor economics of EVSE ownership in today's market. However, with a well-designed policy structure aimed at drawing in private investment and market activity, NYS can minimize the public cost while maximizing efficiency of charging network deployment.

2 New York State Market Review

2.1 New York State EV and EVSE Goals

On January 9, 2013, Governor Cuomo launched the ChargeNY initiative to increase the total amount of EVs and EVSE in NYS. He laid out a plan that would put up to 40,000 EVs on NYS roads by the end of 2018. These EV purchases would need to be supported by at least 3,000 public charging stations across NYS. These charging stations are expected to be in “municipal and private parking lots, transit stations and park-and-ride lots, retail and tourist destinations, major travel corridors and workplaces of all sizes, including state government lots.”[2]

In addition, in May 2014, NYS joined with seven other states to participate in the new Multi-State Zero-Emission Vehicle (ZEV) Action Plan. ZEVs include both electric vehicles and fuel cell vehicles. These states set a collective goal of having 3.3 million zero-emission vehicles on the road by 2025.[3] Together, these goals are based on the California regulations that the eight states have adopted, which mandate car manufacturers to have sold a certain number of ZEVs by specific deadlines.

2.2 National EV Market Snapshot

In the United States, over 280,000 plug-in electric vehicles have been sold since 2010. This includes over 150,260 plug-in hybrids or extended range vehicles and 135,425 full battery electric vehicles through the end of 2014. In the same period, over 1.6 million standard hybrids were sold, and nearly 60 million total vehicles were sold in the United States. The plug-in electric vehicle market now makes up a 0.72% share of total U.S. vehicle sales, while hybrids make up 2.75% of total sales.

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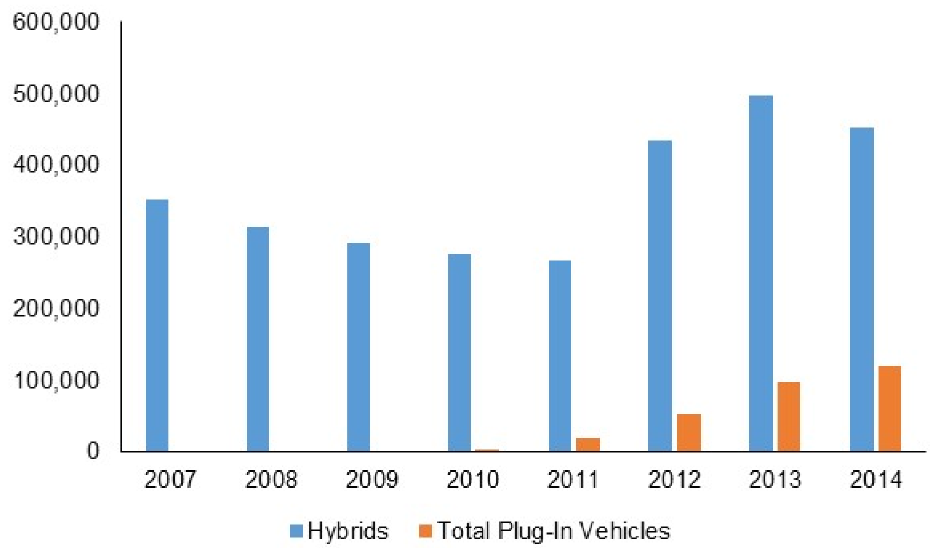
2 NY Rising 2013 State of the State address, Governor Andrew M. Cuomo, January 9, 2013

3 “Governor Cuomo Announces Multi-State Plan to Increase the Number of Zero-Emission Vehicles in the U.S.,” May 29, 2014, press release, nyserda.ny.gov/About/Newsroom/2014-Announcements/2014-05-29-Governor-Cuomo-Announces-Multi-State-Plan-to-Increase-Zero-Emission-Vehicles

Table 2. Hybrids, EV, and Total U.S. Vehicle Sales 2007 – 2014[4]

	Hybrids	Plug-in Vehicles		Total Plug-In Vehicles	Total Hybrid and Plug-In	Total U.S. Vehicle Sales
		Plug-in Hybrids & Extended Range	Battery EVs			
2007	352,273	0	0	0	352,273	11,777,314
2008	313,673	0	0	0	313,673	13,260,747
2009	290,292	0	0	0	290,292	10,429,014
2010	274,210	326	19	345	274,555	11,588,783
2011	266,329	7,671	10,064	17,735	284,064	12,734,356
2012	434,645	38,584	14,251	52,835	487,480	14,439,684
2013	495,530	49,008	47,694	96,702	592,232	15,531,609
2014	451,702	55,357	63,416	118,773	570,475	13,642,517
Total	**2,878,654**	**150,946**	**135,444**	**286,390**	**3,165,044**	**103,404,024**

Figure 3. Hybrid and EV U.S. Vehicle Sales 2007 – 2014



In 2014, the Nissan Leaf was the highest selling plug-in vehicle in the U.S., with over 30,200 vehicles sold. Chevrolet Volt was second with 18,805 vehicles, followed by the Tesla Model S with 17,300 vehicles, and Toyota Prius PHV with 13,264 vehicles. In 2014, 22 different plug-in vehicle models were offered for sale, with the top five models accounting for approximately 75% of sales.[5]

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4 Electric Drive Transportation Association Sales Data, http://electricdrive.org/index.php?ht=d/sp/i/20952/pid/20952

5 Inside EVs Monthly Plug-in Scorecard, http://insideevs.com/monthly-plug-in-sales-scorecard/

By state, California has the most electric vehicles with 84,879 as of December 2014.[6] NYS had 12,000 EVs at the end of 2014 (and 14,200 as of August 2015).[7] Washington, Hawaii, California, Georgia and Oregon led the nation in 2013 in terms of new car registrations from EVs. In each state, EVs made up over 1% of new registrations. By this measure, NYS ranks 25th in the country.[8] And California's total vehicle market penetration for EVs is 0.23%, three times greater than NYS' penetration rate of 0.073%.[9] Washington, Oregon, Georgia, and Maryland are the only other states with a penetration greater than 0.2%, or 2 in 1,000 vehicles, as measured in December 2014.[10]

2.3 New York State EV and EVSE Markets

2.3.1 New York State EV Data

As of mid-2014, 16 counties in NYS have more than 100 registered plug-in vehicles. Table 3 shows the density of EVs in the New York counties with the most EVs by both area and population. The highest density of plug-in cars is around the New York City metro area. The density of EVs in the New York metro area, and expanding to the nearby Orange, Dutchess, and Ulster counties, suggesting early EV growth is likely to continue in those areas. County-level EV density is shown in Figure 4.

6 https://energycenter.org/clean-vehicle-rebate-project/rebate-statistics

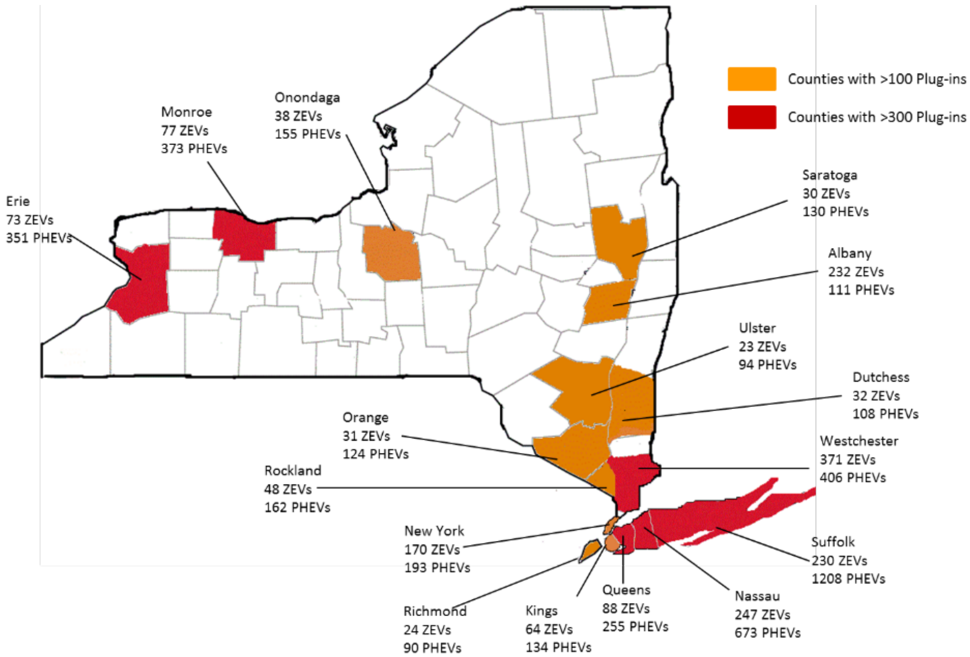
7 Data from New York Department of Motor Vehicles and NYSERDA.

8 http://www.edmunds.com/industry-center/analysis/drive-by-numbers-tesla-in-all-50-states.html

9 New York DMV Data for NY EVs; http://dmv.ny.gov/statistic/2013reginforce.pdf for total NY vehicles; http://energycenter.org/clean-vehicle-rebate-project/rebate-statistics for CA EVs; http://apps.dmv.ca.gov/about/profile/official.pdf for total CA vehicles.

10 http://www.eia.gov/todayinenergy/detail.cfm?id=19131

Figure 4. New York Counties with Highest Density of EVs



Monroe and Erie counties, home to Rochester and Buffalo, also have sizeable EV populations. Buffalo has a strong history with electric vehicles. The city was home to Buffalo Electric Vehicle Company, one of the original EV companies.[11] Albany and Saratoga have relatively large EV populations, boosted by NYS fleet EVs at the capital. EV driving is also likely to grow near Albany, Buffalo and Rochester, however with less traffic in the areas surrounding these cities, EV growth may be slower than in the New York City metro area. Fewer destinations outside of the cities will be accessible within a single charge.

11 http://earlyelectric.com/carcompanies.html

Table 3. New York Counties with Greater than 100 PEVs

Above average counties are highlighted in red. New York County is an outlier and was excluded from the average.

County	# of PEVs	Public Chargers	Population	PEVs/1000 People	Area (Sq Mi)	PEVs/Sq Mi
Albany	343	62	304,204	**1.13**	523	0.66
Dutchess	140	9	297,488	0.47	796	0.18
Erie	424	60	919,040	0.46	1,043	0.41
Kings	198	18	2,504,700	0.08	71	**2.80**
Monroe	450	44	744,344	**0.60**	657	0.68
Nassau	920	25	1,339,532	**0.69**	285	**3.23**
Onondaga	193	96	467,026	0.41	778	0.25
Orange	155	9	372,813	0.42	812	0.19
Queens	343	24	2,230,722	0.15	109	**3.16**
Richmond	114	2	468,730	0.24	58	**1.95**
Rockland	210	6	311,687	**0.67**	174	1.21
Saratoga	160	22	219,607	**0.73**	810	0.20
Suffolk	1438	68	1,493,350	**0.96**	912	**1.58**
Ulster	177	7	182,493	**0.97**	1,124	0.16
Westchester	777	42	949,113	**0.82**	431	**1.80**
New York	**363**	**152**	**1,585,873**	**0.23**	**22.83**	**15.90**

A direct correlation between EV chargers and EVs does not always exists. Suffolk, Nassau, and Westchester counties have relatively high EV penetration rates but relatively little supporting EV infrastructure. This data indicates that EV growth can exist in the absence of high charger density. The opposite phenomenon can also be observed. Counties like Erie and Onondaga have built out the public infrastructure but have yet to see the demand materialize. Erie County has nearly as many public charging stations as Suffolk County, yet Suffolk has more than three times as many EVs. Based on this data, it is hard to definitively conclude that pre-emptively building public charging stations will lead to increased EV sales in all possible markets.

2.3.1.1 New York City Metro Area

The suburbs around New York City—Nassau, Suffolk, Rockland and Westchester—are among the counties in NYS with the highest density of plug-in vehicles both in terms of population and area. Plug-in cars are particularly attractive to people in these areas because driving distances around the New York metro area are short, but have a lot of traffic. EVs have enough range for trips around the area and are very efficient in traffic.

Drivers in these areas tend to have relatively high per capita incomes, and also have the best access to the existing State incentives for EVs. In Suffolk and Nassau, drivers along the Long Island Expressway can use the high occupancy vehicle (HOV) line to reduce their commute times. Drivers in the counties surrounding New York City get a 10% discount on the tunnel and bridge tolls operated by the Port Authority of New York and New Jersey, but the discount is only available at off-peak times. So it is not helpful for regular commuters.

EVs are less popular in the five boroughs of New York City than in the surrounding counties. Four of the five boroughs in New York City rank among the densest counties for EVs in terms of area, though not population. The Bronx has not yet reached one hundred plug-in vehicles.

The boroughs of New York City present several challenges for EV driving. First, these areas have high population density, but a smaller percentage of people drive regularly because they can rely on public transportation. Second, many New Yorkers that do drive do not have a dedicated parking spot at home. Charging at home is the most convenient place for most EV drivers to charge, which presents a challenge for potential New York City EV drivers.[12]

Third, street parking is limited, so taking a spot away from the general population for exclusive EV charging use is challenging, and perhaps undesired by the City government. New York City has over 200 public charging stations, but many are in garages that are expensive to park in. Garage locations make EV charging stations harder to find because people cannot see them from the street. The expense of parking there would also limit drivers from parking for a short time to charge.

The zip codes with the highest number of EVs are Huntington, Dix Hills, Scarsdale, and Rye. These areas are both relatively wealthy and well-educated, two characteristics that are commonly associated with early adoption of EVs.

12 http://www.nyc.gov/html/om/pdf/2010/pr10_nyc_electric_vehicle_adoption_study.pdf

The counties surrounding New York City—Nassau, Suffolk, Rockland and Westchester—present particular opportunities for growing EV driving in NYS. The majority of the housing in these counties is single-family homes with dedicated parking. Many families have two cars, which means a family could choose to have one EV for local trips and one ICE vehicle for longer trips. And because traffic in this region is largely centralized on a few major throughways into and out of New York City, naturally high traffic areas can be identified to put public charging stations.

2.3.1.2 Albany and Saratoga Area

The Capital District presents another area of opportunity for increased EV driving in NYS. Albany County has a very high number of ZEVs compared to the rest of NYS largely due to state fleet vehicles. Of the 232 ZEVs registered in Albany County, 167 of them are in zip code 12238, which is where New York State Department of Environmental Conservation is. The DEC fleet skews the Albany market data.

In addition to EV fleets, The "Albany Electric Vehicle Feasibility Study," conducted by VHB Engineering in 2012 suggested that Albany would be a promising area for EV driving due to the availability of dedicated parking for homes, public parking, and short commute times.[13]

Commutes in the Capital Region Census Combined Statistical Area are below the national average. Commutes between Albany and the closest suburbs are under 10 miles. Albany and Troy are only 7 miles apart. Schenectady and the Clifton Park area are each only 20 miles away. Saratoga is about 35 miles away from Albany and is another common trip for residents of the area. All of these destinations are all well within the range limits of the Nissan Leaf and other economical electric vehicles on the market today.[14]

The challenge in the Capital District is that the population is more diffuse with less traffic around a central point. This distribution will make efficient charging coverage more difficult.

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13 http://www.albanysustainability.com/documents/Albany_EV_Final%20Plan.pdf, p. 20

14 Ibid.

2.3.2 New York State EVSE Market vs. Other States

NYS has 409 public charging station locations as of December 2014, with a total of 907 vehicle charging outlets.[15] 400 of these stations are level 2 chargers, with only 5 DC fast chargers.[16] NYS is fifth in the nation in the absolute number of public charging stations, only behind California, Texas, Florida, and Washington.[17] California has the most chargers, with 1,959 station locations and 5,719 charging outlets.[18] With 194 DC fast chargers, California's share of DC fast chargers as a percentage of all chargers is roughly 10 times higher than NYS.[19] However, on a stations per EV basis, NYS is greater than California, with 0.11 compared to 0.07 stations per EV. By this measure NYS, EV drivers have a greater availability of public charging stations than drivers in California.

Table 4. U.S. State Ranking by EV Charging Outlets – December 2014[20]

State	Stations	Outlets	Rank
California	1,959	5,965	1
Texas	557	1,487	2
Florida	470	1,114	4
Washington	452	1,198	3
New York	409	907	5
Oregon	379	878	6

15 http://www.afdc.energy.gov/fuels/stations_counts.html

16 Ibid.

17 Ibid.

18 Ibid.

19 Ibid.

20 DOE AFDC Alternative Fueling Station Count by State; U.S. Census.

NYS' charging infrastructure is split relatively evenly between Upstate and Downstate: 45% of chargers are located Downstate and 55% are located Upstate. This distribution matches the location of EV registrations in NYS, with 55% of all EVs registered in Upstate counties.[21] It is disproportionate to state demographics as the Downstate region has approximately 65% of the NYS population.[22] However, it makes sense because New York City has 42% of the NYS population and much lower rates of car ownership than Upstate. In addition, the lack of personal garages in New York City limits EV ownership personal garages are often the only way to charge EVs at night.

It is important to note, however, that more public charging stations do not necessarily correlate with higher EV adoption rates. Georgia, for example, has relatively few public charging stations, yet it is the fastest growing EV market in the United States.[23] Similarly, Utah ranks 25th in EV infrastructure per capita, but is 7th in EV adoption. These observations do not allow clear conclusions to be drawn about the direction of causation, if any, between EVs and EV charging stations. However, the data does suggest that EV markets are at least partially driven by factors besides the availability of public charging infrastructure.

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21 NY DMV Data.

22 Downstate includes New York City, Suffolk, Nassau, Westchester, Putnam and Rockland counties.

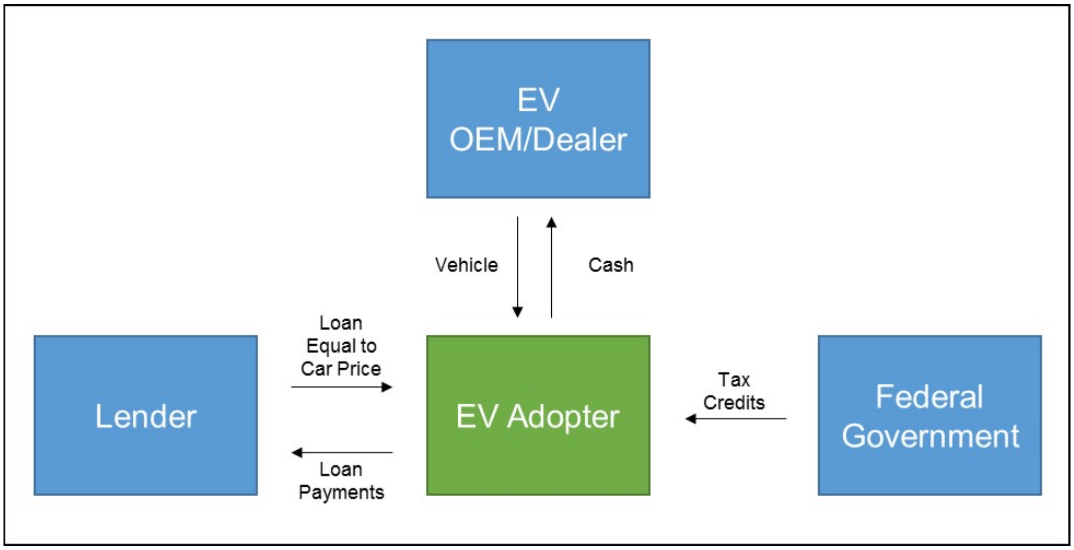
23 DOE Alternative Fuels Data Center, http://www.afdc.energy.gov/

3 Barriers to EV and EVSE Adoption

3.1 Barriers to EV Adoption

A common set of barriers slow the adoption of EVs by consumers in any state. EV market growth depends on consumers deciding to purchase an EV in place of an ICE. Behavioral, economic, and psychological barriers exist that hinder that substitution. The basic EV purchase model is diagrammed in Figure 5.

Figure 5. Simple EV Purchase Model (with Vehicle Financing)



3.1.1 Upfront Cost

Sticker price is a major barrier preventing greater adoption of EVs. When compared side-by-side at an auto dealership, the price of an EV is higher than the price of a comparable ICE. However, this price does *not* account for the on-going costs of gasoline and maintenance, and therefore the price does not accurately reflect the total cost of ownership (TCO) of the vehicle. If a TCO were calculated and displayed, the price would show the consumer that EVs may cost less than ICE because of future costs beyond the upfront cost of purchase.

Implicit in any TCO calculation, though, is a discount rate on future expenses. A “reasonable” discount rate would show that the TCO of an EV is less, however research indicates that consumers tend to use extremely high discount rates.[24] Or, said more generally, consumers are less likely to care about the future gasoline costs of an ICE as much as they care about the amount of money they pay upfront for a vehicle. Therefore, merely presenting a TCO figure at purchase or explaining to the consumer that EVs are actually a better deal overall may not lead to an EV purchase. This result suggests that lowering the sticker price of an EV is critical to increasing consumer substitution of ICE for EVs.

3.1.2 Range Anxiety

Range anxiety is a key psychological barrier to EV adoption because drivers are concerned that their cars will not have enough electricity to get them where they want to go and/or that no charging station will be accessible if the car runs low on electricity. Drivers are likely also concerned that even if a charging station is available, recharging will take too long. In some cases, a full charge may take 12 hours. The average EV drives a far shorter distance before recharging than an ICE does before refueling. Therefore, drivers often express concern that an EV would not be able to cover the distances the driver typically needs to drive in a single driving session without running out of power. This concern is compounded by the fact that EV charging stations are not nearly as ubiquitous and visible to drivers as gas stations are. The combination of shorter range and uncertainty about charging station locations leads consumers to fear that their EV might not get them where they want to go.

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[24] Academic research has found that the implicit discount rate of consumers when making consumption choices related to energy savings is significantly higher than 14%. See Alan K. Meier and Jack Whittier, “Consumer discount rates implied by purchases of energy-efficient refrigerators, Energy, Vol. 8. Iss. 12, December 1983, 957-962; Henry Ruderman, Mark D. Levine and James E. McMahon, The Behavior of the Market for Energy Efficiency in Residential Appliances Including Heating and Cooling Equipment, The Energy Journal, Vol. 8, Iss. 1, 1987, 101-124.

Many consumer surveys consistently find that range anxiety is top of mind for consumers. In one survey, over 71% of respondents acknowledged that range anxiety is a major concern when considering purchasing an EV.[25] Another survey found that only 10% of respondents would be satisfied with an EV range of less than 100 miles.[26] Mounting evidence shows that range anxiety is unfounded and that the average driver behavior can be adequately served by current EV battery technology.[27] Also, plug-in hybrids do not face this barrier because they can run on gasoline if the vehicle goes beyond its electric range. However, until greater awareness and understanding about EV range is formed or EV range increases, this barrier will persist.

3.1.3 Charging Requirement Uncertainty

Drivers are also broadly uncertain about how EVs are charged and what kind of new behaviors they may have to adopt to accommodate the charging of their EV. Whether charging at work or in public, drivers are unsure how to assess how far they can go with their EV, how to find charging stations, how long charging will take and other fundamental questions about EV operation. Each of these questions is certainly answerable, and many EV's will actually provide all this information automatically to the driver. But for a driver considering switching from an ICE to an EV, these questions may appear complex to answer. This uncertainty highlights the fact that lack of information about EV operation is a significant barrier to adoption. A smaller but still important barrier to EV ownership is that driving an EV does require some modest changes in driver behavior.

3.1.4 Home Charging Challenges

Drivers who do not have their own garage and park on the street or in a lot are hesitant to buy an EV because charging the EV at home is not an immediately viable option. The vast majority of EVs currently on the road are charged in private garages. Converting drivers without access to easy home charging will require a concentrated effort to increase public or workplace charging station availability. This barrier is particularly acute in cities where few drivers have their own garages, as is the case in New York City.

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25 http://theweeklydriver.com/range-anxiety-still-deterent-electric-car-sales/

26 http://www.plugincars.com/survey-be-satisfied-electric-car-drivers-want-150-miles-range-127255.html

27 http://blog.rmi.org/blog_2014_11_04_enough_with_the_range_anxiety_already

3.1.5 Lack of Consumer Awareness

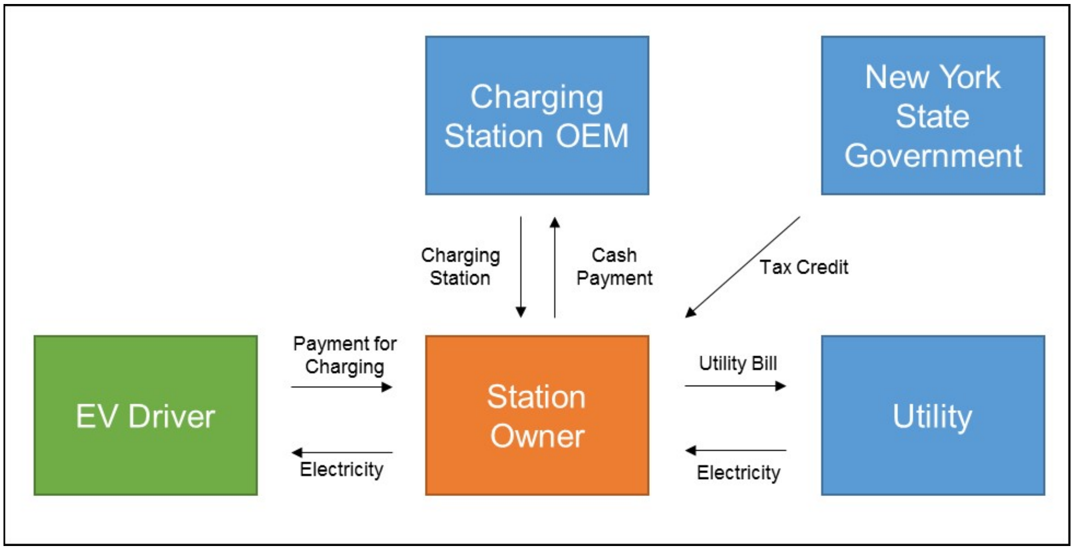
Finally, a general lack of consumer awareness of EVs as a viable option remains a barrier to market growth. While consumers may see EVs on the road and know that they exist, some consumers may still not recognize how far the technology has evolved. An information gap remains about the cost effectiveness of EVs, their increased ranges, and the advent of models with lower up-front costs. Greater marketing by manufacturers, more focused selling techniques by dealerships and greater market penetration (and therefore greater visibility) of EVs will all help consumers consider switching from an ICE to an EV.[28]

3.2 Barriers to EVSE Investment and Adoption

Figure 6 diagrams the basic purchase and usage model for public EVSE. However, much like EVs, a set of barriers slows the installation of and investment in EV charging stations. Some of these barriers apply across the charging market and some are specific to the market sector. The EV charging station market can be broadly divided into three sectors, based on the location of charging – public locations, managed properties and single-family homes. Public locations include retailers, public garages and other places that the average person views as public. Managed buildings include office buildings and multifamily housing. These two sectors will be the primary focus of this report.

[28] http://www.ey.com/GL/en/Industries/Automotive/Gauging-interest-for-plug-in-hybrid-and-electric-vehicles-in-select-markets---Alternative-powertrain-survey-highlights

Figure 6. Simple EV Charging Station Purchase Model (Owner-Operated)



3.2.1 Upfront Cost

The first barrier a potential station owner may run into is the upfront cost of purchasing and installing charging station equipment. The cost of acquiring and installing a station can vary widely depending on the kind of station installed and the complexity of the installation. The total cost can range from approximately $1,000 for a non-networked charger to nearly $100,000 for a DC fast charger.[29] Even at the low end, the expense may be enough to stop a customer from moving forward. The high end represents a significant capital expenditure that currently does not offer a strong opportunity to earn a return.

3.2.2 Utilization Uncertainty

A major barrier to adoption of EVSE is the station owner's uncertainty about how much the station will actually be used. The risk of low utilization due to low EV penetration creates uncertainty for the station about how or when the cost of the EVSE installation might be recovered. With a high number of EVs on the road and a high level of public charging, a potential EVSE installer might feel confident that the high upfront cost of installation could be recovered by charging customers for the use of the station. In markets with low EV penetration such as NYS, though, potential station owners do not feel confident that the necessary amount of revenue can be generated to recover the cost of installation, let alone make a profit.

[29] C2ES AFV Finance Initiative, http://www.c2es.org/docUploads/afv_fueling_infrastructure_deployment_barriers.pdf, page 12.

3.2.3 Complexity and Cost of Installation

Many potential station owners do not understand what is involved in the physical installation of a charging station. Details include understanding the hardware required, the hardware costs and where to purchase hardware, what is involved in installation, and the cost of installation. An owner can choose to install many possible types of hardware, and the technical complexity of installation can vary widely. This lack of information and perceived complexity may prevent potential station owners from moving forward on an installation.

3.2.4 Station Management Uncertainty

Once a charging station is installed, owners still may not know how to manage the use of that station and how to collect revenue from it. Owners looking to charge customers for the use of the station need to understand a range of potential pricing structures and a host of potentially complex regulatory rules around demand charges to ensure their utility bill does not increase significantly. The station must also be technically managed to make sure the equipment works properly, that only drivers with appropriate credentials are allowed to access the station, and, ideally, that cars do not continue to charge once the battery is full.

3.2.5 Difficulty Assessing Ownership and Revenue Models

An increasing number of new business models and companies allow a site owner to install a charging station without having to directly own the station, pay the cost of installation and/or manage the device. However, this market is not yet fully mature, making clear comparisons between options and providers difficult. A site owner must decide if he or she wants to allow somebody else to own a station on their site, and also if the users of that station should be charged for usage. In a retail location, a site owner might see the station as a direct source of revenue. Or the site owner might see the station as a marketing tool that draws customers into their store with free charging. The choice to charge or not charge tenants of managed properties is an equally challenging one. New charging station businesses can help site owners navigate these questions, but the lack of market development means clear information can be hard to obtain.

3.2.6 Difficulty Assessing Indirect Benefits

A station owner at a retail location or a managed property may believe there are indirect benefits of installing a charging station, but those benefits are hard to measure. For example, a retailer may believe that consumers will stay in the store longer and spend more money if they are waiting for their EV to charge. But precisely measuring this additional revenue is difficult. Similarly, an employer may believe s/he can retain employees by offering EV charging as an amenity, but measuring the value of that retention is difficult. These value streams are real, but it is hard to justify capital investments based on these indirect benefits.

4 Increasing EV and EVSE Adoption

4.1 EV and EVSE Market Dynamics

Studies have shown that reducing the TCO of EVs and plug-in hybrids relative to ICE vehicles increases the likelihood of EV adoption in a market.[30] For example, tax credits of $1,000 can increase hybrid sales by 3%. Total cost of ownership includes the purchase price of the vehicle as well as fuel, tax, insurance and maintenance costs throughout the vehicle's life. Consumer fiscal incentives to bring down the purchase price of EVs are a powerful way to create a beneficial total cost of ownership for consumers.[31]

Though exceptions exist, in general, markets with the highest fiscal incentives for EVs also have the highest market share. An International Council on Clean Transportation (ICCT) analysis of seven EV markets finds clear examples in the Netherlands and Norway. Figure 7 shows that both countries have high fiscal incentives and also very high market share. Similarly, California's relatively high incentives for all electric vehicles help NYS to stand apart from the rest of the U.S.

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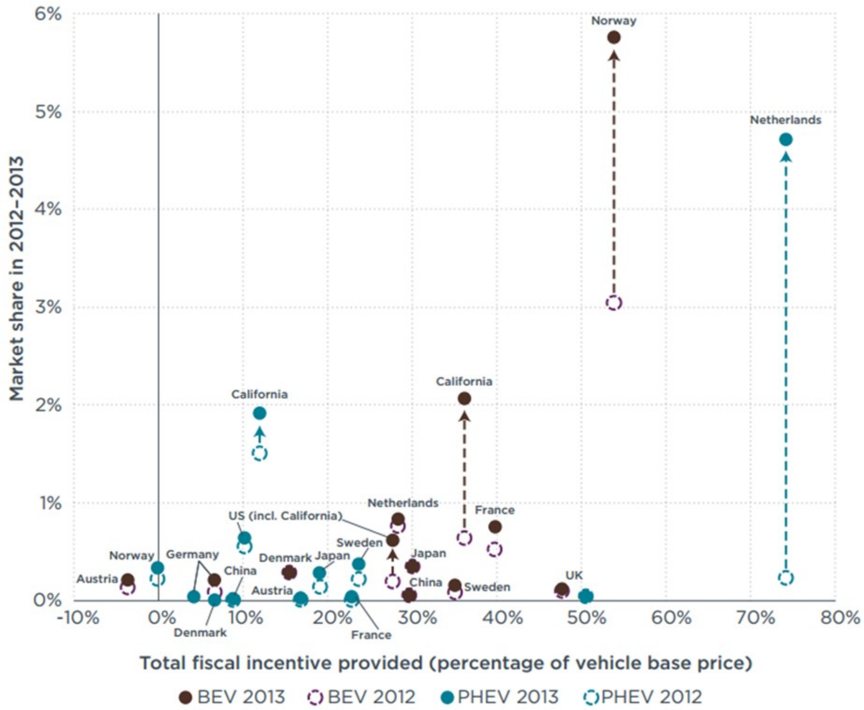
30 Collantes and Eggert, "The effect of monetary incentives on sales of advanced clean cars in the United States: Summary of the Evidence," UC Davis, September, 2014. http://policyinstitute.ucdavis.edu/files/ZEMAP-Policy-Memo-Vehicle-Incentives.pdf

31 Mock and Yang, "Driving Electrification: A Global Comparison of Fiscal Policy Incentive for Electric Vehicles," International Council on Clean Transportation, May 2014. http://www.theicct.org/sites/default/files/publications/ICCT_EV-fiscal-incentives_20140506.pdf

Figure 7. Vehicle Market Share vs. Per-Vehicle Incentives[32]



Several studies have attempted to quantify the impact of fiscal incentives on EV adoption. Sierzchula et al. found that holding all other factors constant, each $1,000 increase in financial incentives would cause a country's EV market share to increase by 0.06%. Each additional EV charging station per 100,000 residents was found to have twice the impact, increasing market share by 0.12%.[33] These studies are important because they confirm that incentives do in fact have a market impact, but it is hard to precisely measure their effectiveness or the driver of increased EV market share because EV adoption also relies in some part on the existence of a charging network. Therefore, isolating the pure subsidy impact proves challenging.

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32 Mock and Yang, "Driving Electrification: A Global Comparison of Fiscal Policy Incentive for Electric Vehicles," International Council on Clean Transportation, May 2014. http://www.theicct.org/sites/default/files/publications/ICCT_EV-fiscal-incentives_20140506.pdf

33 Sierzchula et al. 2014. "The Influence of Financial Incentives and Other Socio-Economic Factors" on Electric Vehicle Adoption." *Energy Policy* 68: 183–194. http://www.sciencedirect.com/science/article/pii/S0301421514000822

Other studies have looked at the impact of incentives for hybrid vehicles as a proxy for all electric vehicles. These studies have found that in hybrids, a $1,000 increase in consumer financial incentives caused a 3 to 4.5% increase in adoption.[34] Interestingly, the timing of when the customer receives the incentive could have a much greater impact than the amount. Gallagher and Muehlegger found that while an income tax credit of $1,000 resulted in a 3% increase in hybrid sales, that same $1,000 dollars offered as a sales tax waiver resulted in a 45% increase in sales.[35] This idea is corroborated by Eric Cahill at University of California, Davis on the role of dealers in the EV market. Uncertainty about tax credits and rebates makes selling EVs even more challenging for dealers. Cahill also suggests that making savings from fiscal incentives more immediate and simpler would greatly increase their value to consumers with no additional cost to the government.[36]

Nissan Leaf sales over the past two years show a similar relationship between reducing the price of EVs and increasing adoption. In 2012, the base price of the Nissan Leaf was $35,200. Only 9,819 Leafs were sold that year. In January 2013, Nissan dropped the base price to $28,800 (a $6,400 reduction). In 2013, Nissan sold 22,610 Leaf (a 230% increase). This data demonstrates a 35% increase in EV demand per $1,000 decrease in cost. Though other changing market conditions during this period may have contributed, a strong correlation exists between the EV price and sales.

Reducing the upfront cost of EVs, either through fiscal incentives direct to the consumer or through policies that encourage car companies to reduce prices, is likely to have the greatest impact on decreasing the TCO of EVs relative to ICE vehicles. Policies that allow customers to see the savings immediately rather than waiting until the end of the year will be more effective. Other ways to reduce the cost of EV ownership include reducing the cost of electricity and charging, parking, tolls and insurance.

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[34] Jenn et al. 2013 “The impact of federal incentives on the adoption of hybrid electric vehicles in the United States,” Energy Economics.

[35] Gallagher and Muehlegger. 2011. “Giving green to get green: Incentives and Consumer Adoption of Hybrid Electric Vehicle Technology,” Journal of Environmental Economics.

[36] Cahill, Eric et al. 2014. “New Car Dealers and Retail Innovation in California’s Plug-in Electric Vehicle Market.” http://its.ucdavis.edu/research/publications/publication-detail/?pub_id=2353

The relationship between the number of public EV charging stations available in a geographic area and the amount of EV driving in that area is not clear. The availability of charging at home and variations in the pricing and placement of public EV charging stations are additional factors. Researchers believe that visible, public EV charging is important to promote the adoption of EV driving, but a mismatch of demand and infrastructure often leads to underutilization.[37]

However, Nissan's No Charge to Charge pilot program in Texas provides anecdotal evidence that access to free public charging increases EV adoption. According to Nissan, when the company began offering free charging through its No Charge to Charge pilot program, Leaf sales in test markets grew 60 to 150% faster than in other markets.[38]

Availability of workplace charging has also led to additional EV adoption. EVs parked at workplace chargers become a miniature EV showroom, which can inspire conversation and knowledge sharing about EVs.[39] The workplace also provides a location outside the home that a driver can conveniently leave a car parked for many hours. In some cases, workplace charging stations have been so effective in promoting purchase of EVs that after chargers are installed, charger demand tends to outpace supply.[40]

4.2 Potential Strategies for EVSE Investment and EV Market Growth

To develop a financing or business model aimed at growing EVSE adoption and EV uptake, one must first analyze which strategy will be the most effective. A business model must target a specific segment of the market, such as a set of site owners or a set of potential drivers. The choice of who to target should be based on which strategy will lead to the most efficient conversion of drivers from ICE to EVs. Efficiency in this case means that the least amount of private and public dollars are spent to affect the conversion.

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37 Cai, Hua et al. 2014. "Siting public electric vehicle charging stations in Beijing using big-data informed travel patterns of the taxi fleet." Transportation Research Part D: Transport and Environment 33: 39-46. http://css.snre.umich.edu/publication/siting-public-electric-vehicle-charging-stations-beijing-using-big-data-informed-travel

38 http://chargedevs.com/features/will-nissans-no-charge-to-charge-program-drive-leaf-sales/

39 http://www.pevcollaborative.org/sites/all/themes/pev/files/Workplace%20Charging%20Webinar%20Full%20PPT%20Presentation.pdf

40 "Charging for Charging:The Paradox of Free Charging and Its Detrimental Effect on the Use of Electric Vehicles" http://www.its.ucdavis.edu/research/publications/publication-detail/?pub_id=1919

Today many within the EV and EVSE industry and community express "conventional wisdom" about which strategies will most effectively lead to greater EV adoption. Some potential strategies involve greater deployment of EVSE, while others do not. Five examples of commonly expressed market growth strategies are explained as follows.

Example 1: The best way to get more EVs on the road is to subsidize the purchase of EVs directly, and then build EVSE infrastructure to follow demand created by the EV drivers.

This strategy is based on the simple premise that lowering the upfront cost of the EV itself is the most effective way to increase EV adoption. As previously discussed, the difference in sticker price between an ICE and EV is a major barrier to consumer adoption of EVs. A strategy based on this view could be expensive, and may require a significant outlay of public funds to cover the cost of the subsidy. Such a strategy also doesn't directly address the barriers to EVSE installation, though if more EVs are on the road due to subsidies then the concern over EVSE utilization may be reduced. Although evidence in several states, particularly California and Georgia, shows that vehicle subsidies lead to adoption, some states have grown their markets without heavy subsidy.

Example 2: Public charging stations are a critical signal to potential EV drivers that range anxiety is not an issue, but most charging will still be done at home.

This strategy agrees with the premise that public charging stations must lead the market to increase EV adoption, but questions whether or not the public stations will ever be highly used. As most EVs actually have adequate range for daily driving habits, the mere sight of public charging stations may give drivers confidence to switch to EVs without the concerns of range anxiety. However, once the driver has purchased an EV, past evidence suggests s/he may end up primarily charging the car at home. The strategy suggests that public stations are indeed important for EV market growth, but leaves open the question of whether or not the public stations that are installed will ultimately be viable investments.

Example 3: Public charging stations will really only be used if they are at the location an EV driver was already driving to.

This strategy is based on the idea that EV drivers do not view public charging the same way they view filling up an ICE car with gasoline. ICE drivers will often drive many miles out of their way to fill up their tank if the car is low on gas. However, it is possible that EV drivers will not exhibit the same behavior to recharge their car. The primary driver for this distinction is that filling a car with gas takes several minutes, while recharging an EV may take many hours. Therefore, a driver will not go to a place s/he does not want to be and then wait several hours for the car to charge. Rather, a driver will only charge at a public station if the station is located at a place the driver already wanted to go or has a need to spend several hours. Note that fast charging stations largely avoid this challenge.

Example 4: Public charging stations only directly lead to actual EV adoption when stations are at precise, targeted locations, such as the workplace.

Related to the view that EV drivers will not drive out of their way to charge, this view is based on evidence that placing charging stations at the locations drivers are most likely to spend several hours is the most effective way to induce EV purchases. The workplace and home are the most obvious locations that drivers will predictably spend several hours a day. So putting a charging station at an office parking lot may lead a driver to switch to an EV because s/he has certainty about a charging location. Interviews with market participants confirm that in certain cases this “build it and they will come” approach does work when stations are installed at workplaces.

Example 5: Because barriers are currently preventing rapid adoption of EVs, installing public EVSE today is only to increase market readiness and prepare for wider EV adoption in several years.

Because the cost of EVs, the cost of charging stations, and consumer awareness are currently such high barriers, significant EV uptake shouldn’t be expected in the near future. Once the cost of EVs declines, a more focused effort can be made by all market participants to realize meaningful gains in market size. Under this strategy, charging station installations made today are primarily to create market readiness for the eventual uptake of EVs. The stations serve an important function in signaling market readiness and can be used by EV drivers on the road today. However, the stations will not be heavily used or be viable investments for several years. A strategy based on this view means that the targets and goals of charging installations should be limited.

5 EV Charging Industry

5.1 EV Charging Business Models

A set of business and purchasing models has evolved in recent years in an attempt to increase EVSE adoption and simplify the purchase process. Though a range of models and variations exist in the EVSE market, most models contain a set of attributes that define who owns the station, who earns revenue from the station and who manages the station. The critical attributes of these models include:

- Station ownership – Site owner vs. second-party.
- Station management – Site owner vs. second-party.
- Station maintenance – Site owner vs. second-party.
- Station network – Station visible to drivers as part of a network of stations vs. independent.
- Station revenue recipient – Revenue to site owner vs. second-party station owner.
- Station electricity cost bearer – site owner vs. second-party station owner.
- Station pricing model – pay per kilowatt-hour vs. pay per hour vs. monthly subscription vs. free charging.

These attributes can be arranged in many potential permutations. However, among the numerous companies now operating in this market, their business models can broadly be broken down into two categories, defined by whether the station is owned and operated by the site owner (host) or a second party.

5.1.1 Host Owns and Manages Station

In this model, the EV charging company sells a charging station to a host (an individual or business) that wants EV charging on their property. Once the host purchases a charging station, they have full control over that station. The two big categories of charging stations that the host has to choose from are networked and non-networked stations.

Non-networked stations just deliver electricity and are not connected or affiliated with any other charging-related service. They do not allow station hosts to charge the driver for electricity. When a host purchases a non-networked station, they pay the up-front costs for the hardware and installation costs. The only recurring costs are for the electricity itself. The hardware for non-networked stations is cheaper than for networked stations but they provide no mechanism for the host to recover the up-front costs or the recurring electricity costs.[41] This market is almost entirely level 2 chargers. Clipper Creek is an example of a popular non-networked charging station.

Many residential chargers are non-networked because the electricity costs are just added to the homeowner's utility bill. Workplaces may also opt for non-networked chargers if the employer is sure that they will always want to cover the costs for electricity or establish another way to charge employees for the use of the stations. Non-networked chargers are less popular for public charging purposes.

Networked stations connect to a monitoring and management platform so that the host can manage the station remotely. They allow hosts to charge drivers for EV charging and set the pricing as they see fit. If the host chooses a networked station, they can sometimes choose which network for managing it. Networked chargers constantly report their status to the network they belong to which allows the data to be fed through cell phone applications like ChargePoint. This option allows drivers to locate available stations nearby and can let them know when their car has finished charging. It might help site hosts who would like to use the charging station to attract customers to their business. The data from the management platform also allows the charging company to maintain all of the chargers on the network, removing the burden from the host. In addition to the up-front and electricity costs, networked charging stations usually also require a monthly service charge paid to the EV charging network for access to the management software and the network benefits. ChargePoint and SemaConnect are examples of popular networked charging stations that a site host could purchase.

Networked stations are most commonly used for public charging because they allow for remote management and they allow the host to charge the driver directly for electricity. Through charging a premium on the electricity, a station host could eventually recoup the costs of the station and earn a profit. They provide the additional benefit of bringing EV driving customers to their location to charge. EV drivers often use applications on their cell phones, computers, or in-car navigation systems to find charging stations. If a driver needs to charge his/her car, s/he is likely to choose a retail destination that she knows has a charging station over one that does not.

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41 http://www.lilypadev.com/choosing-an-ev-charging-station-for-commercial-use/ Note, that a non-networked station could recover some cost by making customers pay at an associated parking meter, or some other parking-spot related payment mechanisms.

5.1.2 EVSE Provider Owns and Manages Station

Property owners and lessees can also choose to give parking spaces to an EV charging service provider (EVSP) to install a charging station. In this case, the EVSP may pay a licensing fee to the host for the right to use the space. The station remains completely in the control of the EV charging service provider. The service provider manages the station and sets the pricing consistent with the other stations in its network. Revenue sharing may or may not be a component of the arrangement, in which the host gets to keep a small portion of the revenue from charging.

Under this model, the EVSP bears all of the risk of the investment. These companies are relying on earning a profit from the sale of the service they are offering (charging an EV). They often charge membership fees in addition to fees per charging session. Examples of EV charging companies using this model are Car Charging Groups' Blink Network and NRG's eVgo network.

Nissan is helping to defray these higher costs to Leaf drivers by partnering with NRG evGo, Blink, and Aerovironment. Through its No Charge to Charge program, NRG is making charging free for its customers in select markets for limited periods of time.[42]

In short, many combinations of business partnerships in networked charging exist where different players in the value chain can split costs (both fixed and variable) and revenues. Fostering partnerships in this regard may be one NYS' best policy options.

5.2 EV Charging Technology

Three levels of EV charging could be made available to the public. Level 1 charging is a standard 120-volt electrical outlet, which can be made available to drivers with minimal cost. This provides about 3-5 miles of range per hour of charge. This charging option is convenient for plug-in hybrids with small batteries, but not for all-electric cars with larger batteries. All-electric cars with 80 miles of range or more would take more than 12 hours to charge from empty on a Level 1 outlet.

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42 http://chargedevs.com/features/will-nissans-no-charge-to-charge-program-drive-leaf-sales/

Table 5 describes the three types of EV charging. For public charging the real decision is when and where to install level 2 and level 3 charging stations. Each has pros and cons. A combination of both throughout NYS roadways will be necessary to meet drivers varying needs.

Table 5. EV Charging Level Data

Data source: California PEV Collaborative, http://www.driveclean.ca.gov/images/pev/charge_times_chart_lg.jpg

Charging Level	Power Supply	Charger Power	Miles of Ranger per Hour of Charge	Charging Times from Empty to Full	
				BEV	PHEV
Level 1	120VAC Single Phase	1.4 kw @ 12 amp	~3-4 miles	~17 Hours	~7 Hours
Level 2	240VAC Single Phase	3.3 kW	~8-10 miles	~7 Hours	~3 Hours
		6.6+ kW	~17-20 miles	~3.5 Hours	~1.4 Hours
DC Fast Charge	200 - 450 VDC up to 90 kw (≈200 amp)	45 kW	~50-60 miles (~80% per 0.5 hr charge)	~30-45 Minutes (to ~80%)	~10 Minutes (to ~80%)

5.2.1 Level 2 Chargers

Level 2 chargers provide up to about 20 miles of range in an hour and require about 3.5 hours to fully charge a typical all-electric car. Given that 95% of all driving trips are under 30 miles,[43] EV drivers rarely need to charge their car from empty and an hour is often sufficient to recharge a car for the next trip. Level 2 chargers make sense anywhere people might spend an hour or more, such as shopping centers, sit-down restaurants, gyms, theaters, museums, hospitals, schools, and workplaces. Level 2 charging has been particularly popular at workplaces.

All EVs come with the same SAE J1772 plug that enable them to plug into a Level 1 or 2 charging station. Level 2 chargers are cheaper to install than DC chargers. Including installation costs, on average Level 2 chargers cost between $8,000 and $10,000 per charging station.

43 http://www.solarjourneyusa.com/EVdistanceAnalysis5.php

5.2.2 DC Fast Chargers

DC fast charging (DCFC) is often referred to as Level 3 charging. Not all EV models have DC charging capability. Those EVs with DC charging capacity can typically charge up to 80% of their battery in about 30 minutes. This speed is convenient for short stops, including highway rest stops, street parking, or grocery shopping. DC charging allows cars to take longer drives in EVs with shorter stops along the way. DC charging is still not as fast as refueling a car with gasoline. Chargers should still be sited at locations that drivers would want to go to anyway, so drivers have something to do while the car charges.[44] DC charging would also be convenient outside of coffee shops and other retail locations where you spend about 30 minutes.

Keeping an EV plugged into a DC charger for longer than 30-45 minutes has diminishing returns. As the battery gets closer to full, the battery takes much longer to charge because the EV must reduce the current.[45] Pricing to customers on DC charging stations is usually designed to incentivize drivers to remain plugged in for no longer than 30-45 minutes. For example, the NRG evGO network charges $0.10 to $0.20 per minute of charging. Remaining plugged in for an extra half-hour costs an extra $3 to $6 with minimal gain in additional range.

Three different major DC charging technologies are on the market now. Tesla has its own proprietary system for its Supercharger network. Other EVs use either the SAE Combo or CHAdeMO standard. The technology is broadly split by geography, with Asian manufacturers using CHAdeMO, and American and European manufacturers using SAE Combo. For example, Nissan uses CHAdeMO while BMW uses SAE Combo. Charging stations are usually only compatible with one DC charging technology (though some now offer both types). The NRG evGo stations have both CHAdeMO and SAE combo. Efacec also makes a DC charger with both charging technologies that can be operated on a network such as ChargePoint or Greenlots.

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44 Cai, Hua et al. 2014. "Siting public electric vehicle charging stations in Beijing using big-data informed travel patterns of the taxi fleet." Transportation Research Part D: Transport and Environment 33: 39-46.

45 http://www.teslamotors.com/supercharger

DC charging stations can provide several different levels of power. Tesla Superchargers provide 120 kW. ChAdeMO chargers usually provide 50 kW.[46] SAE Combo chargers can provide either 24 or 50 kW.

DC charging stations are generally much more expensive than Level 2 charging stations. Including installation costs, they usually cost between $60,000 and $80,000 per charging station. Among the cheapest DC fast chargers available on the market today is BMW's 24 kW fast charging station. The station, made by Bosch, can be purchased for only $6,500 by "partners" that put the stations in public locations. These charging stations use SAE Combo charging only. They can restore the BMW i3's 22 kWh battery in 30 minutes.[47]

5.3 EV Charging Ecosystem

Many different industries and groups of people have a stake in the growth of EV market (see Table 6). Increasing the adoption of EV driving and charging will require understanding each of these groups' roles and their incentives.

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46 http://www.pluginamerica.org/drivers-seat/ac-versus-dc-charging-what-difference

47 http://www.motorauthority.com/news/1093622_bmw-gives-i3-a-boost-with-new-6500-dc-fast-charger

Table 6. EV Charging Ecosystem Stakeholders

Stakeholder	Role	Incentive
Property owner	Hosting charging stations	• Happier tenants • Increase property value • Increase revenue
Workplace Property Lessee	Hosting charging stations	• Happier employees • Decrease fuel costs for fleets • Green brand image
Commercial Property Lessee	Hosting charging stations	• Happier customers • Increase profits from customers • Green brand image
EV Charging Company – Host Owns Model	Sell charging stations and charging station management packages	• Increase sales of charging stations and packages • Build brand • Grow network
EV Charging Company Owns Model	Install and operate a network of charging stations	• Maximize profits from electricity sales • Build brand • Grow network
Auto Companies	Make and market EVs	• Sell cars • Green brand image
Auto Dealers	Sell EVs to end customers	• Sell cars quickly and easily • Maximize profits
Utility	Provide electricity	• Sell electricity • Load management
Municipalities	Provide and manage parking	• Promote commerce in municipality • Safe and healthy communities
Drivers	Purchase and charge EVs	• Decrease fuel costs • Reliable driving • Convenient charging
Advertisers	Sponsor charging stations	• Impactful ads • Maximize impressions • Build brand • Green brand image
Banks	Finance charging stations	• Maximize return on capital
State and Federal Government	Promote EV driving and charging	• Maximize impact of investments

5.4 Charging Station Utilization

EV charging has the potential to earn a premium on the sale of electricity for providing access to charging in public. Given high station utilization, this premium can allow the station owner to recoup its investment and earn a profit. However, in order to recover costs in a reasonable time period, stations must have a sufficient level of utilization. In many areas with small populations of EVs, charging station utilization is currently low. Over the last year, utilization at public charging stations in New York State ranged from 3-4% on average.[48] Regardless of whether the premium a station owner charges on electricity, it will take many years to make a return on the investment.

Charging station utilization is a function of both the number of charging stations and the number of EVs in a market. All things equal and assuming well-placed stations, if the number of EVs in a geographic area grows faster than the number of charging stations in that area, utilization can be expected to increase. If the number of charging stations in an area grows faster than the number of EVs, utilization can be expected to decrease in the short term.[49] Table 7 demonstrates this relationship observed in NYS through data from a subset of charging stations participating in a study by NYSERDA and Idaho National Lab. From the fourth quarter of 2013 to the first quarter of 2014, plug-in vehicles in NYS increased by 19%, but the number of charging ports only increased by 10%, so utilization spiked 27%. Then from the first to the second quarter of 2014, plug-in vehicles grew by 6%, but charging ports increased by 27% so utilization fell 7%.[50] Many factors at play here, and direct causality cannot be assumed from this small sample size of data. However, the data may be instructive.

Table 7. Change in EVs, Charging Stations, and Utilization in New York 2013-2014[51]

	% Increase in PEVs	% Increase in Charging Ports	% Change in Public Charging Utilization
Q4 2013 - Q1 2014	18.80%	10.10%	27.30%
Q1 2014 - Q2 2014	5.80%	27.00%	-7.10%
Total (Q4 2013 - Q2 2014)	**25.60%**	**39.90%**	**18.20%**

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48 NYSERDA Electric Vehicle Charging Infrastructure Reports October 2013 – October 2014, http://beta.nyserda.ny.gov/About/Publications/Research-and-Development-Technical-Reports/Transportation-Reports.aspx

49 An increase in EVSE may encourages more people to drive their EVs farther and encourages them to join EVSE networks. So in the long term it could increase usage rates at all (or many) stations.

50 Ibid

51 NYSERDA Electric Vehicle Charging Infrastructure Reports October 2013 – October 2014, nyserda.ny.gov/About/Publications/Research-and-Development-Technical-Reports/Transportation-Reports.aspx

Due to what many describe as the chicken-and-egg nature of EVs and EV charging, EV experts at the Electrification Coalition expect that in the early stages of the EV market, the ratio of charging stations to EVs must be high. The charging stations are considered a necessary signal that the infrastructure exists to support drivers, even though too few drivers may exist to use the stations frequently. As more drivers start to see more charging stations, drivers will become more comfortable with the idea of driving an EV and will be more likely to purchase one. Over time, the ratio of EVs to chargers should increase and as a result, utilization will increase. Although this path of market development might in fact be accurate, it shows that a strong disincentive exists to be an early investor or adopter of public EVSE when utilization is expected to be low.

In addition to the ratio of EVs to charging stations in an area, the other two factors that influence utilization are placement and pricing. Charging stations should be in locations that people want to visit anyway so drivers don't need to go out of their way to charge. Studies attempting to optimize charging station locations have used the goal of minimizing drivers' costs in terms of walking distance to their final destinations.[52] Reports from NYSERDA and Idaho National Labs demonstrate that concept, showing that workplaces and university and medical campuses have relatively high utilization in NYS. Retail locations in NYS are also associated with relatively high utilization on a per session basis. The sessions are shorter than at a workplace or medical campus, so overall utilization appears lower, but over the past year retail locations were second to medical campuses in terms of the highest number of charging events. Central, highly visible, high traffic locations would also help increase utilization.[53]

Pricing for charging in public greatly impacts utilization. For driving an EV to make financial sense, the cost of electricity must be lower than the cost of gas to drive the same distance. When a driver charges at home, savings relative to the cost of gas are clear because the driver pays the basic residential retail electricity rate. EV drivers may be willing to pay a small premium at public charging stations for the convenience of being able to charge where they need to. However, if the cost of charging in public is too high relative to the cost of gas or to what they pay for electricity at home, they will not be willing to charge in public, which may limit EV driving.

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52 Chen, et al, "The Electric Vehicle Charging Station Location Problem: A Parking-Based Assignment Method for Seattle," Proceedings from the 92nd Annual Meeting from the Transportation Resources Board in Washington DC, January 2013.

53 NYSERDA Electric Vehicle Charging Infrastructure Reports October 2013 – October 2014, nyserda.ny.gov/About/Publications/Research-and-Development-Technical-Reports/Transportation-Reports.aspx

When the site host owns the charging station, the host receives ancillary benefits such as happier employees and customers and a greener brand image, which could make the investment in charging stations worthwhile, regardless of the return from the sale of electricity. These benefits could make them open to a longer investment horizon than they might be otherwise. As a result, many hosts provide free, subsidized, or at-cost charging.

In the business model where the station is owned by an external operator, the station owner is relying only on the premium from the sale of electricity to make a return on investment. However, given low utilization rates, the availability of free public charging, and the low-cost of charging at home, finding a pricing strategy that seems affordable to drivers, but still makes a significant margin on the cost of electricity is challenging. In NYS today, the market is generally split on pricing, with for-a-fee stations located mostly in NYC, and free stations mostly in the rest of NYS. Therefore, to date, for-a-fee stations are not directly competing with free stations. This practice is likely to change as the EV market in NYS grows.

More than just the overall cost to the driver of a charging session, the structure of the pricing plays a big role in incentivizing driver behavior and utilization. Station owners can choose to charge by the kilowatt-hour, by the hour, per session, or some combination of the three. Charging by the kilowatt-hour is the most transparent and straightforward way to charge. However, once a car's battery is full the car draws very little power giving the driver little incentive to unplug. One car could end up hogging a charging station all day, blocking the station from use by others. Charging by the hour incentivizes drivers to stay plugged-in for as little time as possible. Charging for the session incentivizes drivers to stay for as long as they would like. Any pricing package that deviates from the straight per-kilowatt-hour rate makes price comparison between home charging, public charging, and gas fueling more difficult. This information gap could deter current EV drivers from charging in public and potential EV drivers from investing in an EV.

To be profitable for the station owner, charging stations need high utilization. They need to charge a small premium on electricity such that they can use the margin to earn a return on investment. The premium cannot be so high as to deter people from charging in public.

6 Economic Viability of EVSE in New York State

Owning a charging station is like owning any other revenue-generating asset. Ownership of the asset is attractive if the expected revenue generated is adequate in comparison to the cost of purchasing, operating, and maintaining the asset. EV charging station ownership can be assessed based on this simple transaction structure. Two simple methods for assessing the economic viability and attractiveness of charging stations are the simple payback period analysis and discounted cash flow (DCF) analysis. The payback period is a measure of the period of time required for an investment to generate income equal to the initial upfront cost of the investment. For example, a $1,000 investment that generates $200 in income annually has a simple payback period of 5 years. In the case of EVSE, the investment is the upfront cost of the charging station, and the income is generated by drivers using and paying for electricity from the charging station. The precise amount of income primarily depends on the price of electricity charged to customers and how frequently the charging station is used. Though this analysis does not account for the time value of money or future profits beyond the break-even point, the metric is a simple yardstick for investment viability for particular investors.

A DCF analysis is more detailed, and produces a precise expected value of the investment, accounting for all present and future costs and revenue sources. In this type of evaluation, the upfront cost of buying and installing a charging station is compared to the long-term cash flow generated by the station. This long-term cash flow is generally the difference between the revenue generated by the station and the cost to operate the station. Revenue is generated by charging customers for the use of the station under a given pricing structure, and the operating expenses include the cost of electricity and other on-going maintenance or service costs. The future cash flows are then discounted to a present value figure using a given discount rate, and that present value is compared to the initial upfront cost of the station. If the resulting net-present value (NPV) is positive, then the station is a viable investment. If the NPV is negative, the investment would not create value for the station owner and is therefore not a viable investment in purely economic terms.

It is worth noting that other indirect revenue streams may be attributable to station ownership. For example, these streams may include increased sales at a retail location caused by longer customer time in the store while the customer waits for his/her car to charge. However, for the purposes of this analysis, these indirect revenue streams will be excluded to assess the viability of charging stations in NYS on a stand-alone basis.

Both payback and DCF methods are often used as investment "yardsticks," as investors compare investment opportunities to predetermined thresholds of viability. Some investors maintain a payback threshold, where investments with paybacks periods beyond the threshold are not undertaken. For the DCF, an investor will have a predetermined "hurdle rate," or required rate of return to vet investments. This required hurdle rate is used to discount future value streams of the investment, and if the DCF produces a positive discounted value, then the investment exceeds the threshold for required profits. But if the present value is negative when discounted using the hurdle rate, then the investment opportunity does not meet the necessary threshold.

6.1 EV Charging Model Overview

The model works off several core inputs that break down into three categories: usage, costs, and revenues. With regard to usage, the three key inputs are utilization (measured in charging events per year), annual utilization growth rates, and time spent charging per charge. Costs are broken into two categories: fixed and variable. The fixed costs are the purchase price of chargers, the installation costs, and the electricity upgrade costs. Variable costs include electricity, demand charges, and maintenance costs. Revenue is derived from three different pricing options: price per kilowatt-hour used, per hour, or per session. The charging networks also derive revenues from subscription fees.

The base assumptions in this model replicate real world data as much as possible. For a Level 2 charger, the current utilization is based on NYS market data, with 1.6 charging events per week and 6.7 kWh used per charging event.[54] The model assumes an electricity cost of $0.15/kWh, increasing at 1% annually. The assumed total cost of installation for a Level 2 charging station, including equipment and installation, is $10,000. Assumed annual operating expenses are equal to 3% of the install cost, and a state tax credit for 50% of the install cost is applied to a maximum of $5,000. This model assumes that the installation of a new Level 2 charger does not trigger any new demand charges, which would otherwise significantly alter the economics of installation.

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54 NYSERDA Electric Vehicle Charging Infrastructure Report, April 2014 through June 2014, nyserda.ny.gov/About/Publications/Research-and-Development-Technical-Reports/Transportation-Reports.aspx

Using these current market inputs and plausible future market projections, the economic viability of EVSE on a stand-alone basis is at best mixed, and is unattractive in many circumstances. The payback period analysis shows that payback periods are long (greater than 5 years) for most potential future scenarios, even with increased station usage and significant premiums charged for electricity. These long payback periods point to the need for public sector intervention, as few private sector investments are drawn to these investments. For the DCF analysis, DCFC stations in NYS are NPV negative when tested under various scenarios and plausible inputs, which means the lifetime cash flow of the system does not compensate for the upfront cost of installing the station. Level 2 stations can be NPV positive, assuming significantly increased utilization over time and no demand charges. This analysis assumes no financing and that the station is paid for with cash upfront by the station owner. This business model might not prove to be the most successful for EVSE market growth, but the template provides a starting point for assessing stand-alone charging stations as an investment.

6.2 Payback Period Analysis

The payback period analysis uses the base model inputs previously described and alters the assumed charging station usage and price charged for electricity to calculate payback across a range of scenarios. Currently, NYS market data shows that public stations are used 1.6 times per week. One can fairly assume that utilization will grow, but the price amount and growth of charging is hard to determine. Therefore, this analysis looks at weekly usage range from 2 to 6 times per week throughout the period of analysis. A station owner can also control the price that customers are charged for using the electricity. Many potential pricing structures exist, but this simple analysis pricing is based on a dollars per kilowatt used, as is typical of electric utility pricing. Current retail electricity prices in NYS are approximately $0.17/kWh, but this payback analysis assumes drivers are charged a premium above this rate in order to earn a return. Prices of $0.30 to $0.55/kwh are considered.

Using these assumptions and across the identified range of usage and pricing, payback periods for a Level 2 charger are longer than those sought by typical private investors. As a rough rule of thumb, payback periods less than 4 years are broadly suitable and attractive to private investors. Payback periods above 8 years may be suitable for a specific segment of private investors, but are broadly more suitable for some kind of public ownership model. Table 8 shows the payback period across the ranges described, with payback period greater than 8 years highlighted orange and less than four years highlighted in blue.

Table 8. Payback Period of Level 2 Charger Across Amount of Charging and Price

		Charging Events per Week				
		2	3	4	5	6
Electricity Price to Drivers (per	$0.30	20+	14.33	10.68	8.42	6.89
	$0.35	16.56	11.01	8.14	6.39	5.21
	$0.40	13.50	8.90	6.55	5.14	4.18
	$0.45	11.36	7.46	5.48	4.29	3.49
	$0.50	9.79	6.41	4.70	3.68	2.99
	$0.55	8.59	5.61	4.12	3.22	2.62

As previously stated, payback period is a relatively simple analysis that is a helpful measurement for quick investment assessment. Payback does not discount future values to account for the time value of money and it does not account for returns after the breakeven point. However, in this case this method is highly instructive, as payback period shows that broadly, even under favorable future projections, the investment horizon for stand-alone EVSE will make it difficult to attract private investment. To make payback period more appealing for private investment, the upfront cost of the station will need to fall, or usage will have to increase. So policy mechanisms aimed at accomplishing those two objectives may directly support private investment in charging stations.

6.3 NPV Calculation

The NPV calculation is a more detailed assessment of the precise expected value of a charging station, rather than only a calculation of its breakeven point. For the NPV analysis, the same base case assumptions are used. However, rather than assuming a fixed amount of charging every year going forward, charging station utilization is grown annually at a fixed rate. In these circumstances, with a base case assumption of 12% annual growth to utilization and $0.45/kWh pricing, the NPV of a Level 2 charger is $7,482. Therefore, in the base case of assumptions, Level 2 station ownership is a positive economic investment, though only modest returns are generated. This NPV is calculated over a 20-year period at a 7% discount rate. Note that the payback period under these assumptions is 8.71 years, above the typical threshold. This payback also relies on charging customers triple the retail price for electricity to be profitable.

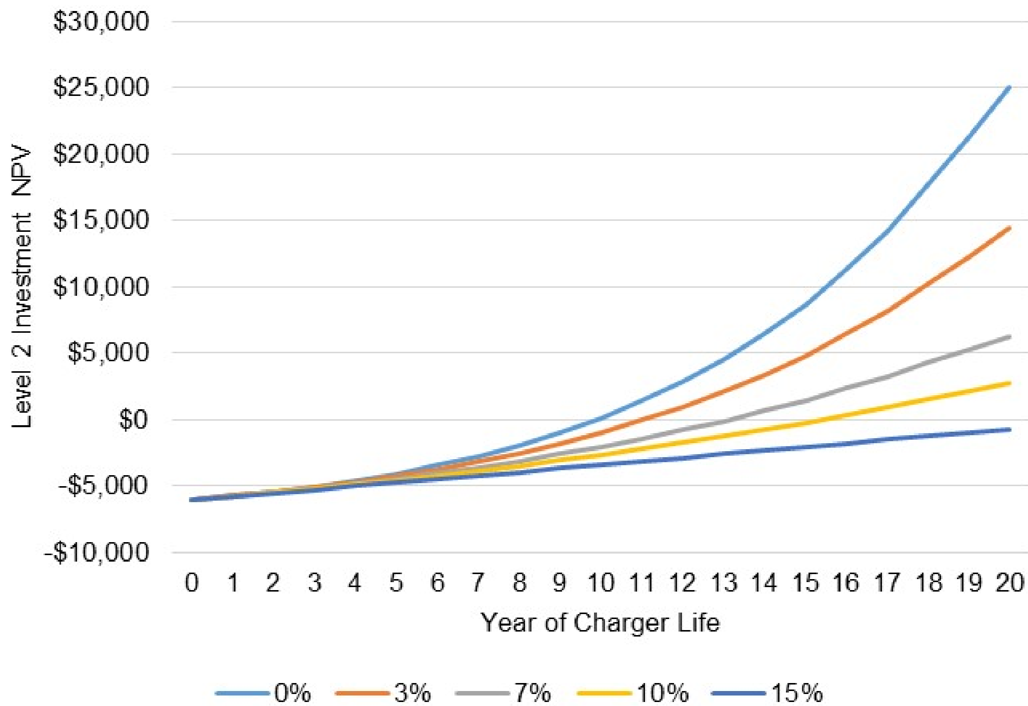
Although all of the model variables affect profitability, the greatest impact is caused by changing the annual utilization growth rate. A reduction in upfront costs will lower the present day financial burden, but an increase in utilization makes all future years profitable. As an example, Table 9 shows NPV in the base case changing dramatically with utilization growth rates.

Table 9. NPV of Level 2 Charger across Electricity Prices and Utilization Growth Rates

		Annual Utilization Growth Rate				
		5%	10%	12%	15%	20%
Electricity Price to Drivers (per kwh)	$0.30	($1,997)	$189	$1,355	$2,686	$4,150
	$0.35	($945)	$1,887	$3,397	$5,128	$7,039
	$0.40	$106	$3,584	$5,439	$7,569	$9,928
	$0.45	$1,157	$5,281	$7,482	$10,011	$12,817
	$0.50	$2,208	$6,979	$9,524	$12,452	$15,705
	$0.55	$3,260	$8,676	$11,566	$14,894	$18,594

It is worth noting, too, that the discount rate, though unrelated to actual charger operations, is an important driver of the investment's NPV. Under the base assumptions for a Level 2 charger, increasing the discount rate to 10% lowers the NPV to $3,905, but lowering the discount rate to 3% raises the NPV to $15,635. This impact is highlighted in Figure 8.

Figure 8. NPV of Level 2 Charging Station Across Discount Rates



When a similar analysis is run on DCFCs, the economics are significantly worse. The NPV of a DCFC is very negative, and reaching a break even NPV is extremely difficult within the bounds of plausible modeling assumptions. This negative economic impact is driven by the increased cost of equipment and installation (assumed to be $50,000) and the placements of demand charges. Demand charges charged to the station owner by the utility are based on the station's peak amount of electricity usage, not the amount of electricity actually used by the station. Because DCFC draw more power, and do so above the typical threshold at which demand charges are placed, the DCFC must bear an additional, on-going fixed cost. NYSEG's currently listed demand charge of $8.31/kW is used in this model.[55]

Based on these inputs and the same assumed 1.6 charging events per week but with 15 kWh used per charging event, the NPV is -$62,081. This calculation includes the same assumed 12% annual growth in the charging sessions and $0.75/kwh pricing for electricity. Even the price is raised to $1.00/kWh, the NPV is still -$38,744. Alternatively, keeping the price fixed at $0.75/kWh but assuming 20% annual utilization growth brings the NPV slightly above zero, at $9,117. Although this calculation demonstrates the poor economics of a stand-alone DCFC, the analysis does highlight the impact that utilization has on the quality of investment. This impact is shown in Table 10. Growing annual utilization by 20% versus 12% is equivalent to a grant of approximately $100,000 when the price is $0.75/kWh. Because utilization is currently so low, high growth rates are needed and should be fostered.

Table 10. NPV of DCFC Across Electricity Prices and Utilization Growth Rates

		Annual Utilization Growth Rate				
		5%	10%	12%	15%	20%
Electricity Price to Drivers (per kwh)	$0.75	($90,645)	($72,749)	($62,081)	($40,486)	$9,117
	$0.80	($88,291)	($68,949)	($57,419)	($34,083)	$19,522
	$0.85	($85,938)	($65,149)	($52,758)	($27,680)	$29,928
	$0.90	($83,584)	($61,349)	($48,097)	($21,277)	$40,333
	$0.95	($81,231)	($57,549)	($43,435)	($14,874)	$50,738
	$1.00	($78,877)	($53,749)	($38,774)	($8,470)	$61,144

55 Demand charge of $8.31/kW is from NYSEG's rate schedule for commercial customers with load between 5 kW and 500 kW. Demand charges are based on a customer's peak level of demand. The peak amount at a given point in the year is used as the basis for the demand charge. If an EV charging station increases the site's peak energy consumption, the station will trigger an increase in demand charges faced by the site host.

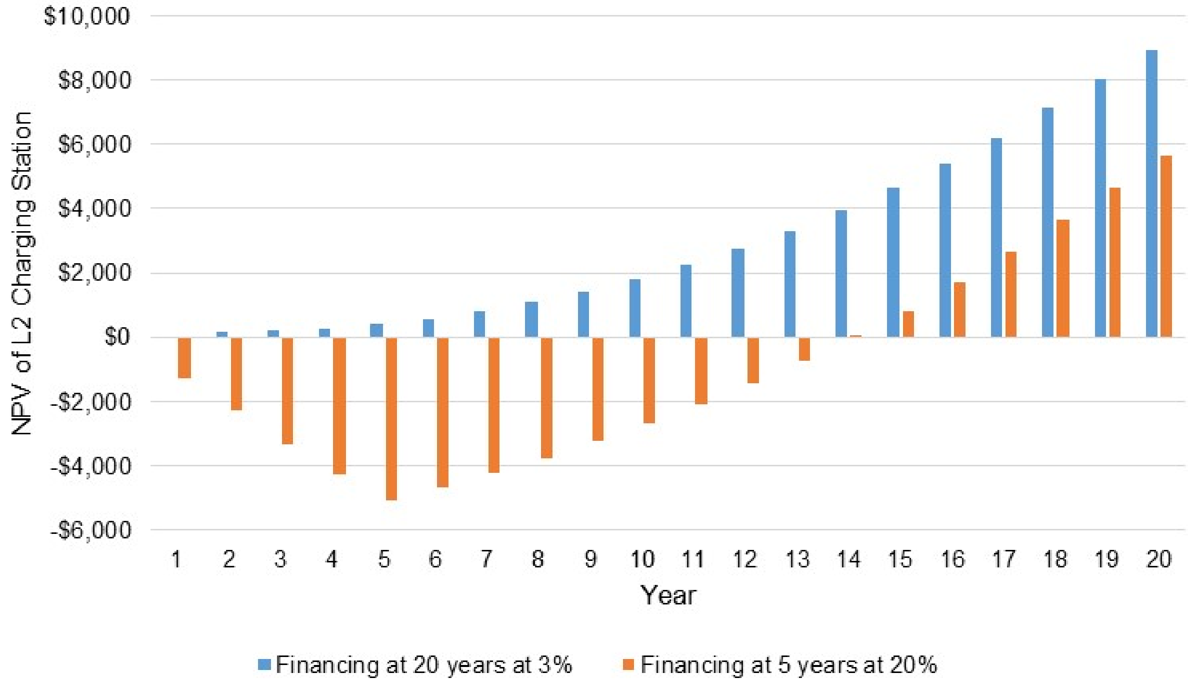
6.4 Impact of Financing

The introduction of financing for charging stations can greatly alter the project cash flow and the ownership profile for charging stations. Financing could come from private sources, public sources, or through public-private partnerships, like those used by NY Green Bank. Currently, most chargers being installed are not being financed and are being paid on balance sheet. Financing for chargers is an undeveloped market and most chargers are now financed through a mix of equity and grant money. The ability to provide reasonably priced financing with long terms can benefit the EVSE market in several crucial ways. First, this financing can eliminate upfront costs and reduce the barriers to adoption. Second, increased availability of financing can accelerate deployment, which in turn increases awareness and adoption of EVs and a positive feedback cycle. Finally, cycle will help establish the financing market – establishing a risk profile for EVSE lending and demonstrating its viability.

The establishment and success of green banks in various states, including NYS, have demonstrated that these state-supported financing policies have helped accelerate the market in other clean technology markets like renewable energy and energy efficiency. Increased financing of chargers could be accomplished in NYS through NY Green Bank or through a policy like Property Assessed Clean Energy (PACE) financing. PACE provides an opportunity for local governments to offer off balance sheet loans to businesses that can repay the loan via property assessment taxes. PACE is also beneficial because the loan is attributed to the property – not the owner – making potential future sales significantly less complicated.

If financing was offered to station owners, with or without State support, a 15-year loan at a 3% interest rate, for example, the NPV of a Level 2 charger would increase by roughly $1,000 over a 20-year period. But more important than the NPV increase would be the new cash flow pattern. Rather than paying a significant upfront cost and waiting years to break even, financing allows a station owner to install a charger with no upfront cost. Rather than going into a deep financial hole, the station owner simply reaps the benefits of annual cash flows. And if annual cash flows are negative, the financial pain is far less severe than if the loss was added to a significant upfront outlay. And both the rate and term of the loan alters the cash flow pattern. A 5-year loan at 20% for a Level 2 station has an NPV of $5,626, compared to an NPV of $8,921 for the 15-year loan at 3%. Not only do the better loan terms raise the NPV, but they paint a far more attractive cash flow pattern. As shown in Figure 9, the 5-year loan term requires annual loan payments that wipe out all potential economic gain to the station owner at the start of the period. Therefore, favorable loan terms are essential to attracting station adoption.

Figure 9. Annual Cash Flow of Level 2 Charging Station with Varying Finance Terms



States, through green banks or other mechanisms, can attract private financing for charging stations by offering credit enhancements like loan loss reserves or partial guarantees. Or a green bank could offer gap financing in a subordinated position to entice private lending into this space.

6.5 Scenarios and Policy Levers

In addition to facilitating financing, the economic viability of Level 2 and DCFC stations can be altered by pulling numerous possible levers. Some of these levers are in control of the station owner/manager, and some are policy levers NYS could use to attract investment. One way that station operators could improve economics would be to change the pricing structure of charging. For instance, on a Level 2 charger, charging a $1 fee for using the station in addition to the $0.45/kWh nearly doubles the NPV from $7,482 to $13,755. Or if the driver was charged $1 per hour connected to the charger rather than a price per kWh, the NPV would come at $32,475. These price structures would certainly erode the total cost of ownership (TCO) savings that attract EV drivers, but highlight how the choice of pricing structure can greatly alter station economics, holding all other factors fixed.

NYS' possible policy levers for directly altering station economics could include increased subsidy or tax credit for stations, reducing the cost of electricity for charging stations or lowering demand charges. A slightly increased subsidy for a Level 2 charger could create more favorable economics, or protect a station from losing money in the event utilization does not increase as expected. Under the base model, if annual growth in utilization is 5% instead of an assumed 12%, the NPV falls to $1,157. A modest additional subsidy would protect station owners from a loss even if utilization remains flat or grows very slowly. Using a grant to support DCFC, though, would have to be very expensive to make an investment attractive. With a base model NPV of -$62,081, assuring economic return would require a subsidy from NYS that would be hard to justify.

NYS could work with regulators and utilities to allow power to be sold at charging stations at wholesale costs, rather than retail electricity rates. This would either allow the station owner to earn a greater profit by keeping the same price to the driver, or the lower electricity price could enable the station owner to lower the price of electricity to the driver to increase the attractiveness of charging. On a Level 2 station, lowering the assumed cost of electricity from $0.15/kWh to $0.06/kWh, for example, increases the NPV by roughly $3,000. Again, though, this kind of change will have a marginal impact on the economics of DCFC.

NYS could also eliminate new demand charges, which could greatly alter the calculus around DCFC adoption. The current assumed demand charge of $8.31/kW accounts for more than half of the economic cost in the DCFC's NPV. Eliminating the demand charge increases DCFC NPV from -$62,081 to $1,305. With no demand charge, DCFC ownership becomes marginally profitable.

7 The Role of Financing

No matter the strategy chosen for market growth, introducing financing into the EVSE market will be essential for growth. Today, the vast majority of site owners who want to purchase and install charging stations have to pay the entire upfront cost themselves out-of-pocket. The introduction of available and reasonably priced capital to finance that purchase would eliminate a major barrier to the installation of EVSE. A loan, lease or similar financial product would allow site owners to install stations at no cost and then pay back the financing over time, similar to auto financing or any other asset-based financing.

Another benefit of financing is that lending allows an upfront capital expense to look more like an on-going operating expense. Under this structure, the cash flows for the cost of the station more closely match the timing of the revenues from the station. Or, if the station owner is not charging for the use of the station, the owner can treat the financing payment more like another marketing expense that occurs over time. Matching cash flows in this way makes it far easier for a site owner to manage the financial aspects of charging station ownership.

Financing also allows for creative business models that can make the entire EV proposition more attractive. For instance, one way to reduce the sticker price of an EV is to set the price equal to an ICE, finance the price reduction and have the driver pay back the financing through payments to charge the car. This financing model is similar to that used by Apple for its iPhone, in which a $600 phone is sold at $200, the carrier finances the price reduction and the carrier is repaid through monthly contract payments from the customer. One can imagine a similar structure in which EV dealers, drivers, utilities, and station owners all collectively participate in the financing and repayment of EVs and EV charging within one business model.

Several categories of investors could finance the installation of charging stations, and one choice may be preferred over others. Stations could be self-financed, meaning the station owners pay for the station themselves, as is currently done. But, as previously described, this strategy still leaves some barriers that external financing can overcome.

7.1 Private Lenders

Financing could be provided by commercial lenders, institutional investors, or other typical third-party investors. These third-party investors do not sell the charging station or use the charging station. This model might look similar to many solar electric financing models used today, in which a homeowner installs solar on his/her roof but doesn't actually own the system. Rather, financing payments are made to the third party that owns and finances the system for the homeowner. The advantage of having commercial lenders or investors play this role is that they have access to large and liquid capital markets, allowing them to bring in large amounts of capital. However, drawing these investors into a nascent market like EVSE may be difficult.

7.2 Public Financing

Financing could also be provided by a public financing authority like a green bank or an infrastructure fund that either lends directly or in partnership with private lenders to support market development. This model has many potential variations, which resemble the third-party financing model with the addition of capital at least partially provided by the public financing authority. This public authority could spark initial market growth with public financing until private capital providers are willing to step into the market. Entities such as the New York Power Authority (NYPA) could play this kind of role for public entities in New York State that want to purchase charging stations. Public financing authorities could also co-invest with private investors or de-risk private investment to incentivize more private financing, which is the kind of role that NY Green Bank might play.

7.3 Station Installer/Manager

The station manufacturer or installer could offer their own financing product to station owners. This product would resemble the ESCO model used in energy efficiency retrofits. The provider of the equipment and/or service also provides capital to allow their customers to make a purchase without the barrier of upfront costs. ChargePoint is the only EVSE installer and servicer to date to introduce its own financing product similar to the ESCO model. A related model would involve the creation of an independent financing corporation, formed by either the EV or the EVSE dealers, with the role of exclusively financing their own products. General Motors used this model to create the General Motors Acceptance Corporation (GMAC, now Ally Financial). GMAC was formed specifically to offer financing to the purchasers of GM cars. A similar approach could be used in the EVSE industry.

7.4 Electric Utilities

Finally, electric utilities are well-suited to invest in the installation of EV charging stations. The growth of the EV market means greater demand for electricity, so utility support makes sense and utility financing specifically would also be an important market signal. If utilities gave a strong, positive message on their outlook for the EV market, potential industry participants might feel that technical, regulatory, and economic barriers to EV growth are lower than previously thought. And creating an industry structure in which utilities participate in a positive way would stand in stark contrast to other clean energy markets, such as renewable generation, which utilities have broadly fought and in which they have struggled to find profit-making opportunities.

One can imagine a range of possible ways the utilities could become involved in financing the growth of the EVSE and EV market. They could provide third-party financing for stations, as previously described. Or they could own the physical battery of the car, and then lease the battery to the driver at no money down. This strategy would suddenly create relative sticker price parity between EVs and ICEs and drivers could then pay the utility a monthly service fee that covers the cost of charging (home and/or public) and the cost of the battery. Or, even more broadly, utilities could finance the creation of generation and charging systems in homes or at businesses, in which building owners use distributed generation to create electricity that is stored in an on-site battery. And then an EV driver could charge their car using that stored electricity at a lower cost. These innovative models move beyond the pure question of how to finance public charging stations, but they highlight ways in which financing can bring EV charging stations into an interconnected ecosystem of electricity generating and consuming technologies.

8 EVSE Investment Partners

The EV market creates opportunities for several private actors to potentially invest in building the EVSE network. Investments from these private actors can stimulate the market and reduce the costs of installing EVSE to local site hosts. State policies can encourage and support these actors working together with cities and local communities to attract investment in EVSE in NYS.

8.1 Utilities

Utilities are one of the most logical partners to help finance the growth of the EVSE market. Utilities have a business model equipped to make long term investments in infrastructure with high up-front costs and long pay back periods. They also have a tremendous amount to gain from EV charging. With every charger, a utility is given a new point of sale to generate revenue. An EV driver is expected to provide a utility with $4,000 of additional revenue over the course of ownership.

At the same time, investing in EVSE allows utilities to pilot “smart charging” programs in which EV charging stations can be integrated into demand response schemes to help utilities manage their load during peak times. Southern California Edison is already using this strategy on 80 charging stations throughout its territory.[56] Further, supporting EV drivers through EVSE can help utilities position themselves as environmental leaders. Kansas City Power and Light is attempting this strategy through its 1,000-station Clean Charge Network that will deploy this year.[57]

Utility investment to help defer up-front costs may be the biggest and most beneficial role that utilities can provide. Utilities in several states are already beginning to help subsidize up-front costs. In addition to the Kansas City Power and Light program mentioned above and the heavy investments the three big California utilities are making in EVSE, Georgia Power has committed to installing 50 public EV chargers beginning in the second quarter of 2015.[58]

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[56] http://www.greentechmedia.com/articles/read/sce-tests-electric-vehicles-for-demand-response

[57] http://www.kcpl.com/CleanCharge

[58] http://www.bizjournals.com/atlanta/blog/atlantech/2015/01/georgia-power-brands-12m-ev-charging-program-get.html

A tension exists between encouraging utility investment in EVSE and supporting monopoly ownership of EV charging stations. NYS should be conscious of providing utilities significant EVSE market power, which could stifle competition from other EVSE businesses or slow technical innovation. Southern California Edison's proposed model of installing the wiring so that a charging station can be easily added (also called "make readies") and offering a substantial rebate for site hosts to install the charger of their choice is a good example of utility involvement in the market that also protects competition. This would allow the site host to choose to own and operate the EVSE for little additional upfront fee, or to choose an EVSP.

Demand charges are another area of electricity regulation that can greatly impact EVSE development. For DC chargers specifically, demand charges are a significant portion of costs. At present, and until utilization increases significantly, demand charges make up the majority of variable costs to DCFC owners. A policy either waiving or significantly decreasing demand charges can have a large impact, and would require PSC approval. In this model, reducing the demand charge to DCFC by 50% increased the NPV to the station owner by 28%. Another tool available to utilities that has seen progress elsewhere in the clean energy market is on-bill repayment. Here again, the utility can use its built-in customer service infrastructure to help proliferate EVSE. A policy that could allow station owners to repay low-cost loans via their electricity bill would achieve many benefits, including off balance sheet financing and a cost of capital potentially lower than that offered through ordinary capital market structures. This kind of on-bill repayment could even be paired with energy efficiency installations, possibly offering owners greater incentives for multitechnology projects.

Regulators and utilities could also support EV driving by offering reduced rates to residential and commercial customers with EV charging. In this time-of-use pricing scheme, EV drivers can take advantage of lower electricity prices at night. Or conceivably a new rate tier could be created by regulators, offering lower standard electricity rates to electricity users who own EVs. This strategy would help reduce the total cost of ownership for drivers charging at home, and public charging site hosts could make a higher margin on charges at their stations.

California has two complementary policies that help to nudge utilities toward supporting EVs and EV charging. In the first policy, the California Energy Commission and the California Public Utilities Commission evaluated and created policies to develop infrastructure sufficient to overcome barriers to widespread EV adoption including grid stability, electrical infrastructure upgrades, code and permit requirements, and new technology development.[59] In the second policy, the California Energy Commission and the California Public Utilities Commission must maintain a website with relevant information for Plug-in EV owners including resources to help consumers determine if their residences will require utility upgrades to accommodate EVs, utility rate options and load management techniques.[60]

Though these policies are not prescriptive, they ensure that those in control of NYS' energy resources are considering and supporting EVs. The fact that the California Energy Commission and the California Public Utilities Commission must also provide information and resources to the public about EVs, supports market growth while opening the agencies' work up to review and critique from the public. In addition to encouraging utilities to create special programs to support EV driving like the ones proposed here, utilities also have an important role to play in supporting the electricity site preparation and permitting process in a timely manner. At a minimum, utilities should be incentivized to provide basic support to this growing market.

8.2 Automobile Original Equipment Manufacturers and Dealers

Automobile original equipment manufacturers (OEMs) that have invested in electric vehicle lines have as much, if not more, to gain from widespread EVSE as anyone else. For electric vehicle OEMs, a worst case scenario is for early adopters to find charging in public too difficult and, as a result, have overall negative experiences with the car. Much like Henry Ford assisting in road building when penetration of the Model T grew beyond the capacity of the road system, OEMs can partake in the process to guarantee a good customer experience for EVs.

Several OEMs have already made substantial investments in public charging. Tesla has built out a proprietary network of 148 DC fast chargers mostly installed along major highways that is free for all Tesla owners to use.

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59 http://www.afdc.energy.gov/laws/laws_expired?jurisdiction=CA

60 http://www.afdc.energy.gov/laws/8842

Nissan has been active both in defraying the cost of charger installation to site hosts and by defraying the cost to drivers to charge. In Nissan's top markets, they have engaged with NRG's eVgo platform to provide free public charging to its drivers for the first two years of car ownership. No Charge to Charge was a successful pilot in Texas and has now expanded to 13 cities (none in New York State). In cities with lower EV penetration and less established EV infrastructure, Nissan is partnering with site hosts to pay for a portion of the fixed costs of installation. As the model demonstrates, defraying the up-front cost provides the most significant impact on profitability of all the cost subsidy policies.

BMW is also offering free public DC charging to new buyers of the BMW i3. Drivers can use NRG eVgo stations equipped with SAE combo chargers.[61] In January of 2015, BMW and Volkswagen announced that they would also be investing in DC charging infrastructure. They are partnering with ChargePoint to build 100 SAE combo DC chargers up and down the East and West Coasts of the country. The chargers will also have a Level 2 port. Drivers will access the chargers with their ChargePoint accounts. The companies aim to place the chargers at 50-mile intervals along the heavily-trafficked Portland to San Diego and Boston to Washington, D.C. corridors. The chargers will be within and between the major metropolitan areas along the coasts to facilitate longer road trips in EVs.[62]

OEM involvement in the EVSE market is growing. Fostering OEM involvement in the EVSE market and engaging with them on partnerships may be one of the most cost effective ways to help grow the market. One example of how government may be able to support OEMs in their mission to build EV charging infrastructure is through access to parking spots. To install charging stations, OEMs and EVSE companies need access to parking spots. Finding site hosts for charging stations has been a challenge even when the charging station is basically free for the host. Some OEMs are paying a lot of money for prime parking spots for EV charging. State, city, and local governments often have access to parking spots that could be good locations for EV charging. NYS can facilitate conversations between OEMs and city governments to propose high visibility spots.

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61 http://www.greencarreports.com/news/1101102_bmw-i3-electric-car-owners-get-expanded-free-fast-charging

62 http://www.chargepoint.com/press-releases/2015/0122

NYS could also directly partner with OEMs on EVSE investment and market growth. This partnership could include State financing for OEM-sponsored charging stations, State support for greater marketing of EVs, or other creative EV fleet purchase models. If NYS wanted to incentivize private lending, rather than direct public lending, then NYS could offer credit enhancements or other financial incentives or tools for mitigating risks to private lenders. These kinds of financing tools have proven helpful for drawing in private investment in other clean energy technology markets. As OEMs appear to have the greatest direct benefit of increased EV adoption, NYS and OEMs should be able to negotiate partnerships in which both parties have aligned incentives and mutually benefit from increased EVSE and EV adoption.

8.3 Advertising Partnerships

Companies outside of the immediate EV value chain might be interested in using charging stations as advertising space. EV drivers are captive audiences while they are plugging in their cars and while they are using applications to look for places to charge. Advertisers could help offset the hardware and installation costs, as well as the electricity costs, in exchange for branding the charging stations with their logo. Charging stations with screens could also run advertisements on-screen. Depending on the EVSE provider, the advertiser's logo could also appear in the online and mobile applications that direct drivers to the station to further increase advertising impressions. The state could again play the role of convener to facilitate partnerships between EV charging companies and local businesses.

Volta, a charging start-up based in California, is basing its whole business model on this concept. "Free Charging – Brought to you by brands who care" is its tagline. They offer EV drivers free charging, retailers a free amenity to attract desirable customers, and brands a unique medium to engage the community. They only have a few dozen charging sites in California, Massachusetts, and Hawaii so far. They are already achieving 30 million cumulative monthly views on advertising on their currently installed stations.[63]

[63] http://voltacharging.com/advertisers

ChargePoint is also experimenting with a similar idea. Their stations can be customized to any brand with easily replaceable components. ChargePoint recently made Atlanta Falcons-branded stations for the Georgia World Congress Center, Georgia Dome, College Football Hall of Fame, and Arthur Blank Family Offices. These stations help the Atlanta Falcons support sustainability in their home community.[64]

The two categories of businesses that might be most interested in this form of advertising are local businesses (such as restaurants, shops, gyms and salons) and car-related businesses (such as insurance, car servicing companies, and tires.) For local businesses car charging is a way to draw customers in while they wait for their car to charge. Car-related businesses get the benefit of the customer being in the right frame of mind to think about their auto needs.

8.4 Energy Service Bundling

The broad national proliferation of solar and efficiency financing structures creates an opportunity to pair EV charging stations with these other clean energy technologies. Solar leases and energy efficiency upgrades are often designed to be immediately cash flow positive. Therefore, a project has no upfront cost, and the energy savings created by the technology are larger than the on-going financing payment. As seen in the DCFC analysis, it is hard to make EVSE cash-flow positive in this same manner. However, sales of EVSE could be bundled with solar and energy efficiency upgrades so that the savings in electricity costs resulting from the solar and energy efficiency measures help offset the EVSE costs.

A start-up called Snugg Home in Boulder, Colorado is already selling financing for a solar, energy efficiency, EVSE bundle for the residential sector. They calculate a total savings from the three technologies based on total home and fuel costs without the upgrades and demonstrate that even with loan repayments, the homeowner saves money in the first year.

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[64] Johnston, Adam, “Atlanta Falcons & ChargePoint Score a Touchdown with EV Chargers,” Clean Technica, December 18, 2014, http://cleantechnica.com/2014/12/18/atlanta-falcons-chargepoint-score-touchdown-ev-chargers/

In commercial settings, the savings relative to fuel costs cannot be factored in unless an organization is charging a fleet of vehicles on those same chargers. However, even without savings from fleet fuel costs, financing all three systems together may make EVSE seem more affordable to commercial property owners because they are seeing a savings from the solar and energy efficiency at the same time that they are paying for the EVSE.

9 Financing Solutions

The economic analysis of EVSE ownership finds that public charging stations are an unattractive investment in NYS' current EV market. A private investor could only expect to earn a return over a very long period of time on a Level 2 charger, and that is assuming a steady increase in station utilization and a sizable premium charged for electricity. The economics of DC fast charger ownership are even worse.

The value proposition of EV ownership and EVSE investment can be improved by increasing the benefits or reducing the costs to transaction participants through monetary or nonmonetary policies. Examples of nonmonetary policies include access to HOV lanes for EV drivers. By granting HOV lane access, EV drivers are able to save time by avoiding traffic, which has a clear benefit without a direct financial transfer from NYS to the driver. Although these nonmonetary benefits can affect the value proposition of a transaction and have no direct fiscal cost to NYS, NYS may need to provide direct monetary benefits to EV market participants to achieve NYS' outcomes. Monetary benefits may include cash subsidy, a permanent monetary gain for the recipient, or financing, broadly defined as a monetary benefit that must be repaid in some form back to NYS. This chapter will analyze the need and role for different kinds of financing strategies and assess how these benefits can be conveyed most effectively to achieve NYS' goals.

9.1 EVSE Network License and Finance

Economic analysis shows that stimulating private investment in public EV charging stations will require some amount of private capital. Investment is needed to reach NYS' goal of 3,000 EV charging stations by 2018. But beyond 2018, the precise number of public charging station needed to support roughly 800,000 EVs is unknown. The economic viability of public charging stations is dependent on high station utilization. But the end goal is not merely heavily used EVSE, but heavily used EVs. Therefore, NYS should seek to minimize the public sector cost of supporting EV infrastructure while maximizing station utilization and EV VMT as a percentage of all VMT.

The question of how and where to build NYS' EV charging station network is an optimization problem faced by many other network and location-based businesses. Cell phone base stations and electricity distribution are the most obvious examples. In each case, early technology adopters face the pricing problem of having to pay for the initial infrastructure that all others later adopters will benefit from. Therefore, the network built most efficiently will produce the least cost for early adopters. An efficiently built network is optimized to serve the market needs and population at the least possible cost compared to all possible network permutations.

Economics suggest that NYS will have to pay to build the network, so the objective is to pay the least cost possible to get the desired outcome. The basic principles of network design tell us, though, that it is inefficient for NYS to subsidize any and all charging stations in NYS no matter where they are. To build the most efficient network that maximizes EV VMT at least cost to NYS, NYS could work with industry to determine where charging stations are most valuable and where they should optimally be constructed.

If NYS were to specifically support a charging station network built in geographically optimal stations, private parties would still be able to build additional stations where they chose. NYS need not dictate to the market exclusive charging station locations or pick specific "winning" charging station technologies. However, if NYS seeks to minimize the use of public funds to get the maximum EV market growth, it could partner with industry and strictly support stations built in the most efficient locations. In principle, many clean energy programs that currently exist are similar. For example, many states offer grants for the installation of solar electric, but the system must be built at a certain level of efficiency to receive the grant. NYS does not restrict the construction of inefficient solar, but will not provide limited public resources to promote inefficient systems. The concept outlined herein is no different.

One option for supporting a geographically optimal network is an auction-based licensing system, in which NYS and industry partners determine a set of ideal charging station locations within specific geographic markets, and then NYS auctions off the right to build and own those stations to private entities. Today charging stations are a money loser, which means NYS may have to pay bidders to build the network. If that is the case, then a reverse auction mechanism will be needed, in which each bidder submits the least amount of money needed from NYS to take the license and build the desired charging network. Or, NYS may find that private actors are eager to own stations at locations that may have the highest utilization and will therefore pay NYS for the rights to build this specific set of stations. Auction winners would then be given a low-cost, and long-term loan from NYS of the amount requested. A loan at 2% over 20 years, for example, will provide ample value to the winner yet have little cost to NYS, which has a low cost of capital. The positive impact that this kind of financing has on charging station economics was described earlier in the report.

Before launching the auction, however, NYS would first need to identify the target locations for charging stations in NYS. The best locations will be ones that can support the maximum number of EV VMT. NYS can define specific geographic markets that have a high enough population density and traffic routes to require heavy public EV infrastructure, and through modeling, identify the optimal charging locations in those geographic markets. (This analysis is not attempted here, but would be a fruitful topic for further study.) NYS could choose to restrict the targeted sites to public or State-owned property. Or NYS may also consider stations sites on private property, in which case the property owner would need to be compensated through the auction structure or station usage. NYS would then publicly list each geographic market and the set of charging stations within that market, and auction off licenses to build the network in each geography.

NYS can choose the number of licenses to auction for each market. Offering multiple licenses in a single geography would allow winners to benchmark against each other and allows for competition. One can imagine many types of potential bidders for this auction. Winning bidders (those requiring the least amount of money from NYS or willing to pay the most for the right to build the stations) could form bidding consortiums with retailers at the designated locations, forming partnerships to allow for site hosting in exchange for shared revenue. And these kinds of arrangements could lead to positive bids for NYS because the retailers surrounding the host site would benefit from increased traffic to their stores while drivers wait for charging. (A retailer that is part of a losing bid would not be shut out of the market. Rather, they can install a charging station through current private market mechanisms.) A winning bidder may be an energy services company with extensive experience managing distributed energy assets. Or one could also imagine other innovative bids based on new, undiscovered charging business models.

This model of auctioning licenses to build an early network is precisely how the cell phone infrastructure in the U.S. was efficiently built in the 1980s and 1990s. This approach ensures that charging stations are located at the sites that will invite the greatest amount of EV driving at the least cost to NYS. Any party may build a charging station at other locations; they just won't benefit from the financing offered by NYS. To use its resources most efficiently, NYS should prioritize and give financial support to those stations that most directly aid achievement of NYS' EV goals.

9.2 Public-Private Financing Partnerships

NYS could support financing through a less targeted solution by launching a standard-offer credit enhancement mechanism for private lenders who offer financing for EV charging stations. Credit enhancements like loan loss reserves are a proven tool for drawing in private capital that is hesitant to enter certain clean energy markets, and can help borrowers access capital at better terms. As shown in earlier analysis, the interest rate and tenor of a loan can significantly impact the cash flow of a charging station. Therefore, a credit enhancement that reduces the rate or extends the tenor of a loan can be an effective tool for market growth.

Credit enhancements like loan loss reserves are valuable tools from NYS perspective, as well, because it doesn't involve an actual cash outlay or grant to enable private sector activity. Rather than pay a direct subsidy to an end customer, or give an interest rate buy-down to a bank, a loan loss reserve (or partial loan guarantee) is a cash set aside that is only drawn upon in the event of a loss or default. If there is never a loan default, then the reserve merely accumulates interest over time, meaning public capital is preserved.

Lenders benefit from credit enhancements because it allows them to enter new, and potentially profitable markets with a risk mitigation and certainty that comes from state support. Therefore, a green bank credit enhancement could draw far more attention from private lenders into this space that may not have been previously considered for lending.

As discussed in the prior chapter, there are many possible private lenders who may be interested in participating in this market. Rather than choose one type of lender over another, the credit enhancement could be offered through standard terms that any private partner can use. Whether it is a utility or an OEM, the credit enhancement could be offered at identical terms and available to any kind of participant willing to invest into the market. Importantly, though, the credit enhancement would need to be tied to a set of conditions that the private lender must agree to in exchange for using the credit enhancement. The simplest version of this restriction would be a "not-to-exceed" rate, where NYS requires that interest rates and loan tenor doesn't exceed certain level in exchange for accessing the credit enhancement. Without this type of restriction, NYS cannot assure that its credit enhancement is actually being used to increase the benefit to the end owner of the charging station. (For example, if a private lender makes a loan that they were entirely willing to make, at the same rates, without credit enhancements, then the benefit of the credit enhancement is going purely to the lender and not the end borrower.)

The specific terms of the credit enhancement would have to be developed based on private lender input, as well as economic analysis of station ownership. For instance, a credit enhancement that produces loan terms that still result in a negative NPV for the station owner isn't all that valuable. So the terms of the program would have to be modeled to ensure a positive market outcome can be reached. It may turn out that there is no solution under this structure. For instance, economic modeling done in this report shows that financing needs to be offered at fairly low rates and long terms to make station ownership economically viable. If lenders require a credit enhancement that NYS isn't willing to offer, then alternative solutions, like direct state lending may be needed. (Although direct State financing may not be desirable as the goal is to increase private financing, it could still provide a path to private investment. NYS could provide 100% financing for charging stations, build a portfolio of charging station loans, and then sell that portfolio to a private lender. By building a portfolio, NYS can diversify risk, build scale, and demonstrate a track record, which may be sufficient to draw in private capital that was hesitant to underwrite individual, and possibly riskier, loans.)

10 Subsidy Solutions

Although not an explicit requirement of this report, it is impossible to consider EVSE deployment and investment without also examining EV markets directly. As previously stated, EVs and EVSE are complementary products, which means they are best offered in tandem. A left shoe is not valuable without the right, and an EV charging station is not viable without EVs. NYS cannot look at EVSE or EVs in isolation. Private actors under today's policy structure might bid on a license to build a public charging network, but if they did a larger public sector stake would probably be needed. As discussed earlier, the current level of charging station utilization is too low to produce attractive economic returns, suggesting greater EV penetration is required. NYS' hesitation to offer vehicle-based rebates based of economic or political challenges is entirely reasonable. However, achieving the lofty EV goals established without EV driver incentives will be incredibly challenging. Some minor incentives do exist today, but NYS could address the incremental cost of EVs through a direct rebate. States with quickly growing EV markets, like California and Georgia, offer these kinds of direct EV rebates. (Georgia eliminated this rebate in July 2015. The policies are explored in greater detail in the appendix.)

Like the previously described EV charging station structure, if NYS were to offer subsidies, NYS should strive to use those dollars most efficiently, maximizing EV VMT per public subsidy dollar. Through close market analysis and alignment of the subsidy with NYS goal, NYS can create an efficient EV subsidy scheme that drives the market directly toward NYS goal.

10.1 Types of Subsidies

The goal of any subsidy that NYS offers should be to maximize the number of EV VMT per dollar subsidy. This metric will orient NYS toward effective subsidy delivery and track the market objective. NYS could provide four different potential kinds of subsidies: 1) a price subsidy (monetary benefit); 2) a nonmonetary benefit; 3) a psychological benefit; and 4) free public info. A price subsidy may be a direct reduction in the cost of the good at issue or new revenue creation associated with that good. A nonmonetary benefit could be travel time reduction from HOV access. A psychological benefit would increase the ease or reduce the mental barrier associated with the desired outcome. This type of benefit could be increased access to public EVSE in order to reduce range anxiety. And free public info facilitates market participation by boosting consumer confidence and can drive supplier competition, which improves customer economics.

Leading EV states have adopted a range of subsidies across all four types. California and Georgia, as well as other states, use large price subsidies in the form of reduced EV cost for consumers that have proven highly effective at increasing EV adoption. Though this subsidy is common, multiple potential forms of price subsidy can be designed to target the specific desired outcome of increased EV VMT. Price subsidies can reduce costs of desired goods. In the EV market, this could include the vehicle itself, the charging station or the electricity consumers buy to charge. NYS currently uses an EVSE tax credit as a cost-focused price subsidy. Rather than reducing costs, price subsidies can also open opportunities to create new revenue streams for the subsidy recipient.

For future subsidies, NYS would want to consider what NYS is trying to accomplish when determining what kind of subsidy to offer and what to subsidize. The ultimate goal is to maximize the share of VMT driven by EVs to reach 40,000 EVs by 2018 and approximately 800,000 by 2025. If the goal is to increase EV ownership, then a price subsidy aimed at the vehicle itself may be suitable. But if the goal is to increase the amount of miles EVs drive, then the subsidy must in some way incentivize EV driving. Therefore, to maximize the impact of the subsidy, rebates should incentivize both EV ownership and usage. (EVs purchased as additional vehicles by wealthy families that primarily still rely on ICEs are not particularly valuable.) More steady usage is also essential for increasing the economic viability of the EV stations NYS licensed the construction of, as described in the previous section.

10.2 Subsidy Point of Incidence

The next point to address is the most effective point for conveying the subsidy, given the previous determination that NYS wants to incentivize both EV adoption and EV usage. The purchase-based EV subsidy is most logically conveyed at the point of sale by the car dealer. Cash rebates built directly into the price of the vehicle are the most efficient way of conveying the subsidy, which means NYS would need to compensate dealers very quickly after purchase for each EV sold. A rebate or credit that passes from NYS to the customer after purchase creates additional burden on the driver and makes the price impact less transparent.

For the subsidy to encourage regular usage of the vehicle, the most effective point of incidence is at the point of charging, which by its nature is correlated to the amount of EV miles driven. The more an EV recharges its batteries with electricity, the more that vehicle is being used. Therefore, incentivizing and subsidizing the charging itself might most effectively achieve increased EV VMT. A subsidy could be designed so that an EV driven 10,000 miles in a year is given more benefit than an EV only driven 2,000 miles in a year. This combination of subsidies will lead to both adoption and heavier usage, with strong reliance on the previously described, publicly licensed charging network.

10.3 Level of Subsidy

Again, NYS could aim to introduce the lowest subsidy possible that will still accomplish NYS' EV market goals. NYS must first choose what level of subsidy to offer at the point of vehicle sale and then what level of subsidy to offer at the point of charging. NYS also must decide if each vehicle purchaser will be given the same level of subsidy. Subsidies could be given most efficiently if they varied based on demand, need and expected level of driving. For example, NYS may want to provide the lowest possible subsidy to a high-income driver to get that person to adopt an EV. But at the same time NYS would want the subsidy to be high enough to get the most intensely driven vehicles to become EVs. In Georgia, the vehicle-based subsidy is $5,000 per vehicle. This level of subsidy would cost NYS $140 million to reach the 40,000 EV goal by 2018.[65] Although this amount is not trivial, $140 million is relatively small compared to the approximately $840 million in total EV investment in vehicles needed in the next four years to meet NYS goal. And though this level of subsidy has proven effective in California and Georgia, NYS could seek to optimize the subsidy with varying levels across purchasers to ensure the least amount of subsidy is provided per EV VMT. This optimization problem is suggested for further analysis.

The level of subsidy offered at the point of charging should vary and increase as the car is driven more miles. The subsidy can begin at a level that reduces the cost of charging, but still leaves the driver on net paying for charging (i.e., subsidy is less than the cost of electricity at the station). But then the subsidy can increase so that charging becomes a net positive activity for the vehicle owner. The driver still must pay for the electricity, but the subsidy provided by NYS exceeds the cost of the electricity. NYS can design mileage tiers, in which a certain level of subsidy is offered up to a given number of miles driven per period, with the next tier offering a higher subsidy. For instance, an EV could be offered a $0.25/mile subsidy on miles 0 through 5,000 in a given year. That subsidy could increase to $0.50/mile for miles 5,000 through 10,000, and so on. Under these hypothetical tiers, an EV driven 10,000 miles in a year would be given a total driving subsidy of $3,750 based on mileage.[66] This subsidy would more

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65 Georgia's incentive policy was only for BEVs. As New York's goal includes a majority of PHEVs, the state could offer reduced incentives for non BEVs, thus lowering the overall subsidy cost.

66 (5,000 miles × $0.25) + (5,000 miles × $0.50) = $3,750

than cover the cost of actual charging, which is typically around $600 per year.[67] Even subsidies at far lower rates could still provide a meaningful incentive for EV adoption and driving. NYS should set a maximum mileage tier above which no incentive is offered, with the maximum total amount of charging-based subsidy tied to a set percentage of the average EV price.

For example, NYS could decide that, for the most heavily driven EVs, the most that NYS will subsidize across both forms of subsidy would be 40% of total cost of ownership. (Tiers and incentive levels could alternatively be based on lifetime VMT, rather than an annual VMT.) It may be that EV mileage and charging cannot be tracked in real time, so the subsidy would have to be provided at year’s end based on total reported driving. Or this mileage information could be collected at vehicle inspection stations.

Collectively, the multi-pronged approach of financing for optimized, licensed charging networks, broad credit enhancements for increased EVSE lending, point-of-sale EV rebates, and charging-based subsidies can yield the robust EV environment needed to meet NYS’ EV goals. By orienting public financial support around maximizing EV VMT per public dollar and designing the most efficient charging network possible, NYS can provide the resources that are clearly needed to attract private investment and make both sides of the EV market grow quickly while expending the least amount of public dollars possible. None of these solutions are meant to be restrictive or limit the activity that private sector may undertake outside of these specific program structures. Rather, they are meant to foster a broad platform of market growth, with NYS using its limited publicly dollars wisely and efficiently.

[67] EPA Fuel Economy Data, http://www.fueleconomy.gov/feg/download.shtml

11 Conclusions

EV market growth in NYS is hampered by the underlying pricing problem that exists for most new network-based technologies. Early adopters are forced to bear the cost not only of the device (in this case, a car), but also of the installation of the entire supporting network. The specific barriers and challenges to EV and EVSE market growth are analyzed at length in this report, but the poor economics of ownership greatest obstacle to EVSE deployment. The profitability of owning an EVSE is simply too uncertain in today's EV market to attract private capital at scale. This uncertainly leads to slow adoption of both vehicles and charging stations. To date, NYS has had reasonably strong policies to encourage the installation of Level 2 charging, but a robust ecosystem has yet to develop. Some counties in NYS have high per capita rates of chargers without matching high rates of EV penetration, while other, more affluent, counties tend to have the reverse trends.

Across all of the potential solutions, making a return on investment in the NYS market on Level 2 chargers will be easier than on DC fast chargers. Although the fast charging technology is an attractive option for fast-paced New Yorkers who are used to prioritizing speed, their high up-front costs and demand charges make them very expensive. The payback period analysis showed that even in favorable future circumstances Level 2 charges have a long payback period, meaning some form of public support for private investment is likely needed. The NPV analysis showed that Level 2 charging stations may be able to generate a positive return over time, but this result relies on significant annual station utilization growth. This can only come from greater EV adoption. This analysis, then, points to the need for some form of State support for both EV and EVSE market growth. The following sections summarize four options.

11.1 EVSE Network Financing

Economic analysis shows that EV charging stations today are uneconomical and require some level of public financial support to attract investment. This report provides one possible solution that NYS can adopt to support a minimum viable, efficiently designed charging station network. To maximize EV VMT and meet state goals with the least public cost, NYS can work with private parties to identify optimal locations for charging stations. Placing charging stations at highly trafficked locations can ensure those stations have high utilization and are easily visible for drivers. As with many other network-based technologies, like cell phone network construction and electricity distribution, optimal network construction leads to highest usage and least cost for consumers.

NYS can therefore identify the ideal locations for charging stations in defined geographies around NYS that will serve a high level of EV driving and charging station usage. Rather than build the network itself, NYS can auction off licenses per geographic markets for the right to build and operate the network, with stations built at the optimal sites. Respondents will submit bids with the least amount of public capital they would need to build the desired charging network and still be economically attractive. NYS can then choose the lowest cost bidders and provide financing in the amount bid to each license winner. The licensing system is not meant to restrict other actors from building charging stations in a given geography. All private activity is still open, and NYS would not pick specific technologies that must be installed by winning bidders. Rather, the license mechanism is meant to ensure that, at minimum, stations are installed at the most efficient locations, as well as minimize the public capital needed to support a minimum viable charging network across NYS.

This approach would drive down public expenditure on charging stations while maximizing the utilization of the stations that are built, because they are placed at locations that will receive heavy traffic. High utilization is essential for station economic viability. In addition, by placing the stations close to retail outlets, other revenue streams can be generated for host locations which in turn will reduce the level of public financing needed to make license ownership economically attractive.

11.2 EVSE Private Lender Credit Enhancement

In addition to the targeted auction-based system to support EVSE deployment, NYS can more broadly encourage private lending into the EVSE market by using credit enhancements. NY Green Bank is perfectly equipped to offer this kind of financing support, which is meant to mitigate risk, attract private capital, and improve the deal economics for a borrower. A standard-offer credit enhancement could be provided to the market, so that any kind of private lender, wither a bank, a utility or a vehicle OEM, can take advantage of the risk mitigating tool.

The precise terms of the enhancement would need to be determined in collaboration with the private sector. Terms would have to ensure that the borrowers were actually benefiting from improve loan terms, and that the risk mitigation was being used by lenders to actually reduce rates and/or extend tenor. In addition, analysis is needed to confirm that the loans, even at the improved terms, can yield positive economic outcomes for borrowers/station owners. NYS may find that no private lender is willing to offer terms, even with risk mitigation, that yield attractive economics for EVSE ownership, which is why the auction-based mechanism and public financing solution has the potential to be more successful.

11.3 On-Bill Utility Financing for EVs Using Cell Phone Model

Although not discussed in depth in this report, NYS could also provide an EV financing solution. NYS could again borrow from existing structures by combining on-bill financing used for clean energy and the cell phone-plus-service financing structure. If, for example, the marginal price difference between an EV and a comparable ICE is $10,000 in sticker price, that $10,000 could be financed to reduce the upfront price to the customer. That loan could then be paid back by the customer through a premium paid for charging the EV. Cell phone carriers use a similar model to reduce the upfront price of an iPhone from $600 to $200, and then recover that financing through a service contract with monthly payments.

The most logical financing partner for this structure would be the utility itself, though in theory capital could come from any investor. The utility could provide the financing to reduce the EV price to a level comparable to an ICE, and then place a custom, slightly increased rate tariff on that customer for home EV charging. Through home charging, the utility could then recover its financing. One can imagine a scenario in which a customer purchasing an EV at the dealership merely has to check a box on a form agreeing to receive a $10,000 reduction in the price of an EV for a slight increase in his/her utility rate that fades over time.

NYS may be able to help draw its utilities into partnerships to support EV charging through a combination of legislation and information sharing with an approach similar to California's. Mandating that the New York State Public Service Commission (PSC) evaluates and considers policies to support overcoming the barriers to EVs and EV charging in NYS will bring more attention of the people that control NYS' electricity policies. The PSC would then be incentivized to create policies that encourage utilities to support EVs. At the same time, convening utilities to highlight the opportunities available to them through EVs and EV charging can help support the conclusion that the utilities should take a more active role in developing the EV market.

11.4 EV Subsidy

The analysis in this report finds that NYS' EV market would strongly benefit from a subsidy aimed at vehicle adoption and at increased use of public EV charging stations. To overcome the pricing problem inherent in early adoption of network-based technologies, drivers and station owners alike will need additional incentives to enter the market. A subsidy aimed at increased usage of EVs, not merely adoption of those EVs, would effectively shift the market toward NYS' ultimate goal of increased EV VMT.

One subsidy could be conveyed at the point of purchase, similar to subsidies offered in leading EV markets like California and Georgia. A rebate built into the purchase price would be the ideal delivery method of the rebate. A second subsidy would be conveyed at the point of charging, where rather than pay for electricity, an EV driver is paid per mile driven. The subsidy could be tiered so that the rate of subsidy increases the more the car is charged. This system will not only incentivize greater use of VMTs, but will also stimulate demand for the public charging stations licensed by NYS and built by private auction winners. Drivers will seek out public charging opportunities, and stations at retail outlets like malls, grocery stores, and downtown parking garages can earn additional revenue from the influx of customers waiting for their car to charge. Adding non-charging based sources of revenue to the charging station ownership model is critical to long-term viability, so this mileage-based subsidy works hand-in-hand with the charging network financing solution.

Appendix A: Detailed State Policies Comparison

For this report, the EV and EVSE policies across states were examined to identify best practices and policy solutions used in states that have seen their EV markets grow quickly. The two states examined most closely were California and Georgia, in addition to NYS.

A.1 California Policies

California's EV and alternative fuel policies not only provide incentives to stimulate supply and demand of EVs and EVSE in NYS, they also have a growing set of policies to remove deep-seeded barriers to developing a wide-spread EV infrastructure. Local government organizations, public-private partnerships, utilities and private insurance companies also contribute to creating a strong market for EVs by creating their own incentives for EVs and EVSE.

A.1.1 Financial Incentives for EV Purchase

Financial incentives for purchasing plug-in cars are made available by the state, local air and water districts, and certain utilities and insurance companies. Examples include:

- Rebates of $2,500 are available for individuals and businesses that purchase or lease new EVs. $1,500 rebates are available for plug-in hybrids. Funding is expected through 2023. Over 125,000 rebates, with a cumulative $278 million value have already been issued.[68] AB 118 also created a dedicated revenue stream for investments in clean air transportation technologies like EVs by increasing smog abatement and vehicle registration fees for non-EVs.[69]
- The San Joaquin Valley Air Pollution Control District, which covers the Central Valley of California including the cities of Fresno, Bakersfield, Stockton and others, provides additional rebates of up to $3,000 for the purchase or lease of eligible new EVs.[70] It also provides grants to cities, counties, water districts, and public schools to purchase new EVs and hybrids. Grants can be as high as $20,000 per vehicle with a limit of $100,000 per agency per year.[71]

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68 https://cleanvehiclerebate.org/eng/rebate-statistics

69 http://www.afdc.energy.gov/laws/8161

70 http://valleyair.org/grants/driveclean.htm

71 http://www.afdc.energy.gov/laws/9573

- Certain utilities and insurance companies provide additional incentives for their members. For example, residential customers who purchase or lease qualifying plug-in electric vehicles in the Los Angeles Department of Water and Power service area can receive $750.[72] Farmers Insurance offers a 10% discount on all major insurance coverage for EV and hybrid owners.[73]

A.1.2 Financial Incentives for EVSE Purchase and Production

No state-level financial incentives for EV charging stations are offered. Property Assessed Clean Energy (PACE) financing is available for EVSE in areas that have established PACE programs.[74] Local government organizations are also providing funding for EVSE in their areas. Examples include:

- Through June 2014, The Bay Area Air Quality Management District (BAAQMD) awarded grants of up to $20,000 for each DC fast charger installed. The payments included a base award amount of $10,000 per qualifying DC charger installed and incremental bonus awards of up to $5,000 each year for the first two years of operation if the station continues to meet the operating requirements.[75]
- Businesses that install chargers in the Los Angeles Department of Water and Power (LADWP) service area are eligible to receive a rebate of $750, $1,000, or $15,000, depending on the charger type. Up to 2,000 rebates will be issued. The rebate cannot cover installation costs.[76]
- EVSE producers are eligible to receive a sales tax exclusion through June 30, 2016.[77]

A.1.3 OEM Low-Emission Vehicle Standards

- Since 2001, 10% of all cars for sale in California have to be ZEV, hybrids or "ultra-clean gasoline."[78] In 2018, the standards will start to become more stringent and by 2025, 15% of sales will be required to be from plug-in hybrids, ZEVs or fuel cells.

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72 http://www.afdc.energy.gov/laws/9232

73 http://www.afdc.energy.gov/laws/6015

74 http://www.afdc.energy.gov/laws/11558

75 http://www.afdc.energy.gov/laws/11163

76 http://www.afdc.energy.gov/laws/9232

77 http://www.treasurer.ca.gov/caeatfa/ste/index.asp

78 http://www.ucsusa.org/clean_vehicles/smart-transportation-solutions/advanced-vehicle-technologies/electric-cars/californias-zero-emission-1.html#.VC2Ajvn-OSo, http://www.ppic.org/content/pubs/cep/ep_907lbep.pdf

A.1.4 Encouraging EVSE Market Competition

California has tried to protect the competitiveness of the EVSE market by initially barring public utilities from owning and operating EVSE in the state.[79] Companies that own or control EVSE are not considered public utilities and cannot be considered as such.[80] In November 2014, the California Public Utilities Commission proposed a decision to expand the role of utilities in deploying EVSE. The proposed decision would allow the California Public Utilities Commission to consider EVSE proposals from utilities on a case-by-case basis. The proposals will be evaluated using guidelines that protect innovation and competitiveness in the market. Each of the three big utilities in the state have since issued filings to build EV charging stations in their territories.

- Southern California Edison (SCE) has submitted a filing for $350 million for up to 30,000 “make-readies” for EV chargers. This “make-ready approach” involves developing the distribution lines, transformers and wiring in the parking spot. It will also provide rebates of up to $3,900 for third parties to own EV chargers. This brings down the cost of installing a level 2 charger substantially. At the same time, it maintains the site host’s ability to choose the charging station brand and protects competition in the market.[81]
- Pacific Gas & Electric (PGE) has submitted a filing for $650 million for up to 25,000 EV charging stations. PGE’s proposal is to own the charging stations. If approved by the PUC, they would issue an RFP for charging companies and select their preferred bid. They plan to charge drivers the basic commercial electricity rate. Though this makes it completely free for site hosts to install charging stations, critics argue that this approach allows a monopoly to take control over the charging market and could stifle competition and innovation.[82]
- San Diego Gas and Electric’s proposal is smaller than the others, but similar to PGE in that it would like to own and operate the charging stations. It has submitted a filing for up to 5,500 chargers, a $100 million project.[83]

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79 http://www.georgetownclimate.org/sites/www.georgetownclimate.org/files/GCC%20-%20Charging%20Ahead%20-%20June%202014.pdf

80 http://www.afdc.energy.gov/laws/9578

81 http://www.greentechmedia.com/articles/read/california-steps-up-again-on-electric-vehicles

82 http://www.greentechmedia.com/articles/read/pge-seeks-654-million-to-build-25000-ev-charging-stations

83 http://www.utilitydive.com/news/how-sdge-wants-to-power-the-electric-vehicle-market/315887/

A.1.5 Removing Barriers to Installing EVSE

California has attempted to remove barriers to installing EVSE through empowering lessees to install EV charging stations in parking spots, providing online information about EVs and mandating evaluation and review of policies to support EV charging. Examples include:

- Property owners must allow commercial and residential tenants to install an EV charging station in a leased parking spot. The tenant is responsible for purchasing, installing, removing, maintaining, and insuring the charging station.[84] Multi-unit dwellings may not prohibit or restrict a homeowner from installing EVSE in his/her designated parking space. The development cannot implement any policies that would substantially increase the cost or reduce the efficiency and convenience of charging at home. If the homeowner does not have a designated parking space, they can request that an EVSE is installed in a common area and the development must consider the request without avoidance or delay. The homeowner is responsible for the cost of the station, installation, maintenance, removal, and insurance.[85]
- The California Energy Commission and the Public Utilities Commission must evaluate and create policies to develop infrastructure sufficient to overcome barriers to widespread EV adoption including grid stability, electrical infrastructure upgrades, code and permit requirements, and new technology development.[86]
- The California Energy Commission and the Public Utilities Commission must maintain a website with relevant information for Plug-in EV owners including resources to help consumers determine if their residences will require utility upgrades to accommodate EVs, utility rate options and load management techniques.[87]
- The California legislature has requested a feasibility study to move away from the gas tax towards a tax on vehicle miles traveled. This will help ensure reliable funding for highways and roads, while also aligning incentives to reduce gas consumption.[88] California is also conducting its own vehicle miles tax feasibility study.[89]

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84 http://www.afdc.energy.gov/laws/11530

85 http://www.afdc.energy.gov/laws/9579

86 http://www.afdc.energy.gov/laws/6616

87 http://www.afdc.energy.gov/laws/8842

88 http://www.afdc.energy.gov/laws/9581

89 http://www.afdc.energy.gov/laws/11559

A.1.6 Enhanced the Driver Experience

In addition to HOV lane access and toll discounts, California mandates preferred parking spots for EVs and protects those spots from non-EVs. Examples include:

- Plug-in hybrid electric vehicles with the appropriate sticker may use HOV lanes regardless of the number of occupants.[90]
- The Bay Area Toll Authority gives a discount on bridges during certain hours if paying with FasTrac.[91]
- A consistent symbol is used to indicate publicly available charging stations in CA, WA and OR.[92]
- Public Parking facilities operated by the California Department of General Services and the Department of Transportation must provide “meaningful” parking incentives such as preferred spaces, reduced fees, and access to charging.[93]
- Vehicles that are not Plug-in EVs cannot park in spaces designated for charging.[94]

A.1.7 Utility Electricity Rates

- Sacramento Municipal Utility District, Los Angeles Department of Water and Power, Southern California Edison, Pacific Gas and Electric, and San Diego Gas and Electric all offer discounted rate plans for EV drivers. Plans incentivize off-peak charging. Some plans incentivize installing a separate meter for the EV to get an even lower rate.[95]

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[90] http://www.afdc.energy.gov/laws/5359

[91] http://www.nescaum.org/documents/multi-state-zev-action-plan.pdf

[92] Ibid

[93] http://www.afdc.energy.gov/laws/10393

[94] http://www.afdc.energy.gov/laws/9577

[95] http://www.afdc.energy.gov/laws/state_summary?state=CA

A.1.8 State Fleet Requirements

- Governor Brown's executive order B-16-12 requires that 10% of new state fleet by 2015 and 25% by 2020 is electric (vehicles that protect public welfare are exempt).[96]
- Every city, county, special district and school can require that 75% of passenger vehicles acquired be hybrid and alternative fuel vehicles.[97]
- State agencies must actively identify and pursue opportunities to install new EVSE.[98]
- The state fleet must reduce its fuel consumption by 20% compared to 2003 levels by 2020.[99]

A.1.9 Public Private Partnerships

- In 2013, the California PEV Collaborative "Drive the Dream" event brought Governor Jerry Brown and 40 Fortune 500 executives together to announce corporate commitments to PEV workplace charging. The event generated corporate commitments for 2,033 chargers and 1,509 plug-in electric vehicles by September 2014.[100]
- The West Coast Electric Highway has developed a network of charging stations on Interstate 5 that will ultimately provide charging facilities along all 1,381 miles of the corridor from Canada to Mexico, making owning a PEV more convenient for longer distance travel. [101]

A.1.10 Others

- The California Building Standards Commission is mandated to adopt building standards to support EVSE installation in residential and non-residential developments. The standard will go into effect on July 1, 2015.[102]
- Grant funding is available to school districts for occupational training programs that focus on employment in clean technology businesses including EVs and EVSE.[103]
- The Sacramento Emergency Clean Air and Transportation (SECAT) Program provides grants for projects that reduce vehicle emissions in their service area potentially including EVSE projects.[104]

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96 http://governor.maryland.gov/documents/MultiStateZEVActionPlan.pdf

97 http://www.afdc.energy.gov/laws/6010

98 http://www.afdc.energy.gov/laws/10541

99 http://www.afdc.energy.gov/laws/6492

100 http://www.nescaum.org/documents/multi-state-zev-action-plan.pdf

101 Ibid.

102 http://www.afdc.energy.gov/laws/11068

103 http://www.afdc.energy.gov/laws/11162

104 http://www.afdc.energy.gov/laws/6004

A.2 Georgia Policies

A.2.1 Financial Incentives to Purchase EVs

- Individuals who purchase or lease Zero Emission Vehicles (full electric cars) receive an income tax credit equal to 20% of the vehicle cost up to $5,000.[105] (Note:incentive eliminated July 2015.)

A.2.2 Financial Incentives to Purchase EVSE

- Businesses that purchase or lease EVSE receive an income tax credit of 10% of the cost up to $2,500.[106]
- Starting in 2015, Georgia Power is offering a rebate on level 2 chargers. Businesses are eligible for a $500 rebate and residences are eligible for $250.[107]

A.2.3 Enhanced Driver Experience

- Plug-in EVs with the appropriate license plate may use HOV lanes regardless of occupancy. They may also use the High Occupancy Toll (HOT) Lanes toll-free.[108]

A.2.4 Utility Electricity Rates

- Georgia Power offers a special time-of-use rate for residential customers who own an EV.[109]

A.3 New York State Policies

New Yorkers are eligible for the federal income tax credit of $7,500 for purchasing an EV, but NYS does not provide any additional incentive. New York City has passed legislation to make 20% of new parking EV charger-ready, however, no statewide building codes have been put in place to encourage charger-ready parking outside of New York City. NYS' policies to support EV adoption are as follows.

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105 http://www.georgiaair.org/airpermit/html/mobilearea/engines/Alternativefuels.htm

106 http://www.afdc.energy.gov/laws/5180

107 http://www.afdc.energy.gov/laws/11555

108 http://www.afdc.energy.gov/laws/5183

109 http://www.afdc.energy.gov/laws/9372

A.3.1 Financial Incentives to Purchase EVSE

- An income tax credit is available for 50% of the cost of alternative fueling infrastructure, including EVSE, up to $5,000. The credit expires December 31, 2017.[110]

A.3.2 Enhanced Driver Experience

- Through NYS' Clean Pass Pilot Program, EVs and other low-emission vehicles can use the HOV lane on the Long Island Expressway regardless of occupancy.
- Through the Green Pass Discount Plan, EVs and other low-emission vehicles receive a 10% discount on tunnel and bridge tolls operated by the Port Authority of New York and New Jersey. The New York State Thruway also offers a 10% discount.[111]

A.3.3 OEM Low-Emission Vehicle Standards

- NYS has adopted the same standards as California mandating that all OEMs achieve a certain average GHG emissions standard across the portfolio of cars they sell in NYS. They also must offer the same percentage of Zero Emission Vehicle (ZEVs) as in California.[112] (See OEM Low-Emission Vehicle Standards in the California section above).

A.3.4 Building Codes

- As of December, 2013, every new parking lot or garage in NYC, and any expansion to an existing parking lot or garage, must provide at least 3.1 kW of electric supply to at least 20% of the parking spots.[113] This is expected to create 2,000 charger-ready spots by the end of 2015 and 5,000 by 2020.[114]

A.3.5 Research Funding

- NYSERDA provides financial and technical support to public and private fleet managers to evaluate the feasibility of adding alternative fuel vehicles, including EVs, into their operations.[115]

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110 http://www.afdc.energy.gov/laws/11180

111 http://www.afdc.energy.gov/laws/6304

112 http://www.afdc.energy.gov/laws/4627

113 http://legistar.council.nyc.gov/LegislationDetail.aspx?ID=1501659&GUID=65344E17-4C65-4751-81E7-7A0D4DD9F7CD&Options=ID|Text|&Search

114 http://insideevs.com/new-york-city-passes-landmark-charger-bill-20-of-future-parking-spots-required-to-be-charger-ready-potential-for-10000-ev-spots-in-7-years/

115 http://www.afdc.energy.gov/laws/5326

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New York State
Energy Research and
Development Authority

17 Columbia Circle
Albany, NY 12203-6399

toll free: 866-NYSERDA
local: 518-862-1090
fax: 518-862-1091

info@nyserda.ny.gov
nyserda.ny.gov

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