Financing Electric Vehicle Markets in New York and Other States

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EITAN HOCHSTER
ABSTRACT

Should policymakers incentivize electric vehicle (EV) purchases first or invest in charging stations first? This report explores this so-called chicken-and-egg dilemma and provides recommendations for growing the EV market and increasing investment in EV charging stations. We compare EV markets across states with a focus on New York, which falls in the middle of the 50 states in terms of EVs as a percentage of new car registrations and number of chargers per capita. Our analysis suggests that the best way for policymakers to facilitate the growth of the overall market is to grow electric vehicle purchases and allow the private sector to provide charging. At the same time, there are important roles that governments can play in facilitating the development of a more robust EV charging infrastructure. This report also explores policy options for supporting a growing EV and EV charging market.
ACKNOWLEDGMENTS

This work was supported by Yale Center for Business and the Environment.

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June 5, 2015
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EXECUTIVE SUMMARY

The process of sowing the seeds of electric vehicle infrastructure—and thereby creating a backbone of charging stations that can support these vehicles—is still in its infancy. This report outlines the technologies and business models necessary to ramp up growth in the electric vehicle (EV) market in the United States. It also explores the relationship between charging stations and consumer purchases of EVs.

EVs are becoming an increasingly large part of our clean energy economy and are a vital element of sustainable transportation. Because of the many societal and environmental benefits of increased EV ownership, governments have instituted policies to encourage consumers to buy EVs.

The prices of EVs are declining. Their ranges are becoming longer. And distributed generation is making it possible to use locally-sourced renewable energy to power EVs.

But despite substantial growth in the market during the past five years, EVs still make up a small percentage of the cars on the road in the United States.

A Lack of Infrastructure
Creating policies to facilitate the expansion of EV charging stations can be challenging. One obstacle is the low current rate of EV ownership and the resulting limited usage of public chargers. Building up higher station usage is necessary for EV infrastructure to become more financially viable and therefore become widespread.

Some have said this presents a chicken-and-egg problem: should policymakers incentivize EV purchases first or invest in charging stations first?

Our work has indicated that this is not necessarily the case. Our analysis suggests that the best way for policymakers to facilitate the growth of the market is to grow electric vehicle purchases and allow the private sector to provide charging infrastructure.

Over 90% of charging occurs at homes or workplaces, not at public stations. Also, market participants are likely to respond to the presence of EVs by installing electric vehicle supply equipment (EVSE). Therefore, encouraging consumers to purchase EVs may be a better approach than funding public charging stations. This will create a cycle of market growth. Encouraging EV purchases will increase the use of charging stations and make the market more profitable, leading to further expansion.
Real-world examples have demonstrated that if EVs are on the roads, the private market will invest in local charging infrastructure. Market participants including utilities and automobile OEMs have a lot to gain by investing in charging infrastructure to support EV drivers.

The core message, then, is that governments looking to expand EV infrastructure should spend their policy dollars encouraging EV purchases rather than constructing charging stations. This type of policy intervention ensures that EVSE will be installed in areas that will receive relatively high traffic. It also ensures that EVSE will be used and maintained at an optimal level.

A Blueprint for Progress

At the same time, there are important roles that governments can play in facilitating the development of a more robust EV charging infrastructure. While we recommend starting with encouraging EV purchases, the policy groundwork to support private investment in EVSE must also be in place.

This report contains a description of the EV and EVSE market in certain states, a financial model for market growth, and recommendations of new approaches to expanding the market.

We compare EV and EVSE policies in New York to those of two leading states, Georgia and California. While certain states have excelled at developing EV ecosystems, New York is in the middle of the national range, ranking 25th among the 50 states in terms of electric vehicle chargers per capita (U.S. Department of Energy, 2014).

We have also analyzed a variety of policy options dedicated to growing the EVSE market. Policies that ease the permitting and installation process are relatively straightforward and low-cost measures that have proven to be beneficial in other states and in the solar energy market.

Instituting unified statewide permitting, adapting building codes, reducing demand charges, and allowing parking spot lessees to install chargers are just a few of these policies.

Governments can have a massive impact by providing low-cost financing for EV chargers with off-balance-sheet repayment structures like property-assessed clean energy (PACE) or on-bill repayment. This financing would be a significant boon for a market that is not yet sufficiently established to be financeable at low rates.

Higher-cost policy options include lowering the fixed costs of installing charging stations through subsidies or tax credits. Policymakers could achieve a lower-cost approach with the same end goal by facilitating partnerships between market participants who can benefit from a more robust EV charging ecosystem.
Not all charging stations are created equal. Some of the major decisions to make when it comes to building EV charging infrastructure involve choosing between the following alternatives:

1. Level 2 charging vs. DC Fast Charging (DCFC)
2. Networked vs. non-networked
3. Operated by the owner vs. contracted through an electric vehicle service provider (EVSP)

No single technology or business model available today is exactly right for all charging scenarios. There are pros and cons to each alternative, depending on the location and the driver base that the charging station aims to serve.

Where drivers tend to spend multiple hours at one location such as a workplace, movie theater, or sit-down restaurant, Level 2 chargers are most practical. Where drivers want to pause briefly at rest stops or convenience stores, DCFC may be a better choice. A mix of charging technologies and business models will be necessary to meet drivers’ diverse needs and achieve large-scale availability of charging stations for all situations.

Charging Technologies

There are three categories of EV charging that could be made available to the public. The key decision involves when and where to install Level 2 stations vs. DCFC stations. There are pros and cons to each. A combination of both types of stations throughout United States roadways will be necessary to meet drivers’ varying needs.

All EVs come with the J1772 plug that enables them to plug into a Level 2 charging station. But not all EV models have DCFC capability.

Figure 1 describes the three types of EV charging.

(see next page)
### Figure 1. EV Charging Levels (California PEV Collaborative, n.d.)

<table>
<thead>
<tr>
<th>CHARGING LEVEL</th>
<th>POWER SUPPLY</th>
<th>CHARGER POWER</th>
<th>MILES OF RANGE FOR 1 HOUR OF CHARGE</th>
<th>BEV</th>
<th>PHEV</th>
</tr>
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<tbody>
<tr>
<td><strong>Level 1</strong></td>
<td>120 VAC Single Phase</td>
<td>1.4 kW @ 12 amp (on-board charger)</td>
<td>~3 – 4 miles</td>
<td>~17 Hours</td>
<td>~7 Hours</td>
</tr>
<tr>
<td><strong>Level 2</strong></td>
<td>240 VAC Single Phase up to 19.2 kW (up to 80 amps)</td>
<td>3.3 kW (on-board)</td>
<td>~8 – 10 miles</td>
<td>~7 Hours</td>
<td>~3 Hours</td>
</tr>
<tr>
<td><strong>DC Fast Charge</strong></td>
<td>200 – 450 VDC up to 90 kW (approx. 200 amp)</td>
<td>6.6+ kW (on-board)</td>
<td>~17 – 20 miles</td>
<td>~3.5 Hours</td>
<td>~1.4 Hours</td>
</tr>
</tbody>
</table>

#### LEVEL 1

Level 1 charging is convenient for plug-in hybrids with small batteries, but not for all-electric cars with larger batteries. An all-electric car with 80 miles of range or more would take more than 12 hours to charge using a Level 1 outlet.

#### LEVEL 2

Level 2 chargers provide about 20 miles of range in an hour. They require about 3.5 hours to fully charge an all-electric car. Given that 95% of all driving trips are under 30 miles, EV drivers rarely need to recharge their cars from empty. So an hour is often sufficient to recharge a car for the next trip (Solar Journey USA, n.d.).

Installing Level 2 chargers can be useful at any location where people might spend an hour or more. Shopping centers, restaurants, gyms, theaters, museums, hospitals, schools and workplaces can be good choices. Some employers have installed Level 2 chargers for their employees.

Level 2 chargers are more affordable to install than DCFCs. Including installation costs, they cost between $6,000 and $10,000 per station (Center for Climate and Energy Solutions, 2014). Each charging station usually comes with two ports, so it can charge two cars at once.

#### DCFC

An EV with DCFC capability can charge up to 80% of its battery in 30–45 minutes (California PEV Collaborative, n.d.). This is convenient for short-term stopping locations such as highway rest stops, street...
parking spots, and grocery stores. DCFC allows drivers to take longer trips with shorter stops along the way. Not all EV models on the market today have DCFC capability.

DCFC is still not as fast as refueling a car with gasoline. Chargers should still be sited at locations that drivers would need to visit routinely so EV owners will have something to do while their cars charge (Cai, 2014).

DCFC would also be convenient outside of coffee shops and other retail locations where drivers might spend about 30 minutes.

There are diminishing returns to keeping an EV plugged into a DC charger for longer than 30–45 minutes. As the battery gets closer to full, it takes much longer to charge because the car must reduce the current. For example, a Tesla Model S can charge 80% of its battery in 40 minutes on a Supercharger and 100% in 75 minutes. The last 20% takes approximately as long as the first 80% (Tesla Motors, n.d.).

Pricing at 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 10–20 cents per minute. The first 30 minutes of charging costs around $3 and charges a battery to about 80%. Remaining plugged in for an extra half hour costs an extra $3–6 with a minimal gain in range (NRG, 2015).

There are three different major DCFC technologies on the market now. Tesla has its own for its Supercharger network. Other EVs use either SAE Combo or CHAdeMO. For example, Nissan uses CHAdeMO while BMW uses SAE Combo.

Charging stations are usually only compatible with one DC charging technology. The NRG eVgo stations have both CHAdeMO and SAE Combo. Other providers, such as EFACEC, make DCFCs with both charging technologies that can be operated on networks like ChargePoint or Greenlots.

There are also several different levels of power that DC charging stations can provide. Tesla Superchargers provide 120 kW (Tesla Motors, n.d.). CHAdeMO chargers usually provide 50 kW (Plug-In America Blog, 2013). SAE Combo chargers can provide either 24 or 50 kW (Green Car Congress, 2015).

DCFC stations are generally much more expensive than Level 2 stations. Including installation costs, they usually cost between $60,000 and $80,000 each (Center for Climate and Energy Solutions, 2014).

Among the cheapest DC fast chargers available on the market today is BMW’s 24 kW fast charging station. This 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 a BMW EV’s 22 kWh battery in 30 minutes (Halvorson, 2014).
Business Models
There are two main business models for EV charging today. The key difference between them is who owns and controls the charging station. Some stations are owned by site hosts. Others are owned by EV charging networks.

OPTION 1: HOST OWNS AND MANAGES THE STATION
In this model, the EV charging company sells a charging station to a host—an individual or business that wants a station onsite. Once the host purchases a charging station, it has full control over that station. The host can choose to install a networked station or a non-networked station.

Non-Networked Stations
Non-networked stations simply deliver electricity. They do not allow station hosts to charge drivers for electricity. When a host purchases a non-networked station, it pays the upfront costs of the hardware and installation. The only recurring costs are for the electricity itself.

This market is almost entirely for Level 2 chargers.

Non-networked stations are cheaper than networked stations, but they provide no mechanism for the hosts to recover the upfront costs or the electricity costs (LilyPad EV, 2015).

Many residential chargers are non-networked because the electricity costs are simply added to the homeowners’ utility bills. Workplaces may also opt for non-networked chargers if the companies are sure they will always want to cover the costs of electricity. Alternatively, they may also establish other ways to charge employees for use of the stations.

Networked Stations
While the description of networked charging below covers most of the current market, it is a simplified breakdown. There are many combinations of business partnerships in networked charging where different players in the value chain can split costs and revenues. Innovative partnership arrangements may stimulate the market in the future.

Networked stations are most commonly used for public charging because they allow remote management. They also allow hosts to charge drivers directly for electricity. By charging a premium on the electricity, a host can eventually recoup the cost of the station and earn a profit.
Stations provide the additional benefit of bringing EV-driving customers to companies to charge. EV drivers use applications on their cell phones, computers, and navigation systems to find charging stations. If drivers need to charge cars, they are likely to choose retail destinations that they know have charging stations over ones that do not.

Networked stations connect to monitoring and management platforms so the hosts can manage the stations remotely. If a host chooses a networked station, it can often also choose which network to use to manage it.

Networked chargers constantly report their statuses to their networks. This reporting allows the status data to be made available to drivers through cell phone apps like ChargePoint and Plugshare. These apps allow drivers to locate available stations nearby. The apps can also let them know when their cars have finished charging.

The data from the management platform also allow the charging company to maintain all of the chargers on the network, removing that burden from the hosts.

In addition to requiring installation and electricity payments, networked charging stations usually also require that monthly service charges be paid for access to the management software and the network.

ChargePoint and SemaConnect are examples of popular networks that a site host can use.

**OPTION 2: EV CHARGING PROVIDER OWNS AND MANAGES THE STATION**

Property owners and lessees can also choose to rent parking spaces to EVSPs to install charging stations. In this case, the EVSPs may pay licensing fees to the hosts for the right to use the spaces. The stations are then completely in the control of the EVSPs.

The EVSPs manage the stations and set the pricing so it is consistent with the prices of the other stations in their networks. There may or may not be a revenue-sharing component in which the hosts get to keep small portions of the profits.

In this model, the EVSPs shoulder all of the risks of the investments. These companies rely on earning a profit. They often charge membership fees in addition to electricity fees. Examples of EV charging companies using this model are Car Charging Group’s Blink Network and NRG’s eVgo network.

Nissan is helping to reduce charging costs for its customers by partnering with NRG evGo, Blink and Aerovironment. Through its No Charge to Charge program, it is making charging free for its customers in select markets for limited periods of time (Rovito, 2014).
THE CURRENT STATE OF PLAY IN THE CHARGING MARKET

Many different industries and groups of people are seeking to expand the EV market. Increasing EV driving and charging will require understanding each of these groups’ roles and their incentives.

Table 1. PLAYERS IN THE EV CHARGING ECOSYSTEM

<table>
<thead>
<tr>
<th>PLAYER</th>
<th>ROLE</th>
<th>INCENTIVE</th>
</tr>
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<tbody>
<tr>
<td>Property owner</td>
<td>Hosting charging stations</td>
<td>Make tenants happier</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Increase property value</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Increase revenue</td>
</tr>
<tr>
<td>Workplace property lessee</td>
<td>Hosting charging stations</td>
<td>Have happier employees</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Decrease fuel costs for fleets</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Build a green brand image</td>
</tr>
<tr>
<td>Commercial property lessee</td>
<td>Hosting charging stations</td>
<td>Have happier customers</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Increase profits from customers</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Build a green brand image</td>
</tr>
<tr>
<td>EV charging company (host owns station)</td>
<td>Selling charging stations and station management packages</td>
<td>Increase sales of charging stations and packages</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Build brand</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Grow network</td>
</tr>
<tr>
<td>EV charging company (company owns station)</td>
<td>Installing and operating a network of charging stations</td>
<td>Maximize profits from electricity sales</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Build brand</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Grow network</td>
</tr>
<tr>
<td>Auto company</td>
<td>Making and marketing EVs</td>
<td>Sell cars</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Build a green brand image</td>
</tr>
<tr>
<td>Auto dealer</td>
<td>Selling EVs to end customers</td>
<td>Sell cars quickly and easily</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Maximize profits</td>
</tr>
<tr>
<td>Utility</td>
<td>Providing electricity</td>
<td>Sell electricity</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Manage load</td>
</tr>
<tr>
<td>Municipality</td>
<td>Providing and managing parking</td>
<td>Promote commerce</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Have safe and healthy communities</td>
</tr>
</tbody>
</table>
**Driver**
- Purchasing and charging EVs
- Lower fuel costs
- Experience reliable driving
- Access convenient charging

**Advertiser**
- Sponsoring charging stations
- Have high-impact ads
- Maximize impressions
- Build brand
- Build a green brand image

**Bank**
- Financing charging stations
- Maximize return on capital

**State and federal government**
- Promoting EV driving and charging
- Maximize impact of investments

### Barriers to Profitability
EV charging has the potential to earn a premium on the sale of electricity to drivers in public settings. If station usage is high, this premium can allow station owners to recoup their investments and earn a profit.

The greatest challenge to charging station profitability is low usage. In many areas with small numbers of EVs, like New York, station usage is extremely low. Over the last year, usage of public charging stations ranged from 3–4% (NYSERDA). This means that regardless of the premium a station owner charges on electricity, it will take many years to earn a return on the investment.

Charging station usage is a function of both the number of charging stations and the number of EVs in an area. If the number of EVs in an area grows faster than the number of charging stations there, usage can be expected to increase. If the number of charging stations in an area grows faster than the number of EVs, usage can be expected to decrease.

Table 2 demonstrates this relationship, observed in New York, through data from a subset of charging stations participating in a study by New York Energy Research and Development Authority (NYSERDA) and Idaho National Laboratory. From the fourth quarter of 2013 to the first quarter of 2014, plug-in vehicles in New York increased by 19%, but the number of charging ports only increased by 10%, so usage spiked 27%. Then, from the first to the second quarter of 2014, the number of plug-in vehicles increased by 6%, but the number of charging ports increased by 27%, so usage fell 7% (NYSERDA).
Table 2. CHANGE IN STATION USAGE, NUMBER OF EVS, AND NUMBER OF CHARGING STATIONS IN NEW YORK BETWEEN 2013 AND 2014

<table>
<thead>
<tr>
<th></th>
<th>% CHANGE IN VEHICLES</th>
<th>% CHANGE IN NUMBER OF CHARGING PORTS</th>
<th>% CHANGE IN PUBLIC PLUG-IN VEHICLE STATION USAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>2013 Q4–2014 Q1</td>
<td>18.8%</td>
<td>10.1%</td>
<td>27.3%</td>
</tr>
<tr>
<td>2014 Q1–2014 Q2</td>
<td>5.8%</td>
<td>27.0%</td>
<td>-7.1%</td>
</tr>
<tr>
<td>OVERALL (2013 Q4–2014 Q2)</td>
<td>25.6%</td>
<td>39.9%</td>
<td>18.2%</td>
</tr>
</tbody>
</table>

Due to what many describe as the chicken-and-egg nature of EV ownership and charging station installation, EV experts at Electrification Coalition expect that in the early stages of the market, there will need to be more charging stations than EVs initially (City of Albany, 2012).

The charging stations will provide a necessary signal to the market that the infrastructure is there to support drivers, even though there may not be enough drivers to use them very frequently. This implies charging station usage, and therefore profitability, may have to be lower than desired while the market develops.

As drivers start to see more charging stations, they will become more comfortable with the idea of driving EVs and will become more likely to purchase them. Over time, the ratio of EVs to chargers should increase. As a result, both usage and charging station profitability will increase. Table 3 shows Electrification Coalition’s projection of the ratio of EVs to charging stations through 2030 (City of Albany, 2012).

Table 3. EXPECTED PUBLIC CHARGER RATIOS FROM ELECTRIFICATION COALITION (CITY OF ALBANY, 2012)

<table>
<thead>
<tr>
<th>PUBLIC CHARGER RATIOS</th>
<th>2010</th>
<th>2020</th>
<th>2030</th>
</tr>
</thead>
<tbody>
<tr>
<td>EXPECTED PUBLIC CHARGERS PER VEHICLE</td>
<td>2.0</td>
<td>1.5</td>
<td>1.0</td>
</tr>
<tr>
<td>MAXIMUM PUBLIC CHARGERS PER VEHICLE</td>
<td>2.5</td>
<td>2.0</td>
<td>1.5</td>
</tr>
<tr>
<td>MINIMUM PUBLIC CHARGERS PER VEHICLE</td>
<td>1.5</td>
<td>1.0</td>
<td>0.5</td>
</tr>
</tbody>
</table>

In addition to the ratio of EVs to charging stations in an area, the other two factors that influence usage are placement and pricing. Charging stations should be in locations that people visit routinely. Studies attempting to optimize charging station locations have used the goal of minimizing drivers’ walking distances to their final destinations (Chen, 2013).
Reports from NYSERDA and Idaho National Laboratory demonstrate this. EV charging stations at workplaces and on campuses have relatively high usage in New York. Retail locations in New York also have a relatively high usage per session (NYSERDA).

Session lengths vary based on where the stations are placed. Using central, highly-visible, high-traffic locations can also help increase usage. The sessions at retail locations are shorter than they are at workplaces or medical campuses, so overall usage appears lower than it does at these other locations. But between October 2013 and October 2014, retail locations were second to medical campuses in terms of having the highest number of charging events (NYSERDA).

Pricing greatly impacts usage of public stations. In order for driving EVs to make financial sense, car buyers must see the cost of electricity is lower than the cost of gas on a per-mile basis. Charging an EV at home is generally much less expensive than buying gas.

EV drivers may be willing to pay a small premium at public charging stations for the convenience of being able to charge there. However, if the cost of charging in public is too high relative to the cost of gas or compared to what they pay for electricity at home, they will not be willing to charge in public. That reluctance may limit EV driving.

Drivers are price-sensitive when choosing charging stations. NYSERDA’s Electric Vehicle Infrastructure Reports show that free stations had about 15 times as many charging events as stations with fees over the last year. Free stations also had vehicles connected to them for about twice as long. In New York, a charging station is free when the host owns the station and has decided to make it free to use (NYSERDA).

Due to marketing benefits, many hosts provide free, subsidized or at-cost charging. When the site host owns the charging station, the host’s brand may be perceived as “green.” Customers and employees may also be pleased with the presence of the station. These marketing benefits could make the investment in charging stations worthwhile above and beyond the return from the sale of electricity. These benefits could motivate companies to consider longer investment horizons than they might require otherwise.

In the EVSP model, the station owner relies only on the premium from the sale of electricity to earn a return on investment. However, because of low station usage rates, the availability of free public charging, and the low cost of charging at home, it is challenging to find a pricing strategy that seems affordable to drivers but still makes a significant profit.

The structure of the pricing plays a major role in influencing driver behavior and station usage. Station owners can choose to charge per kilowatt-hour, per hour, per session, or some combination of the three. Charging by the kilowatt-hour is the most transparent and straightforward approach. However, once a
car’s battery is full, it draws very little power, so there is little incentive for the driver to unplug. One car could sit at a charging station all day, blocking it from use.

Charging by the hour incentivizes drivers to stay plugged in for a short time. Charging by the session incentivizes drivers to stay for as long as they would like. And any pricing package that deviates from the straight kilowatt-hour rate makes it harder for drivers to compare the cost of charging their cars in public to the cost of charging the cars at home or filling them up with gas. This information gap could deter current EV drivers from charging in public and discourage potential drivers from investing in EVs.

In order for charging stations to be profitable for their owners, they need high usage. They need to charge a small premium on electricity so they can use the margin to earn a return on investment. The premium should not be so high as to deter people from charging in public.
Studies have shown that reducing the total cost of ownership of EVs and plug-in hybrids relative to internal combustion engine vehicles increases the likelihood of EV adoption (Collantes & Eggert, 2014). 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 reduce the total cost of their ownership (Mock & Yang, 2014).

Though there are exceptions, markets with the highest fiscal incentives for EVs usually also have the highest market shares of these vehicles. An International Council on Clean Transportation (ICCT) analysis of seven EV markets finds clear examples of successes in the Netherlands and Norway (Mock & Yang, 2014). Both countries have high fiscal incentives and also very high market shares. Similarly, California’s relatively high incentives for all-electric vehicles help it to stand apart from the rest of the United States.

Several studies have attempted to quantify the impact of fiscal incentives on EV adoption. Sierzchula et al. found in 2014 that, holding all other factors constant, each $1000 increase in financial incentives can 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% (Sierzchula, Bakker, Mat, & van Wee, 2014).

Other studies have looked at the impact of incentives for hybrid vehicles as a proxy for all electric vehicles. These studies have found that a $1,000 increase in consumer financial incentives for hybrids caused a 3–4.5% increase in adoption (Jenn, Azevedo, & Ferreira, 2013).

Interestingly, the timing of when the customer receives the incentive could have a much greater impact than the amount. Researchers have 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 (Gallagher & Muehlegger, 2011).

This idea is supported by a recent paper by Eric Cahill at University of California, Davis on the role of dealers in the EV market. Consumer uncertainty about tax credits and rebates makes it very challenging for dealers to sell EVs. Cahill also suggests that making savings from fiscal incentives both immediate and simple would greatly increase their value to consumers with no additional cost to the government (Cahill, Davies-Shawhyde, & Turrentine, 2014).
A similar relationship between reducing the price of EVs and increasing their adoption can be seen in Nissan Leaf sales over the past two years. 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 Leafs, a 230% increase. This demonstrates a 35% increase in EV demand per $1,000 decrease in cost (Tutor, 2013).

Though other changing market conditions during this period may have contributed, this suggests that there is a strong correlation between EVs’ prices and their sales (Inside EVs, 2015).

Reducing the upfront costs of EVs, either through fiscal incentives for consumers or through policies that encourage car companies to reduce prices, is likely to have the greatest impact on decreasing the total costs of ownership of EVs.

Policies that allow customers to see the savings immediately will be more effective than policies that require them to wait until the end of the year. Other ways to reduce the cost of EV ownership include lowering the costs of electricity, charging, parking, tolls and insurance.

There is not a clear relationship between the number of public EV charging stations available in an area and the amount of EV driving in that area. This is due to the availability of charging at home and variations in the pricing and placement of public charging stations. Cai et al. believe that visible, public EV charging is important to promote the adoption of EV driving. But they also believe the mismatch of demand and infrastructure leads to low usage (Cua, Jia, Chiu, Hu, & Xu, 2014).

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 it began offering free charging through its No Charge to Charge pilot program, Leaf sales in test markets grew 60–150% faster than in other markets (Rovito, 2014).

Workplace charging has also been demonstrated to lead to additional EV driving. EVs parked at workplace chargers become a mini showroom, inspiring conversation and knowledge-sharing (PEV Collaborative). Workplace EV parking has been so effective in promoting purchase of EVs that after chargers are installed, charger demand tends to outpace supply (Nicholas & Tal, 2013).
The EV market in the United States has grown considerably during the past five years. Almost 120,000 plug-in cars were purchased in the nation in 2014 compared to only 53,000 in 2012. This was an over-200% increase. However, plug-in cars still only made up about 0.07% of total car sales in 2014 (Electric Drive, 2015). Much more growth will be needed for electric vehicles to become a substantial contender in the market.

There has been relatively little federal investment in supporting the development of a robust market. A tax credit of 30% of the cost of EVSE up to $30,000 was available until December 2014 but was not extended to 2015. There is a $7,500 federal tax credit for purchasing plug-in electric vehicles. Manufacturers can get a loan for up to 30% of the costs of building or expanding manufacturing of alternative-fueled vehicles (U.S. Department of Energy, 2014-1). Finally, there are loan guarantees and other incentives for research projects aiming to advance clean energy transportation.

State and local policies have a very large impact on creating a supportive market. As a result, growth has not been consistent from state to state.

EV sales are growing much faster in California and Georgia than they are in most other states. However, this trend may change soon. In May 2015, Georgia passed a bill that may halt its EV tax credit if it is signed into law by the governor on June 30th. The bill would also require EV drivers to pay additional fees (Blair, 2015).

Though California has the largest market and Georgia has the fastest-growing market, this report focuses on New York because it is more representative of the average market in the United States.

New York falls in the middle of the range of states both in terms of electric vehicle penetration and in terms of charging stations per capita. According to a recent survey by Edmunds and Polk using 2013 data, New York is 25th nationally in new electric vehicle registrations as a percentage of total car registrations (Caldwell, 2014).

Currently, New York has 7,900 plug-in vehicles out of 10.8 million registered cars. This is a percentage of 0.073% (New York State Department of Motor Vehicles, 2014). This includes both all-electric vehicles and plug-in hybrids. In comparison, California currently has 3.15 times that percentage: it has 32.3 million cars registered (State of California Department of Motor Vehicles, 2015). It also has 77,600 plug-in cars (Center for Sustainable Energy, 2015).
For New York, charging infrastructure demonstrates a similar story as EVs show. There are currently 783 chargers in the state, which ranks 25th nationally in chargers per capita with 4.1 chargers per 100,000 people (U.S. Department of Energy, 2014-2).

In contrast, California has 13.5 chargers per 100,000 people. While the state has moderate numbers with regard to overall public charging, it fares much worse with regards to DC fast charging, as there are only 16 DCFCs in the entire state (U.S. Department of Energy, 2014; United States Census Bureau, 2015).

Interestingly, New York’s electric vehicles and charging infrastructure are close to evenly split between upstate and downstate. 55% of EVs are registered in upstate counties. Also, 55% of chargers are located in upstate New York. Many of the electric vehicles are concentrated in higher-income counties, like Westchester, Suffolk, New York and Nassau. There is also high EV registration in Albany (New York State Department of Motor Vehicles, 2014).
Comparing New York to any other state, one key difference is that fewer New Yorkers have personal garages where they can charge EVs. 42% of the people and 20% of the cars in New York are in New York City, where people mostly live in densely-packed apartment buildings with street parking or public garages (United States Census Bureau, 2015; New York State Department of Motor Vehicles, 2014).

Despite having 6,000 public EV charging stations scattered across the state and thousands more workplace chargers for employees, most California EV drivers still charge their cars at home. In that regard, public charging stations may be more critical in New York than they are in other states.

While New York is in the middle of the national data range for both registered EVs and EV charging infrastructure, it is not obvious from the data that a robust public charging infrastructure is necessary to have high EV penetration there.

For instance, in 2013, Georgia ranked 18th nationally with 5.5 chargers per 100,000 people, yet was 4th in EV registrations as a percentage of total car registrations. Similarly, Utah was 25th in charging infrastructure, but 7th in EV registrations as a percentage of total car registrations (Caldwell, 2014).

The reverse pattern also occurs: Vermont has the sixth highest rate of chargers per 100,000 people, yet is not in the top 10 in EV registration percentages. This pattern also exists in New York, where certain counties with high EV penetration are not the counties with the most robust public EV infrastructure (Caldwell, 2014).

While the EV and EVSE relationship is frequently viewed as a “chicken-and-egg” problem, our work has indicated that this is not necessarily the case. As home charging is the most common method EV drivers use and because market participants are likely to respond to the presence of EVs by installing EVSE, encouraging consumers to purchase EVs may be a better approach than funding charging stations.

These data are by no means conclusive. Developing an established EVSE ecosystem is still essential. Many states with the highest numbers of EVs—like Hawaii, California, Washington and Oregon—are also leading in EV infrastructure.

**Variations in State Policies Supporting EVs and Their Infrastructure**

Policies affect the variation of EV adoption across states. We compared the policies supporting EVs in New York, California and Georgia to better understand the ways in which state policies have helped propel the market in some states more than in others.

California and Georgia have both created more incentives for EV adoption than New York has. California has policies that touch every aspect of the EV and EVSE market to incentivize purchases and remove barriers to adoption.
New York, California, and six other states have signed onto the Zero Emission Vehicle (ZEV) Action Plan. This Memorandum of Understanding supports the deployment of ZEVs by outlining 11 priority actions that the states have agreed to take. The six other participating states are Connecticut, Maryland, Massachusetts, Oregon, Rhode Island and Vermont (NESCAUM, 2014).

The eight states have committed to work together toward a target of 3.3 million EVs and adequate charging infrastructure for them by 2025. California has made it law for state agencies and utilities to work with the California Plug-In Electric Vehicle Collaborative and the California Fuel Cell Partnership to achieve its progress benchmarks for the ZEV Action Plan. New York has not formally engaged in any action of this type yet (NESCAUM, 2014).

NEW YORK POLICIES

New Yorkers are eligible for the federal income tax credit of $7,500 for purchasing an EV, but the state does not provide any additional incentives. The federal tax credit is not applicable to leases, so there is no tax credit available to New Yorkers who would like to lease EVs. New York City has passed legislation to make 20% of new parking EV charger-ready, but there are still no state-wide building code policies to encourage charger-ready parking outside of New York City (The New York City Council, n.d.).

New York’s policies to support EV adoption include:

**Financial Incentives for 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 (U.S. Department of Energy, 2014-3).
Drifting Experience

- Through New York State’s 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 Thruway also offers a 10% discount (U.S. Department of Energy, 2014-4).

Building Codes

As of December 2013, every new or expanded parking lot or garage in New York City must provide at least 3.1 kW of electric supply to at least 20% of its parking spots (The New York City Council, n.d.). This is expected to create 2,000 charger-ready spots by the end of 2015 and 5,000 by 2020 (Loveday, 2014).

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CALIFORNIA POLICIES

California’s EV and alternative fuel policies are extensive. In addition to providing incentives to stimulate supply and demand, the state also has a growing set of policies to remove deep-seated barriers to developing a widespread EV infrastructure. Local government organizations, public-private partnerships, utilities, and private insurance companies also contribute to creating a strong market by setting up their own incentives for EVs and EVSE.

Financial Incentives for Purchasing EVs

Financial incentives for purchasing plug-in cars are made available by the state, local air and water districts, and certain utilities and insurance companies. There are no state-level financial incentives for EV charging stations.

- 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 for these two rebates is expected through
23. Over 50,000 rebates, with a cumulative $100 million value, have already been issued. 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 (U.S. Department of Energy, 2014-5).

- The San Joaquin Valley Air Pollution Control District—which covers the Central Valley of California, including the cities of Fresno, Bakersfield and Stockton—provides rebates of up to $3,000 for the purchase or lease of eligible new EVs (San Joaquin Valley Pollution Control District, n.d.). 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 (U.S. Department of Energy, 2014-6).

- 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 (LADWP) service area can receive $750 (U.S. Department of Energy, 2014-7). Farmers Insurance offers a 10% discount on all major insurance coverage for EV and hybrid owners (U.S. Department of Energy, 2014-8).

Financial Incentives for EVSE
There is no state-level financial incentive for installing EVSE at this time.

- PACE financing is available for EVSE in areas that have established PACE programs (U.S. Department of Energy, 2014-9).

- Businesses that install chargers in the 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 rebates cannot cover installation costs (U.S. Department of Energy, 2014-7).

Low-Emission Vehicle Standards
Since 2001, 10% of all cars for sale in California have to be ZEV, hybrids, or “ultra-clean gasoline” vehicles (Union of Concerned Scientists, n.d.). 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 cell vehicles (Public Policy Institute of California, 2007).

Protection of the Competitiveness of the EV Charging Market
California has tried to protect the competitiveness of the EVSE market by barring public utilities from owning and operating EVSE in the state (Zyla, 2014). Companies that own or control EVSE are not public utilities and cannot be considered as such (U.S. Department of Energy, 2014-10). In November of 2014, the California Public Utilities Commission (CPUC) proposed a decision to expand the role of utilities in deploying EVSE. The proposed decision would allow the CPUC 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 major 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 spots. 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 (Hunt, 2014).

Pacific Gas and Electric Company (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 CPUC, 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 (Pyper, 2015).

San Diego Gas and Electric’s (SDGE) proposal is smaller than the others, but similar to PGE’s in that it would involve owning and operating the charging stations. It has submitted a filing for up to 5,500 chargers, a $100-million project (Walton, 2014).

Removal of Barriers to Installing EVSE
California has attempted to remove barriers to installing EVSE by empowering lessees to install EV charging stations in parking spots and mandating evaluation and review of policies to support EV charging.

- Property owners must allow commercial and residential tenants to install EV charging stations in leased parking spots. The tenants are responsible for purchasing, installing, removing, maintaining and insuring the charging stations (U.S. Department of Energy, 2014-11).
- Multi-unit dwellings may not prohibit or restrict homeowners or renters from installing EVSE in their designated parking spaces. The developments cannot implement any policies that would substantially increase the cost or reduce the efficiency and convenience of charging at home. If the homeowners do not have designated parking spaces, they can request that EVSE be installed in common areas. The developments must consider the requests without avoidance or delay. The homeowners are responsible for the costs of the stations and their installation, maintenance, removal and insurance (U.S. Department of Energy, 2014-12).
- The California Energy Commission (CEC) and the CPUC must evaluate and create policies to develop infrastructure sufficient to overcome barriers to widespread EV adoption. These barriers relate to grid stability, electrical infrastructure upgrades, code and permit requirements, and new technology development (U.S. Department of Energy, 2014-13).
- The CEC and the CPUC 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 (U.S. Department of Energy, 2014-14).
Driving Experience
In addition to HOV lane access and toll discounts, California mandates preferred parking spots for EVs and protects those spots from other vehicles.
- Plug-in hybrid electric vehicles with the appropriate sticker may use HOV lanes regardless of their numbers of occupants (U.S. Department of Energy, 2014-15).
- The Bay Area Toll Authority gives a discount on bridges during certain hours if drivers pay with FasTrac (NESCAUM, 2014).
- There is a symbol to indicate publicly available charging stations in California, Washington and Oregon (NESCAUM, 2014).
- Public parking facilities operated by the State of California Department of General Services and the California Department of Transportation must provide meaningful parking incentives such as preferred spaces, reduced fees, and access to charging (U.S. Department of Energy, 2014-16).

Utility Electricity Rates
Sacramento Municipal Utility District, LADWP, SCE, PGE and SDGE 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 (U.S. Department of Energy, 2014-17).

State Fleet Requirements
- Governor Brown's executive order B-16-12 requires that 10% of new state fleet purchases by 2015 be EVs. The percentage will increase to 25% by 2020. Vehicles that protect public welfare are exempt (NESCAUM, 2014).
- Every city, county, special district and school can require that 75% of passenger vehicles acquired be hybrid and alternative fuel vehicles (U.S. Department of Energy, 2014-18).
- The state fleet must reduce its fuel consumption by 20% compared to 2003 levels by 2020 (U.S. Department of Energy, 2014-20).

Public-Private Partnerships
- In 2013, the California Plug-In Electric Vehicle Collaborative “Drive the Dream” event brought Governor Brown and 40 Fortune 500 executives together to announce corporate commitments to workplace charging. The event generated corporate commitments for 2,033 chargers and 1,509 plug-in electric vehicles by September 2014 (NESCAUM, 2014).
- 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 an EV more convenient for longer-distance travel (NESCAUM, 2014).
**Building Codes**
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 (U.S. Department of Energy, 2014-21).

**Career Training**
Grant funding is available to school districts for occupational training programs that focus on employment in clean technology businesses, including those that produce EVs and EVSE (U.S. Department of Energy, 2014-22).

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**GEORGIA POLICIES**
In 2014 and the first half of 2015, Georgia was the fastest-growing EV market in the country. Atlanta is the second largest metropolitan market after San Francisco. Georgia does not have nearly as many policies supporting EVs as California does—but, on average, it has been giving over $4,000 in income tax credits per EV purchase (Ramsey, 2014). However, these state income tax credits will likely be discontinued by a bill that passed in May 2015 (Blair, 2015). The impact on the market remains to be seen.

**Financial Incentives for Purchasing EVs**
- Individuals who purchase or lease plug-in hybrid EVs and other low-emission vehicles have received an income tax credit of 10% of the cost—up to $2,500 (Georgia Department of Natural Resources, n.d.). This tax credit will likely be discontinued in June 2015 (Blair, 2015).
- Customers who purchase or lease ZEVs (fully-electric cars) have received an income tax credit equal to 20% of the vehicle cost—up to $5,000 (Georgia Department of Natural Resources, n.d.). This tax credit will also likely be discontinued in June 2015 (Blair, 2015).
Financial Incentives for Purchasing EVSE
- Businesses that purchase or lease EVSE receive an income tax credit of 10% of the cost up to $2,500 (U.S. Department of Energy, 2014-23).
- 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 a $250 one (U.S. Department of Energy, 2014-24).

Driving Experience
Plug-in EVs with the appropriate license plates may use HOV lanes regardless of occupancy. They may also use the High Occupancy Toll (HOT) lanes toll-free (U.S. Department of Energy, 2014-15).

Utility Electricity Rates

Policy Comparison Overview
Table 4 summarizes the types of policies available in New York, California and Georgia. Though New York and Georgia are both far behind California, Georgia’s generous tax incentives for EV and EVSE purchases and leases have stimulated the market.

Though the full suite of policies in California have contributed to developing California’s market, the fact that both California and Georgia have EV purchase incentives and New York does not suggests that purchase incentives are one of the more important and influential policies supporting the growth of an EV market.

Table 4. Summary of Policies Available in New York, California and Georgia

<table>
<thead>
<tr>
<th>Type of Policy</th>
<th>NY</th>
<th>CA</th>
<th>GA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Financial Incentives for EVSE Purchases</td>
<td>Y</td>
<td>Y</td>
<td></td>
</tr>
<tr>
<td>Driving Experience</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>Research Funding</td>
<td>Y</td>
<td>Y</td>
<td></td>
</tr>
<tr>
<td>Charger-Ready Building Codes</td>
<td></td>
<td>Y</td>
<td></td>
</tr>
<tr>
<td>OEM Low-Emission Vehicle Standards</td>
<td>Y</td>
<td>Y</td>
<td></td>
</tr>
<tr>
<td>Financial Incentives for EV Purchases</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>Financial Incentives for Producing EVSE</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Regulations Removing Barriers to Installing EVSE</td>
<td>Y</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Utility Electricity Rates</td>
<td>Y</td>
<td>Y</td>
<td></td>
</tr>
<tr>
<td>State Fleet Requirements</td>
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<td>Y</td>
<td></td>
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<tr>
<td>Public-Private Partnerships</td>
<td>Y</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Career Training</td>
<td>Y</td>
<td>Y</td>
<td></td>
</tr>
</tbody>
</table>

1 This financial incentive has recently been discontinued.
EVs and EVSE in New York

We conducted a deep dive into the areas in New York that have had a relatively high penetration of EVs to understand what local factors might be contributing to or hindering EV adoption. These patterns of EV adoption across New York may be applicable in other states as well.

As of mid-2014, there were 16 counties in New York with more than 100 registered plug-in vehicles. Table 5 shows the density of EVs in these 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, particularly in areas where people tend to drive into and around New York City. The density of EVs in the New York City metro area and the nearby Orange, Dutchess and Ulster counties suggests that this is where early EV growth is likely to continue.

Monroe and Erie counties, home to Rochester and Buffalo, also have sizeable EV populations. Buffalo has a strong history of EV manufacturing. It was home to Buffalo Electric Vehicle Company, one of the original EV companies (Western New York Heritage, 2006). Albany and Saratoga have relatively large EV populations, boosted by the state fleet 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 there may be slower than in the New York City area. There are fewer destinations outside of these cities that will be accessible within a single charge.
Table 5. COUNTIES IN NEW YORK WITH MORE THAN 100 PLUG-IN VEHICLES

<table>
<thead>
<tr>
<th>COUNTY</th>
<th># OF PLUG-INS</th>
<th>PUBLIC CHARGERS</th>
<th>POPULATION</th>
<th>PLUG-INS/1000 PEOPLE</th>
<th>SQUARE MILES</th>
<th>PLUG-INS/SQUARE MILE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Albany</td>
<td>343</td>
<td>62</td>
<td>304,204</td>
<td>1.1275</td>
<td>522.80</td>
<td>0.66</td>
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<tr>
<td>Dutchess</td>
<td>140</td>
<td>9</td>
<td>297,488</td>
<td>0.4706</td>
<td>795.60</td>
<td>0.18</td>
</tr>
<tr>
<td>Erie</td>
<td>424</td>
<td>60</td>
<td>919,040</td>
<td>0.4614</td>
<td>1,042.69</td>
<td>0.41</td>
</tr>
<tr>
<td>Kings</td>
<td>198</td>
<td>18</td>
<td>2,504,700</td>
<td>0.0791</td>
<td>70.82</td>
<td>2.80</td>
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<tr>
<td>Monroe</td>
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<td>44</td>
<td>744,344</td>
<td>0.6046</td>
<td>657.21</td>
<td>0.68</td>
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<tr>
<td>Nassau</td>
<td>920</td>
<td>25</td>
<td>1,339,532</td>
<td>0.6868</td>
<td>284.72</td>
<td>3.23</td>
</tr>
<tr>
<td>Onondaga</td>
<td>193</td>
<td>96</td>
<td>467,026</td>
<td>0.4133</td>
<td>778.39</td>
<td>0.25</td>
</tr>
<tr>
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<td>372,813</td>
<td>0.4158</td>
<td>811.69</td>
<td>0.19</td>
</tr>
<tr>
<td>Queens</td>
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<td>24</td>
<td>2,230,722</td>
<td>0.1538</td>
<td>108.53</td>
<td>3.16</td>
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<tr>
<td>Richmond</td>
<td>114</td>
<td>2</td>
<td>468,730</td>
<td>0.2432</td>
<td>58.37</td>
<td>1.95</td>
</tr>
<tr>
<td>Rockland</td>
<td>210</td>
<td>6</td>
<td>311,687</td>
<td>0.6738</td>
<td>173.55</td>
<td>1.21</td>
</tr>
<tr>
<td>Saratoga</td>
<td>160</td>
<td>22</td>
<td>219,607</td>
<td>0.7286</td>
<td>809.98</td>
<td>0.20</td>
</tr>
<tr>
<td>Suffolk</td>
<td>1,438</td>
<td>68</td>
<td>1,493,350</td>
<td>0.9629</td>
<td>912.05</td>
<td>1.58</td>
</tr>
<tr>
<td>Ulster</td>
<td>177</td>
<td>7</td>
<td>182,493</td>
<td>0.9699</td>
<td>1,124.24</td>
<td>0.16</td>
</tr>
<tr>
<td>Westchester</td>
<td>777</td>
<td>42</td>
<td>949,113</td>
<td>0.8187</td>
<td>430.50</td>
<td>1.80</td>
</tr>
<tr>
<td>New York</td>
<td>363</td>
<td>152</td>
<td>1,585,873</td>
<td>0.2289</td>
<td>22.83</td>
<td>15.90</td>
</tr>
</tbody>
</table>

Note: Above-average counties are highlighted in pink. New York County is an outlier and was excluded from the average.

Sources:
- NYSERDA (PlugInVehCountsByZip_20140401.xlsx) merged with zip_code_database from http://www.unitedstateszipcodes.org/zip-code-database/
- United States Department of Energy info from www.afdc.energy.gov/locator/stations
- U.S. Census Bureau 2010 Census data from http://quickfacts.census.gov/qfd/states/36/36001.html

NEW YORK CITY METRO AREA

The suburbs around New York City—Nassau, Suffolk, Rockland and Westchester—are among the counties in the state with the highest densities of plug-in vehicles (both by population and by area). Plug-in cars are particularly attractive to people in these areas because driving trips around the New York City metro area are both short and crowded. Electric vehicles have enough range for trips around the area and are very efficient in heavy traffic.
Drivers in these areas also have excellent access to the existing state incentives for EVs. In Suffolk and Nassau, drivers along the Long Island Expressway can use the HOV lanes to reduce their commute times. Drivers in all of the counties surrounding New York City can take advantage of the 10% discount on the tunnel and bridge tolls operated by the Port Authority of New York and New Jersey.

EVs are less popular in the five boroughs of New York City than they are 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 in terms of population). The Bronx has not yet reached 100 plug-in vehicles.

The boroughs of New York City present several challenges for EV driving. First, these areas have high population density, but few people drive regularly because they can rely on public transportation. Second, many New Yorkers who drive do not have dedicated parking spots at home. Charging at home is the most convenient option for most EV drivers, so this presents a challenge (PlaNYC, 2010).

Third, there is very limited street parking, so it is hard to reserve a parking spot for public EV charging and take it away from the general population. There are already over 200 public charging stations in New York City, but many are in garages that are expensive to use. This makes EV charging stations hard to find because people cannot see or access them from the street. Only current EV drivers with cell phone applications or in-car navigation systems are able to find them. The expense of parking would also prevent drivers from parking for a short time to charge.

The areas with the highest numbers of EVs are Huntington, Dix Hills, Scarsdale and Rye. The population of these areas is well-known for being relatively wealthy and well-educated, two characteristics which are commonly associated with EV early adopters.

The high density of EVs in the New York City metro area indicates that adoption is likely to continue to grow there. Though the wealthier communities may be predominantly driving EV use upward at this point, as the price of EVs continues to drop, it is likely that more New York City residents will find the economics of EV ownership are beneficial for them.

The counties surrounding New York City—Nassau, Suffolk, Rockland and Westchester—present particular opportunities for growing EV driving in New York. The majority of the houses in these counties are single-family homes with dedicated parking.

Many families have two cars, so one could be an electric vehicle for local trips and one could be an internal combustion engine vehicle for longer trips. Traffic is largely concentrated in a few major thruways into and out of New York City. These high-traffic areas suggest potential places to locate charging stations.
ALBANY AND SARATOGA
The Capital district of New York presents another area of opportunity for increasing EV driving. Albany County has a very high number of ZEVs compared to the rest of the state, largely due to state fleet vehicles. 167 of the ZEVs registered in Albany are in zip code 12238, which is where the state capital sits. The “Albany Electric Vehicle Feasibility Study,” conducted by VHB Engineering, Surveying and Landscape Architecture 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 commutes (City of Albany, 2012).

The main challenge EV expansion faces in the Albany area is that the population is more diffuse and there is less traffic around a central point than there is in New York City.

Commutes in the Albany-Schenectady-Amsterdam Combined Statistical Area are below the national average. Commutes between Albany and the closest suburbs are under 10 miles. It is only 7 miles from Albany to Troy. Schenectady and the Clifton Park area are each only 20 miles away from Albany. Saratoga is about 35 miles away from Albany and is another common destination. All of these destinations are all well within the range limits of the Nissan Leaf and other electric vehicles on the market today (City of Albany, 2012).

The patterns of EV adoption we observe in New York likely present a similar pattern to what exists in other states. Counties immediately outside of dense city centers may be the best candidates for early EV adoption. These areas tend to have more parking and more dedicated garages than city centers, but they are also close enough to the downtown areas that driving distances are within the comfortable range of most EVs currently available. Their relatively dense population compared to more rural areas ensures that centrally-located public charging stations can serve a large population.

Our analysis also shows that there is not always a direct correlation between EV chargers and EV locations. There are counties in New York—Suffolk, Nassau and Westchester—that have significantly higher rates of EV ownership than one would expect based on the supporting EV infrastructure. This indicates that EV growth can exist in the absence of high charger density. The reverse is also true. Counties like Erie and Onondaga have built public infrastructure but have yet to see demand materialize. This directly challenges the notion of “if you build it, they will come.” EV infrastructure alone is not enough to create EV demand.
We have developed a financial model that projects the economics of the business of electric vehicle charging. This model is applicable to states throughout the nation. The model projects two types of EVSE ownership structures. The first is an own-and-operate model in which the site host owns and manages the chargers. The second is a model in which the EV charging company owns and operates a network of chargers. This company is known as an electric vehicle service provider (EVSP).

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

The base assumptions put into this model all replicate real-world data as much as possible. We based our assumptions on New York as a sample EV market because it is representative of the average United States market. As mentioned previously, New York ranks 25th out of 50 states both in terms of electric vehicle registrations as a percentage of total new car registrations and in terms of EV chargers per capita (Caldwell, 2014).

To project current usage rates, we assumed 100 charges per year per charger, with two hours per charge on average for Level 2 charging and 30 minutes per charge on average for DCFC. This translates to a current usage rate of roughly 2% for Level 2 chargers and 0.5% for DCFC ones.

These usage percentages match the data on public charger usage being provided to NYSERDA by the Idaho National Laboratory. To obtain prices, we
referenced publicly-listed pricing for various chargers. The price of electricity we used was the current average retail rate for electricity in New York. No escalation in electricity price was assumed. We assumed usage would grow at 20% each year with no additional partnership or advertising revenue.

In these circumstances, the economics of EVSE ownership look very undesirable. The 15-year cash flow of our “own-and-operate” model has a net present value (NPV) of $13,053 for one Level 2 charger and -$83,587 for one DCFC. A combined investment in two Level 2 chargers and two DCFCs would have a 15 year NPV of -$141,068. Though Level 2 chargers are NPV-positive investments on their own, they are outweighed by the deficit due to the DCFCs in this model.

NPV is defined as the sum of the discounted incoming and outgoing cash flows over the designated time period.

It is important to note the difference in economics between the two types of chargers. At current prices, a DCFC costs almost ten times the price of a Level 2 charger when including installation. While DCFCs might allow customers to recharge faster than Level 2 chargers do, which is beneficial in many public charging environments, high usage and a substantial premium on the cost of electricity are needed to make the economics work out profitably.

As shown below, the EV market will need assistance or faster growth rates to make DCFC profitable.

While all of the model variables affect profitability, the greatest impact is caused by increasing the annual usage growth rate. A reduction in upfront costs will lower the present-day financial burden, but an increase in usage makes all future years profitable.

As an example, the table below demonstrates the base case with two Level 2 chargers and two DCFCs changing dramatically in NPV with changing usage rates. Though the economics of the two charging technologies are very different from one another, analyzing Level 2 chargers and DCFCs together gives a sense of the EV charging market overall.

Speed of adoption of EVs changes the economics for charging infrastructure much more than a subsidy for installing EVSE can do.

In the base case with 20% usage growth, it would take a subsidy the size of the entire cost of purchase and installation to move the NPV from -$141,068 to profitable.

In the case of 30% usage growth, almost no subsidy is needed for positive net present value. Because usage is currently so low, high growth rates are needed and should be fostered.
While New York chargers are currently experiencing an average of 2–4% usage today, our model shows that in our base case, a combined 14% usage is needed to yield a positive cash flow when financing the entire upfront cost.

### Table 6. An Economic Model of EV Usage Growth Rate

<table>
<thead>
<tr>
<th>Upfront Subsidy</th>
<th>Usage Growth Rate</th>
<th>10%</th>
<th>20%</th>
<th>30%</th>
<th>40%</th>
<th>50%</th>
<th>75%</th>
</tr>
</thead>
<tbody>
<tr>
<td>0%</td>
<td></td>
<td>($201,938)</td>
<td>($141,068)</td>
<td>($4,629)</td>
<td>$230,602</td>
<td>$434,056</td>
<td>$756,857</td>
</tr>
<tr>
<td>25%</td>
<td></td>
<td>($160,688)</td>
<td>($99,818)</td>
<td>$36,621</td>
<td>$271,852</td>
<td>$475,306</td>
<td>$798,107</td>
</tr>
<tr>
<td>35%</td>
<td></td>
<td>($144,588)</td>
<td>($83,718)</td>
<td>$52,721</td>
<td>$287,952</td>
<td>$491,406</td>
<td>$814,207</td>
</tr>
<tr>
<td>50%</td>
<td></td>
<td>($120,438)</td>
<td>($59,568)</td>
<td>$76,871</td>
<td>$312,102</td>
<td>$515,556</td>
<td>$838,357</td>
</tr>
<tr>
<td>75%</td>
<td></td>
<td>($80,188)</td>
<td>($19,318)</td>
<td>$117,121</td>
<td>$352,352</td>
<td>$555,806</td>
<td>$878,607</td>
</tr>
<tr>
<td>100%</td>
<td></td>
<td>($49,938)</td>
<td>10,932</td>
<td>147,371</td>
<td>382,602</td>
<td>586,056</td>
<td>908,857</td>
</tr>
</tbody>
</table>

It should also be noted that these numbers are conservative because the model is restricted to the number of chargers initially built. With sufficiently high growth rates, chargers will reach full usage, meaning that potential revenue is capped in the model.

In reality, owners would probably build more chargers at those sites where usage is nearing 100%. In this 15-year model, any growth above 30% will eventually lead to full usage, so the revenue generated from higher growth is in some ways underestimated. Despite that caveat, it is clear that usage is the most critical factor in determining charger profitability.

This analysis provides similar results when comparing usage growth rates with other key inputs. Usage growth, therefore, is the most critical variable in the model. It is also the one that is hardest to project. Estimates for EV adoption range dramatically and current day growth rates vary wildly between states. The model and its results are highly sensitive to this variable. We recommend taking this issue into account when viewing the model's results.

The analysis above shows the blended economics of both Level 2 chargers and DCFCs. It is also worthwhile to look at the two independently. The trends above hold true in both cases. Usage is the driving factor of profitability, but break-even usage rates are much lower for Level 2 chargers than for DCFCs.
New York’s current $5,000 subsidy for EVSE shows a financial break-even point with only 4% usage, which is just slightly higher than current rates. For DCFCs, break-even occurs at 15%. Getting from current usage rates to 15% usage will require substantial growth.

**Economic Scenarios**

In analyzing different policy options that may directly stimulate the EVSE market, we evaluated four different approaches:
- providing low-cost financing
- subsidizing upfront cost
- subsidizing electricity cost
- subsidizing demand charges

Below are two tables demonstrating the effects of the various policies on the 15-year NPV of the “own-and-operate” model. One table is for an owner who purchases two Level 2 chargers and one table is for the owner who purchases two DCFCs. In the model, any of the variables below can be edited to compare the various policies under different scenarios and see side-by-side results. A discussion of each policy is described in detail below.

<table>
<thead>
<tr>
<th>Percent Financed</th>
<th>BASE CASE</th>
<th>LOW COST FINANCING</th>
<th>UPFRONT SUBSIDY</th>
<th>ELECTRICITY COST SUBSIDY</th>
<th>DEMAND CHARGE SUBSIDY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Loan Rate</td>
<td>8.5%</td>
<td>3%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Upfront Subsidy</td>
<td>0%</td>
<td>0%</td>
<td>50%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>L2 Electricity Cost Subsidy</td>
<td>$0.00</td>
<td>$0.00</td>
<td>$0.00</td>
<td>$0.085</td>
<td>$0.00</td>
</tr>
<tr>
<td>Demand Charge Subsidy</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>50%</td>
</tr>
<tr>
<td>L2 Usage Growth Rate</td>
<td>20%</td>
<td>20%</td>
<td>20%</td>
<td>20%</td>
<td>20%</td>
</tr>
<tr>
<td>L2 Fee per Session</td>
<td>$0.00</td>
<td>$0.00</td>
<td>$0.00</td>
<td>$0.00</td>
<td>$0.00</td>
</tr>
<tr>
<td>L2 Price per kWH</td>
<td>$0.25</td>
<td>$0.25</td>
<td>$0.25</td>
<td>$0.25</td>
<td>$0.25</td>
</tr>
<tr>
<td>L2 Price per Hr</td>
<td>$1.00</td>
<td>$1.00</td>
<td>$1.00</td>
<td>$1.00</td>
<td>$1.00</td>
</tr>
<tr>
<td></td>
<td>$26,107</td>
<td>$29,759</td>
<td>$32,607</td>
<td>$44,902</td>
<td>$26,107</td>
</tr>
</tbody>
</table>
Table 8. 15-Year NPV for an Own-And-Operate Model for Two DCFC Chargers

<table>
<thead>
<tr>
<th></th>
<th>Base Case</th>
<th>Low-Cost Financing</th>
<th>Upfront Subsidy</th>
<th>Electricity Cost Subsidy</th>
<th>Demand Charge Subsidy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Percent Financed</td>
<td>100%</td>
<td>100%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Loan Rate</td>
<td>8.5%</td>
<td>3%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Upfront Subsidy</td>
<td>0%</td>
<td>0%</td>
<td>50%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>DCFC Electricity Cost Subsidy</td>
<td>$0.00</td>
<td>$0.00</td>
<td>$0.00</td>
<td>$0.085</td>
<td>$0.00</td>
</tr>
<tr>
<td>Demand Charge Subsidy</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>50%</td>
</tr>
<tr>
<td>DCFC Usage Growth Rate</td>
<td>20%</td>
<td>20%</td>
<td>20%</td>
<td>20%</td>
<td>20%</td>
</tr>
<tr>
<td>DCFC Per Session Fee</td>
<td>$0.00</td>
<td>$0.00</td>
<td>$0.00</td>
<td>$0.00</td>
<td>$0.00</td>
</tr>
<tr>
<td>DCFC Price per kWh</td>
<td>$0.25</td>
<td>$0.25</td>
<td>$0.25</td>
<td>$0.25</td>
<td>$0.25</td>
</tr>
<tr>
<td>DCFC Price per Hr</td>
<td>$2.00</td>
<td>$2.00</td>
<td>$2.00</td>
<td>$2.00</td>
<td>$2.00</td>
</tr>
<tr>
<td>(NPV)</td>
<td>($167,175)</td>
<td>($124,561)</td>
<td>($92,175)</td>
<td>($135,849)</td>
<td>($116,353)</td>
</tr>
</tbody>
</table>

Low-Cost Financing

Currently, most chargers being installed are not being financed and are being paid on their owners’ balance sheets. Financing for chargers is an undeveloped market and most chargers are now financed through a combination of equity and grant money.

Low-cost financing could benefit the EVSE market in several crucial ways. First, it would lower the cost of capital for charger owners, making the purchase of chargers and their installation more affordable. Second, it would make more capital available to accelerate the proliferation of chargers. Third, it would help establish the financing market by creating a risk profile for EVSE lending and demonstrating its viability.

The establishment and success of green banks in various states has demonstrated that these low-cost financing policies help to accelerate the market for other sustainable technologies such as renewable energy and energy efficiency hardware and software.

Low-cost financing of chargers could be accomplished through the New York Green Bank or through a tool like PACE. PACE provides an opportunity for states to provide off-balance-sheet loans to businesses that can repay the loans via property assessment taxes. PACE is also beneficial because the loans are attached to the properties, not their owners. This simplifies future property transactions.
In the scenario table above, lowering the cost of financing from 8.5% to 3% increased the NPV by roughly 25% for the DCFC. The effect of lower-cost financing on cash flows is significant. In the case of installing just two Level 2 chargers, the effect is not as large, as the upfront cost is more affordable than that of DCFCs.

Vermont Economic Development Authority offers 1% financing for chargers. The difference in annual cash flows from 8.5% to 1% financing is demonstrated in the graph below. The graph below, generated from our model, demonstrates the annual cash flows for a station owner that has fully financed two Level 2 chargers and two DCFCs in a scenario with 25% usage growth and $500 in monthly advertising revenue. The change in loan rates allows the owner to reach profitability two years earlier than they would otherwise. The owner also faces much lower losses in the early years as EVSE usage is building. In this example, the 8.5% financing rate leads to a 15-year NPV of -$30,706 and the 1% rate leads to a 15-year NPV of $22,919.

The benefit of government-sponsored low-cost financing is that it is relatively affordable to the state. Given low municipal interest rates, the state can provide financing at a lower interest rate than financial institutions do. Most importantly, the ability to receive repayments on loans means that loans are a significantly cheaper policy option than direct subsidies.
Cost Reduction
Three types of cost reductions were analyzed in the model:
• reducing electricity costs
• assessing demand charges
• paying upfront costs
In the scenario tables above, all of the three costs above were reduced by 50% each. As demonstrated, the upfront cost is still the highest barrier. Reducing that cost would provide the greatest NPV benefit of all of these alternatives. Lowering demand charges or decreasing the cost of electricity has a smaller impact on NPV.

While the upfront cost is the highest barrier, market participants are beginning to find solutions for this problem, mostly through partnerships and advertising. The high cost of demand charges, however, is still a large barrier that will likely require intervention from government agencies.

Investment Partners
The broader electric vehicle market creates incentives for several private actors to invest in building EVSE. 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.

Utilities
Utilities may be 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 upfront costs and long payback periods. They also have a tremendous amount to gain from EV charging. With every charger, a utility is guaranteed 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 programs to help utilities manage their loads during peak times. SCE is already doing this for 80 charging stations throughout its territory (Tweed, 2015). Further, supporting EV drivers through EVSE can help utilities position themselves as environmental leaders. Kansas City Power and Light is attempting this through the 1,000-station Clean Charge Network it will deploy this year (KCP&L, 2015).

Deferring upfront costs may be the biggest and most beneficial role that utilities can play. Utilities in several states are already beginning to help subsidize upfront costs. In addition to the Kansas City Power and Light program mentioned above and the heavy investments the three large California utilities are making in EVSE, Georgia Power has committed to installing 50 public EV chargers beginning in the second quarter of 2015 (Karkaria, 2015).
There is a tension between encouraging utility investment in EVSE and supporting monopoly ownership of EV charging stations. It is important that the state not allow utilities to take too much control over the EV charging market. Stifling competition in the market would hinder technical innovation and advancement. SCE’s proposed model of installing the site electricity preparation and offering a substantial rebate for site hosts to install the chargers of their choice is a good example of utility involvement that still allows competition. This would allow the site host to either own and operate the EVSE for a minimal additional cost or choose an EVSP.

Consider the following scenario. If a New York utility took the SCE approach of covering the site electricity preparation plus a subsidy to the third party that owns the charger, the results would be as follows:

- If Level 2 chargers were used, the utility would pay $5,900 per charger. The site electricity preparation or “make ready” fee is about $2,000 plus a $3,900 subsidy per charger.
- The site host would cover installation and any premium on the cost of the charger, which would total around $5,000.
- Assuming the third party owned and operated the station and charged $1 per hour and $0.25 per kWh (which is equivalent to about $0.40/kWh), with a 10% annual usage growth rate from current levels, the NPV of the station would be 2.4 times greater for the station owner than it would be if the station owner had to make the full investment.
- The NPV of the electricity revenue to the utility would be about $40,000, a substantial amount of revenue for a $5,900 investment.

Demand charges are another area in which utility policy can greatly impact EVSE development. For DC chargers, demand charges are a significant portion of costs. At present, and until usage increases significantly, demand charges make up the majority of variable costs paid by DCFC owners.

A policy either waiving or significantly decreasing demand charges can have a large impact. In our model, reducing the demand charge for DCFC by 50% increased the NPV to the station owner by 37.5%. 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 PACE policy that could allow station owners to repay low-cost loans via their electricity bills would achieve many benefits such as off-balance-sheet financing and a cost of capital lower than financial markets.

Utilities can also support EV driving by offering reduced rates to residential and commercial customers with EV charging. This would help reduce the total cost of ownership for drivers charging at home. It would also offer public charging site hosts an opportunity to make a higher margin on charges at their stations.
California has two complementary policies that help to nudge utilities towards supporting EVs and EV charging.

- The CPUC must adopt policies to address barriers to broad EV adoption including grid stability requirements, electrical infrastructure upgrade demands, code and permit requirements, and new technology development needs (U.S. Department of Energy, 2014-13).

- The CEC and the CPUC must maintain a website with relevant information for plug-in EV owners including resources to help drivers understand if their homes will require utility upgrades to accommodate EV charging, utility rate options, and load management techniques (U.S. Department of Energy, 2014-14).

Though these policies are not prescriptive, they ensure that those in control of the state’s energy resources are considering and supporting EVs (U.S. Department of Energy, 2014-14).

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.

**OEMs AND DEALERS**

OEMs that have invested in electric vehicles have a great deal to gain from EVSE expansion. In fact, electric vehicle OEMs may be concerned that early adopters will find charging in public too difficult and as a result will have overall negative experiences with their cars. Much like Henry Ford’s proactive role in building roads when the Model T’s popularity grew beyond the capacity of the road system, OEMs may participate in the infrastructure-building process to guarantee a good customer experience for EV owners.

Several OEMs have already made substantial investments in public charging. Tesla has built out a proprietary network of 148 DCFCs which is free to all Tesla owners. The chargers are mostly installed along major highways.

Nissan has been active both in defraying the cost of charger installation to site hosts and in 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 drivers during their first two years of car ownership.
This program—called No Charge to Charge—had a successful pilot in Texas and has now expanded to 13 cities. In cities with lower EV adoption 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 upfront cost of charging stations provides the most significant impact on charging station profitability of all the cost subsidy policies.

BMW is also advertising free public DC charging to buyers of the 2014 BMW i3. Drivers can use NRG eVgo stations equipped with SAE Combo chargers through the end of 2015 (Gareffa, 2014). In January 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. The chargers will also have Level 2 outlets. Drivers will access the chargers with their ChargePoint accounts. The companies aim to place the chargers at 50-mile intervals along the high-traffic Portland-to-San Diego and Boston-to-DC corridors. The chargers will be within and between the major metropolitan areas along the coasts to facilitate longer road trips (ChargePoint, 2013).

OEM involvement in the EVSE market is growing. Fostering this involvement in the EVSE market and engaging with OEMs 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 that it can give OEMs 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 stations are basically free for the hosts. Some OEMs are paying highly 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. The state can facilitate conversations between OEMs and city governments to propose high-visibility spots.

**ADVERTISING PARTNERSHIPS**

Companies outside of the immediate EV value chain might be interested in using charging stations as advertising space. EV drivers are likely to pay attention to advertisements 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 logos. Charging stations with screens could also run advertisements. Depending on the EVSE providers, the advertisers’ logos could also appear in the online and mobile applications that direct drivers to the stations.

Volta, a charging startup 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 while providing brands and retailers with a free amenity to attract desirable customers. They only have a few
dozen charging sites in California, Massachusetts and Hawaii so far. They are already advertising 30 million cumulative monthly views on advertising on their currently installed stations and 83 million cumulative monthly views on their total contracted network (Volta, n.d.).

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 M. Blank Family Foundation.

The two categories of businesses that might be most likely to be 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 tire companies). For local businesses, car-charging is a way to draw customers in while they wait for their cars to charge. Car-related businesses can use charging to remind customers of their auto needs.

Though this would be a new market and ad prices are hard to predict, the pricing of other out-of-home advertising around New York City provides a baseline for this case study. Bus shelters advertise for $1000 - $5000 per month depending on the neighborhood (Glassberg, n.d.). Even if a charging station could only earn $500 per month, the hardware costs for a Level 2 charger could be paid back in under a year. The hardware costs for a DCFC charger could be paid back in under seven years.

Beyond advertisements on the stations themselves, cities and towns may have access to other advertising spaces that could be valuable to members of the EV charging value chain. Bus stops, lamp posts, billboards, and sides of buildings could all be prime locations for EV-related advertising.

Similar to helping OEMs find parking spots to install EV charging infrastructure, the state can facilitate conversations with city governments to find advertising space that could be used for messaging about EV charging. An OEM might be willing to install additional charging stations in a city if it could get access to reduced-cost marketing nearby. Local businesses might be willing to install charging stations if they could get advertising space there. This would help the local business derive additional marketing value out of installing the charging station.
EVSE with Solar Power and Energy Efficiency

Solar leases and energy efficiency upgrades are often designed to lead to immediate energy savings that are greater than the financing payments for the capital investments.

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 startup called Snugg Home in Boulder, Colorado is already selling financing for a solar power, energy efficiency, and EVSE bundle for the residential sector. The company calculates a total savings from the three technologies based on total home and fuel costs without the upgrades and demonstrates that even with loan repayments, the homeowner saves money in the first year (Snugg Home, 2014).

In commercial settings for public EV charging, the savings relative to fuel costs cannot be factored in unless an organization is charging a fleet of vehicles on those same chargers. This is because the commercial site hosts do not pay for the fuel costs of drivers using the stations. However, even without savings from fleet fuel costs, financing all three systems together may make EVSE seem affordable to commercial property owners because they are seeing a savings from the solar and energy efficiency at the same time as they are paying for the EVSE.
State policies have been shown to have a great effect on the adoption of electric vehicles. California, Georgia and other states have made considerable progress in growing their EV markets by using dedicated and strategic policies. New York, in contrast, has yet to see its EV market take off, despite aspirational goals set by the state.

In this report we used New York as a case study because it is currently in the middle of the nation in its progress toward expanding electric vehicle registration and building charging infrastructure. The lack of EVs in New York is largely due to an unremarkable set of policies to help spur the market.

While electric cars are becoming more affordable than they were before and also offer consumers long-term savings, making such a big technological shift is not easy. The state has had policies to encourage the installation of Level 2 chargers, yet a strong ecosystem has yet to develop. Some counties in New York have high per-capita numbers of chargers without matching high rates of EV penetration, while other counties have the reverse trends.

Since New York has set a goal of having more electric vehicles on the road, some amount of support for EV purchases may be necessary to fuel the transition. Most critically with regard to EVSE, Georgia has demonstrated that if the cars are being purchased, the chargers will be built. The economics of owning and operating EVSE will only be profitable with usage growth. This is particularly true for DCFC, which has especially high upfront costs.

Academic research has yet to show a direct relationship between investment in public EVSE and EV registration. This means that EVSE policies do not clearly and directly advance the ultimate goal of getting more EVs on the road. Policies that directly assist EV adoption bring in money to fund the desired outcome of increasing driving EVs relative to conventional vehicles in a straightforward way.

At this point, it is unknown what driving and charging patterns will exist when there is high EV penetration. Therefore, we do not yet know the appropriate number of chargers to install to sustain an EV-based auto industry.

Now, over 90% of charging is residential and most of the remaining 10% is at workplaces. Lowering the price of EVs will drive adoption. And increased adoption will drive EVSE investment.
Summary of Policy Recommendations

Based on our analysis, we encourage state policymakers to consider the following actions to boost the EV market.

1. Create policies that encourage EV adoption and use, since they are the most efficient way to ensure a sustainable and profitable EVSE ecosystem.
   - A. Develop a state tax credit for EV purchase that is easy to implement and can be fulfilled at dealerships.
   - B. Offer education about the ancillary benefits of EV ownership such as HOV lane use and free on-street parking.

2. Streamline the EVSE permitting process for public chargers.

3. Incorporate EV charging infrastructure into building codes.

4. Empower tenants to install EVSE in parking spaces that they lease.

5. Provide low-cost financing through state infrastructure banks.

6. Support legislation that requires utilities to develop policies and infrastructure that support EV charging.

7. Support legislation that requires utilities to provide information about electric vehicles to potential EV drivers.

8. Facilitate investment partnerships with market participants like OEMs, charger networks and manufacturers, and utilities.

9. Encourage city governments to identify high-visibility parking spots that could be valuable to OEMs and other stakeholders looking to build EV charging infrastructure. Facilitate meetings between local governments and EV stakeholders to support investment in infrastructure.

10. Encourage city governments to identify advertising spaces that could be valuable to OEMs and other members of the EV value chain. Facilitate meetings between local governments and EV stakeholders to offer free or discounted advertising space in return for free or discounted chargers.

11. Update building codes across the state to require new developments to put in electrical equipment for EV charging in a portion of their parking spots.

12. Develop training programs on EV charging technology for electricians, real estate developers, and facility managers.

13. Create community-based marketing programs for EVs similar to the solar marketing programs that have been successful in various states.

Policy and Program Recommendations

An easy-to-implement tax credit that can be fulfilled at dealerships would have a high impact. Politically, this may be less desirable than investing in infrastructure, but there are so many market participants with economic interest in a strong infrastructure—utilities, OEMs and EVSE companies—that the proper infrastructure investment can likely be handled by the market.
Additionally, the entry of lower-cost EVs like the Leaf or Volt should mitigate political concerns over tax credits for affluent early adopters. And such tax credits could even be limited by creating a rebate that has an income cap.

Despite our strong conclusion that state policies encouraging EV growth, as opposed to focusing on EVSE, will yield more benefits, there are still a myriad of options that the state can use to help spur the EVSE market. Many are relatively low-cost policies and some simply require the state to serve the role of market facilitator.

States can ensure that when parties want to install EVSE, it is simple and time-efficient to do so. There are several ways states can help with this.

First, they can work with city governments to help ease the process of EVSE permitting. Many EV developers in New York lamented the byzantine process of gaining municipal permitting and utility approval when we spoke with them (personal communication, 2014). Creating a unified, streamlined and expedited permitting process, much in the way that New York created the New York Unified Solar Permit, could aid market participants and accelerate the growth of installations.

Second, states can ensure that tenants are able to install EVSE in spots that they lease. As is the case in California, landlords should not be able to block tenants from installing EVSE. This is especially important in a states with high densities of multifamily rental housing. Both commercial and residential tenants would benefit from this policy.

Third, states can make sure that building codes are comprehensively updated to require new developments to put in appropriate electricity hardware for EV charging in a portion of their parking spots. New York City has already mandated that every new parking lot or garage and every expansion to an existing lot provide at least 3.1 kW of electric supply to at least 20% of the spots. Similar policies should be added to the statewide code. Further, the minimum supply should ideally be raised to at least 6.6 kW, which is what most EVs on the market right now require for Level 2 charging.

Similarly, the impact of financing policies can be applied from solar to EVSE. Green banks have demonstrated the benefits of providing easy-to-secure, low-cost loans to these budding markets. For EVSE, most of the high upfront cost is being paid on balance sheets. This greatly limits who can afford to invest in installing EVSE.
However, a low-cost loan program through a green bank can change that dramatically. Loans coming from the state, rather than from private financial institutions that view this as a new and risky market, bring the benefit of being low-cost.

Lowering costs can have a significant impact on long-term profitability. Our model has demonstrated that dropping the financing cost of EVSE from 8.5% to 1% can move the break-even point by two years. Low-cost financing not only can help grow the market and increase profitability to installers, it can also help establish a market for the financing of these investments. This means the market will eventually be able to take over this role and provide financing at more reasonable rates. Finally, the benefit of such a policy is that it is relatively low-cost, especially for a state that already has a capitalized green bank. States may be able to help draw its utilities into partnerships to support EV charging through a combination of legislation and information-sharing.

Similarly to California’s approach, mandating that public service commissions evaluate and consider policies to support overcoming the barriers to EVs and EV charging would bring more attention to the issue among those who control state electricity policies. This would incentivize the public service commissions 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 encourage the utilities to take a more active role in developing the market.

States can also play a role in motivating OEMs and third-party advertisers to invest in EV infrastructure. OEMs might be more willing to finance EVSE if the state can help identify central, visible locations for charging stations. Local businesses might be more willing to install charging stations if they knew they could get additional, low-cost advertising nearby. To facilitate this, the state should encourage municipalities to identify parking spots and advertising spaces that might be attractive to parties that could install EVSE. The state could use its clout to convene the parties and provide frameworks to help structure the conversations.

It will be easier to make a return on investment on Level 2 chargers than DC chargers. Though the fast charging technology is an attractive option for drivers who are used to prioritizing speed, the high upfront costs and demand charges make this option very expensive.

Meanwhile, even without a subsidy of any kind, Level 2 chargers can yield positive NPVs within 15 years, even with minimal usage growth, as long as a moderate premium can be charged on the electricity.

Further, there are many situations in which people need to be away from their cars for more than 30 to 45 minutes. In these cases, it makes more sense to use Level 2 chargers than Level 3 chargers.
This suggests that states should continue to build out the Level 2 infrastructure near workplaces, residential buildings, hospitals, universities and theaters. Development of DC fast charging should be saved for the places where Level 2 charging does not make sense because drivers would spend less than 2–3 hours there—such as highways, retail locations, and coffee shops.

Finally, states can play an important role in educating the public about EVs and EV charging. Similar to the community-based solar marketing programs that NYSERDA is now supporting, community-based marketing for EVs would help to increase the number of EVs on the road and support the market for EV charging.
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