Existing Conditions and Best Practices

Tompkins County
Plug-in Electric Vehicle Infrastructure Plan

Contract No. 57495

Prepared by:
Energetics Incorporated
Clean Communities of Central New York
The Ithaca-Tompkins County Transportation Council

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List of Acronyms

AC	alternating current, which is available in houses and distributed by the electrical grid
AC Level 1	plug-in vehicle charging at 120 volts of alternating current (1.4-1.9 kW)
AC Level 2	plug-in vehicle charging at 240 volts of alternating current (up to 19.2 kW, usually 6.6 kW)
BEV	battery electric vehicle, which relies entirely on electric power
CO_2	carbon dioxide, a significant contributor to greenhouse gas emissions
DC	direct current, which is stored and provided by batteries
DMV	department of motor vehicles
EVSE	electric vehicle supply equipment, which is more commonly called a charging station
HEV	hybrid electric vehicle, which has a battery and electric motor to increase efficiency, but does not have a plug to charge from the electrical grid
kW	killowatt
kWh	kilowatt-hour
PEV	plug-in electric vehicle, which offsets petroleum fuel with electricity
PHEV	plug-in hybrid electric vehicles, which can run on electric power, but also have an engine
NYS	New York State
NYSEG	New York State Electric and Gas
NYSERDA	New York State Energy Research and Development Authority
MSRP	manufacturer's suggested retail price
MWh	megawatt-hour
MY	model year
SAE	Society of Automotive Engineers
VAC	volts of alternating current
VIN	vehicle identification number
ZEV	zero emission vehicle, which produces no emissions during vehicle operations

PLUG-IN ELECTRIC VEHICLES

Plug-in electric vehicles (PEV) reduce or eliminate the petroleum fuel typically used as a fuel in most vehicles by using a motor powered by electricity stored in a battery pack to propel the vehicle. The electricity stored in the battery pack is primarily obtained by connecting the vehicle to a charging station on the electrical grid (a small portion of electricity may be obtained from regenerative braking while the vehicle is being slowed down or excess power from the engine if it has one). Hybrid electric vehicles (HEV) have been popular for several years (introduced in the U.S. in 1999) which can also use a motor powered by electricity stored in a battery pack to propel the vehicle or add to the power provided by the engine. However, an HEV has no plug-in option and cannot charge its batteries from the electrical grid, so it only relies on regenerative braking and excess power created by the engine. The Toyota Prius is the best-selling HEV which is not offered as a conventional model with only a combustion engine, but almost all major automobile manufacturers offer an HEV model (primarily as a powertrain option for a major model that also has a non-HEV powertrain).

PEVs include plug-in hybrid electric vehicle (PHEV) and battery electric vehicle (BEV) models. The PHEV operates similarly to an HEV, but has a larger battery pack and can connect to a charging station to get electricity from the grid. The Toyota Plug-in Prius is an example of an HEV with these enhanced features to become a PHEV, while the Chevrolet Volt is an example of a BEV with an added engine to provide back-up power once the batteries are depleted. The Volt has a much larger battery pack and thus can go farther on electric power (the 2015 and earlier models had 38 miles of electric range and the new 2016 model will have 53) than the Plug-in Prius (the 2014 and earlier models only had 10 miles of electric range, although the new 2017 model will have 22). BEVs typically have a larger battery pack for more electric miles, but have no back-up option when the battery is depleted. The Nissan Leaf is the best-selling BEV and offers a typical electric range for most lower-cost BEVs available today (the 2015 and earlier models had 84 miles of electric range and the new 2016 model has an option for 107). Another popular BEV is the Tesla Model S which has a much greater electric range between 230 and 253 miles depending on the configuration, but it is also much more expensive ($70,000 to over $100,000 as compared to $30,000 to $40,000 for the Nissan Leaf). Some new BEV models announced for availability in late 2016 are expected to have an electric range around 200 miles per charge with starting costs less than $40,000 (e.g., Chevrolet Bolt and Tesla Model 3). Specifications for PEVs available in Tompkins County are included in Appendix A.

Compared to gasoline-powered cars, PEVs are more energy efficient and cost 50-70% less to operate per mile. The average efficiency of a PEV is 0.32 kilowatt hours (kWh) per mile, so to travel 100 miles the PEV will use 32 kWh which costs $4.16 at a typical New York State (NYS) electricity cost of $0.13 per kWh. Conventional gasoline engine cars average around 25 miles per gallon, so 4 gallons of gasoline is needed to travel 100 miles which costs $10.00 with gasoline at $2.50 per gallon. Electric motors require less maintenance than gasoline engines and have no oil to change, so PEVs typically have lower maintenance costs. Average annual electric miles for a group of Chevrolet Volt and Nissan Leaf drivers through the EV Project was 9,111 and 9,696 respectfully (note that the Volts also had an additional 3,126 miles per year using their gas engine).[1] Driving 9,000 electric miles per year will save a driver $435.60 using the rates

[1] Idaho National Laboratory. How many electric miles do Nissan Leafs and Chevrolet Volts in The EV Project travel? May 2014. https://avt.inl.gov/sites/default/files/pdf/EVProj/eVMTMay2014.pdf

mentioned above because they used 2,880 kWh instead of 360 gallons of gasoline. If all charging was done at home, the driver's electricity bill would be 240 kWh higher each month or $31.20 (about $1 per day).

A large portion of the NYS electricity grid is powered by clean low-carbon energy sources (not oil or coal), allowing PEVs to reduce greenhouse gas emissions and pollutants that cause smog and acid rain. In 2013, the main sources for electricity generation in NYS were natural gas (33%), nuclear (27%), and hydro (16%) which resulted in an average greenhouse gas emission rate of 528 pounds (lbs.) of carbon dioxide (CO_2) per megawatt-hour (MWh) of electricity.[2] Thus, one PEV driving 9,000 electric miles per year will result in net savings of 5,535 lbs. of CO_2 per year.[3]

PEVs have a long history dating back to some of the first vehicles on the road, however, due to the availability of low-cost and high energy density petroleum, PEVs have traditionally been niche products. Now, several automakers have produced or are planning PEV models and some, such as Nissan, are betting their futures on an automobile market with a significant PEV component. Renault-Nissan accounts for half of the PEVs sold worldwide and is committed to being the world's leading maker of full-electric vehicles. The Volkswagen Group plans to deliver 30 PEV models by 2025 as part of a sweeping plan to overhaul its global strategy. Ford is investing an additional $4.5 billion in electrified vehicle solutions by 2020, adding 13 new electrified vehicles to its product portfolio so that more than 40 percent of Ford's nameplates globally will be electrified by the decade's end. General Motors has boosted the battery capacity of the Volt and will soon release the 200 mile fully-electric Bolt. Tesla is planning to reach a much broader market of buyers with their lower cost Model 3 and there is a lot of speculation that Apple is developing an electric vehicle.

A significant number of PHEV and BEV models are available in NYS due to its participation in the multi-state zero emission vehicle (ZEV) initiative led by California. The mandate requires all major car manufacturers to sell increasing percentages of ZEVs. In addition, NYS has prioritized PEV market development support through its ChargeNY initiative. ChargeNY aims to reach 3,000 PEV charging stations to support an expected 30,000-40,000 PEVs in NYS by 2018. Since the program's inception in 2013, ChargeNY has supported the installation of nearly 500 charging stations (bringing the statewide total to more than 1,100), revised regulations to clarify charging station ownership rules, and supported research and demonstration projects on new PEV technologies and policies. Ongoing and additional ChargeNY efforts will continue to promote and incentivize PEV or EVSE ownership.

Existing PEV Fleet and Users

The market for PEVs is growing, with only 18,000 for the first full year of U.S. sales in 2011 to around 115,000 sold nationwide for each of the past two years. In 2015, PEVs accounted for 23% of the combined sales for all vehicles with an electric motor (which includes PEVs as well as HEVs which do not plug-in), but still only 0.7% of all vehicle sales.[4] Ten light-duty BEV models and 12 PHEV models are currently available in the Tompkins County region. These are listed in Appendix A, along with their electric-only range and

[2] NYSERDA. 2013 New York State Energy Fast Facts. www.nyserda.ny.gov/-/media/Files/Publications/Energy-Analysis/2013-New-York-State-Energy-Fast-Facts.pdf [39.2 million metric tons of carbon dioxide emissions from the electricity generation of 163,514 gigawatt-hours]

[3] Gasoline: 360 gallons * 19.6 lbs. of CO_2 per gallon = 7,056 lbs. of CO_2.
Electric: 2.88 MWh * 528 lbs. of CO_2 per MWh = 1,521 lbs. of CO_2

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

manufacturer's suggested retail price (MSRP) after federal tax credit. The federal tax credit for PEVs is up to $7,500 with the actual amount based on the capacity of the battery used to power the vehicle. After a manufacturer has sold 200,000 eligible PEVs, the credit will phase out to 50% of the credit amount, then 25% of the credit amount (to date no manufacturer has hit this mark).

Tompkins County has a diverse mix of PEVs owned by residents with models from most of the major PEV manufacturers as shown in Figure 1.[5] PEVs in the "Other PEVs" category include some recently released models (Volkswagen e-Golf, Ford C-MAX Energi), as well as some older, less common models (Tesla Roadster, Toyota Rav4 PEV, and Mitsubishi iMiEV). Figure 2 shows the number of registered PEVs by model year (MY). This analysis was conducted on data as of December 31, 2015, so not all model year 2015 PEVs may have been sold yet. However, the most popular PEV model in Tompkins County, the Toyota Prius Plug-in, was not offered as a 2015 model which impacted new PEV sales. In addition, some manufacturers have announced significant improvements for PEV models (longer electric ranges for the Chevrolet Volt and Nissan Leaf) or new models (Chevrolet Bolt and Tesla Model 3) that will come out in 2017 which may have persuaded some buyers to hold off on their PEV purchase. Similarly to many other areas around the country, Tompkins County's early PEV adopters have likely contributed to most of the purchases to date, but that should start to change with new offerings, lower MSRPs, and NYS incentives.

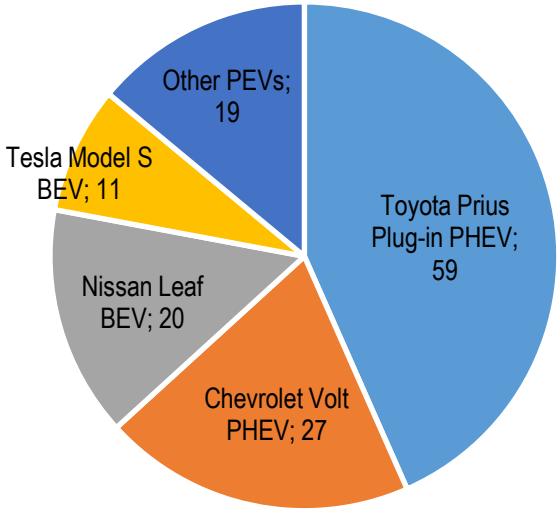


Figure 1. PEV Make & Model Distribution in Tompkins County as of December 31, 2015

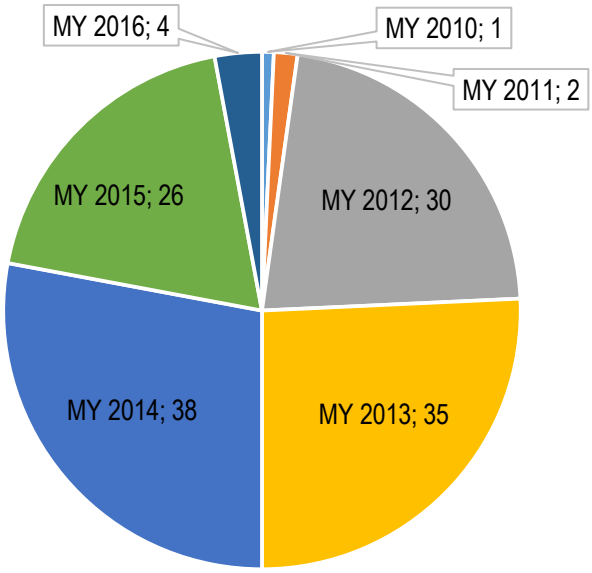
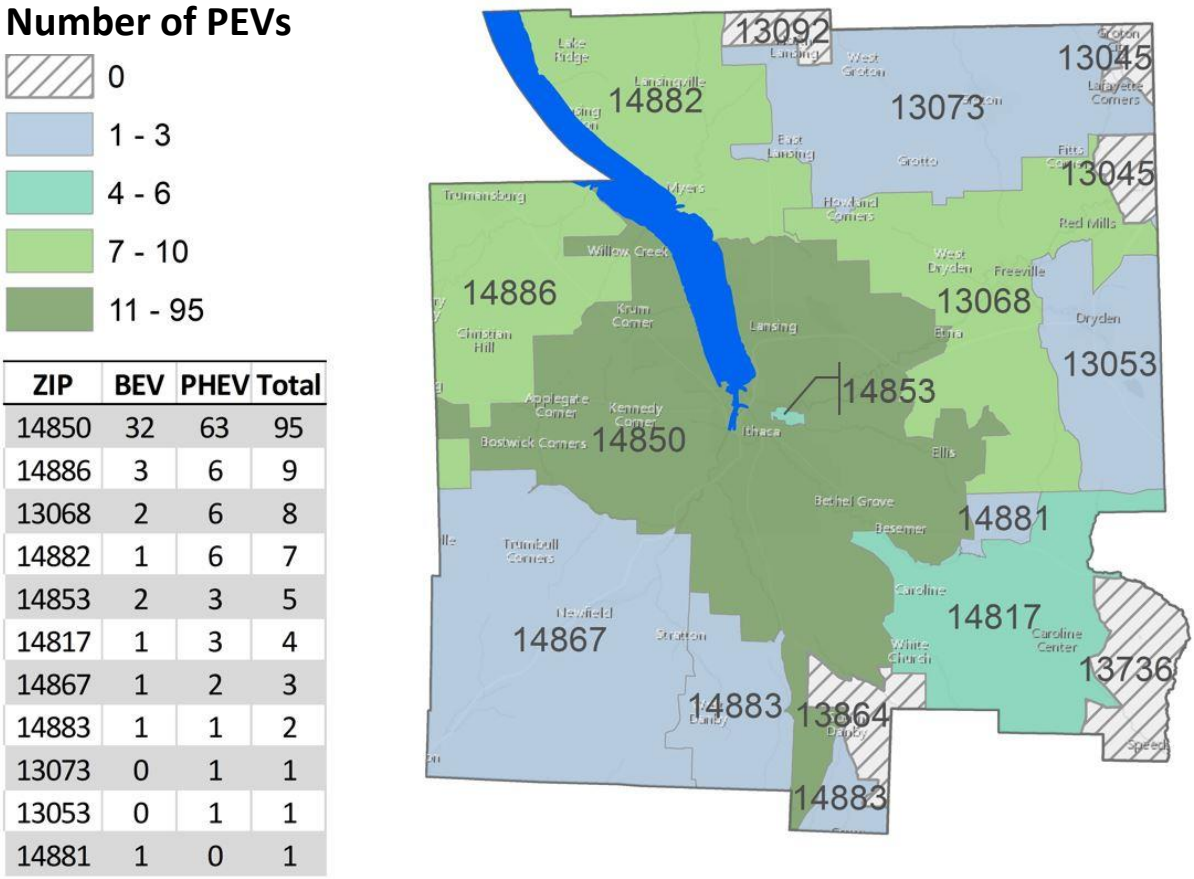


Figure 2. PEV Registration Data by Model Year (MY) in Tompkins County as of December 31, 2015

[5] PEV ownership was determined through an analysis of NYS department of motor vehicles (DMV) data available at https://data.ny.gov/Transportation/Vehicle-Snowmobile-and-Boat-Registrations/w4pv-hbkt which lists all vehicle, snowmobile, and boat registrations. PEV models must be identified by the first eight values in the vehicle identification number (VIN) which were obtained from existing lists compiled by the California Air Resources Board and other sources because the DMV data does not list a vehicle model and the fuel type designation is not accurate. Results shown are based on registration data as of December 31, 2015.

Tompkins County has high PEV ownership rates as compared to the rest of the state. There were 136 PEVs registered in Tompkins County as of December 31, 2015, which represents 0.27% of all registered vehicles. In the entire state, PEVs are only 0.16% of all registered vehicles and only two other counties have a higher percentage than Tompkins County (New York at 0.30% and Suffolk at 0.28%). The distribution of PEV registrations throughout the county is shown in Figure 3. Of all registered PEVs in the County, 70% list Ithaca as the owner's city of residence. However, there are some PEVs throughout most of the county even though some areas are rural where driving patterns do not typically favor widespread PEV use.



ZIP	BEV	PHEV	Total
14850	32	63	95
14886	3	6	9
13068	2	6	8
14882	1	6	7
14853	2	3	5
14817	1	3	4
14867	1	2	3
14883	1	1	2
13073	0	1	1
13053	0	1	1
14881	1	0	1

Figure 3: Tompkins County PEV Population Density as of December 31, 2015

PEV owners are also likely among the nearly 1 million visitors annually to Tompkins County. These visitors tend to be highly educated and have high disposable incomes which likely corresponds with the PEV owner profile. Arriving primarily by car from other locations within the state, almost half make the trip for a university- or college-related purpose with many others are coming for the state parks and gorges (environmentally focused people that would also likely be interested in driving PEVs). Half of Tompkins County overnight visitors lodge at a hotel, motel, or resort which supports the installation of charging stations at these locations for guests.[6]

[6] Profile of Visitors to Tompkins County.
http://tompkinscountyny.gov/files/tourism/docs/TompkinsCountyVisitorProfile.pdf

Tompkins County dealerships that currently offer PEV models are shown in Figure 4. These locations provide residents with opportunities to view, test drive, and purchase new and used PEVs. Maguire dealerships with access to order new PEV models include Audi, Kia, Volkswagen, Chevrolet, Fiat, Nissan, Ford, and Hyundai. Honda has stopped selling previous PEV models (Fit PEV, Accord Plug-in), but is expected to come out with a new one in late 2016 (Clarity) which would be offered by Honda of Ithaca. Toyota temporarily stopped manufacturing the Prius Plug-in PEV, but will resume selling a 2017 Prius Plug-in, now called the Prius Prime. In addition to new PEVs, many local dealers may also have used PEVs that are coming off a lease and only a few years old.

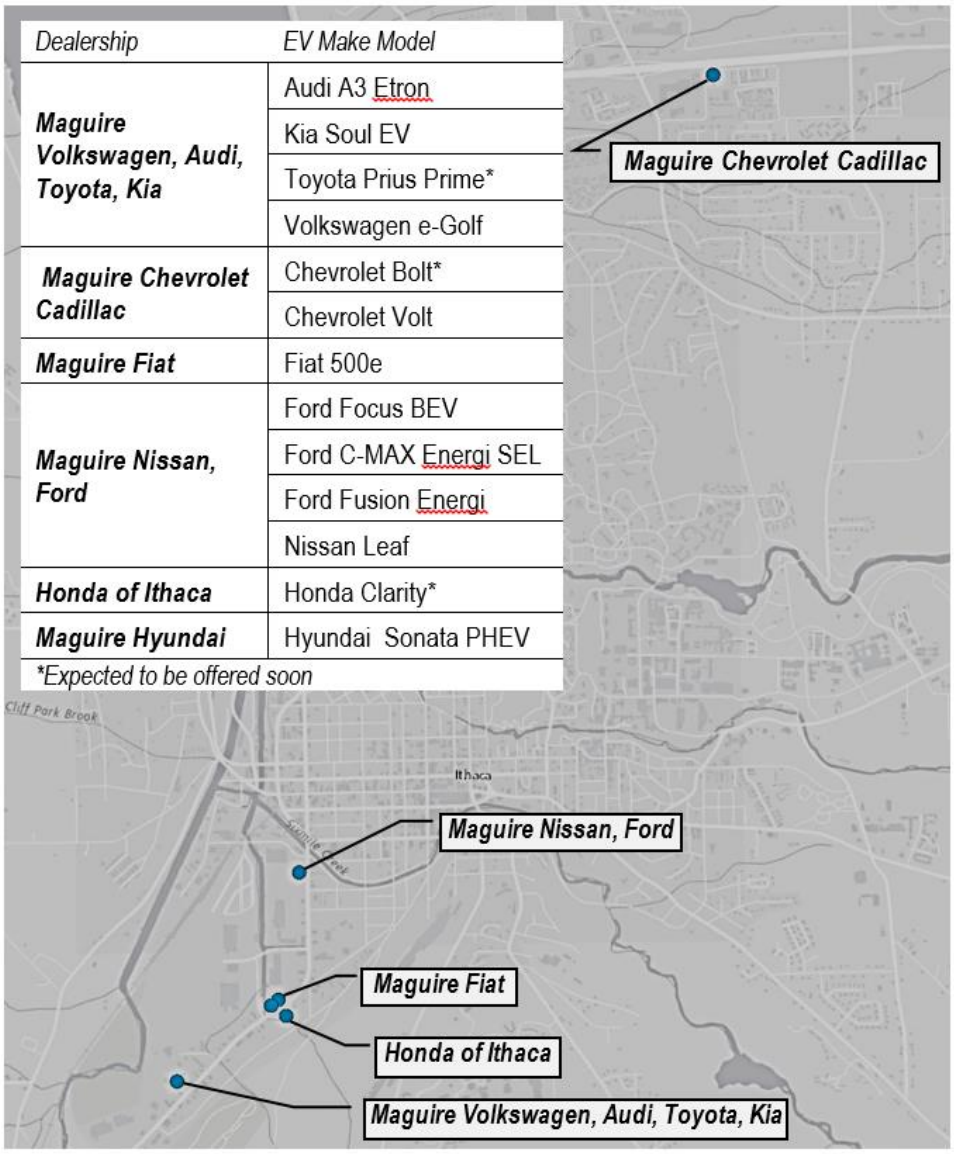


Figure 4: Tompkins County PEV Dealerships

Tompkins County Resident's Current PEV Knowledge

As a county with a higher level of educated citizens and a long history of environmental activism; the level of PEV awareness in Tompkins County is currently quite high as compared to NYS in general, particularly the smaller cities and towns in Upstate NYS. The education level specifically in Ithaca (the largest city in Tompkins County) is quite high, which is typically correlated with higher PEV knowledge and ownership. Over 93% of the Ithaca's residents have at least a high school education, 62% have a bachelors or higher, and 37% earned a graduate degree.[7]

[7] City-Data.com. Ithaca, New York. www.city-data.com/city/Ithaca-New-York.html

A survey conducted with the project's steering committee members, advisory group, and other residents in Tompkins County captured their view on PEVs and overall knowledge and interest. The small pool of survey participants (26) prohibits any statistically relevant conclusions to be drawn from the survey results, but it does provide some insight about EVs from those living in Tompkins County. All 26 survey participants knew about PEVs to some extent with most having a little (10) or some knowledge (14) on the subject. Only two felt they had a lot of PEV knowledge.

Most survey participants (64%) learned about PEVs online. No one listed dealerships or event exhibit booths as their primary source for PEV information. Three participants received their information through broadcast media (newspaper or TV), while others listed sources such as work interactions, conversations with friends, personal experience, and independent research. Survey participants estimated in their opinion, the level of PEV knowledge by all Tompkins County residents. Their responses are based on previous discussions or interactions they had with neighbors and colleagues on this topic. Most felt that more residents had little to no existing knowledge of this technology as shown on Figure 5.

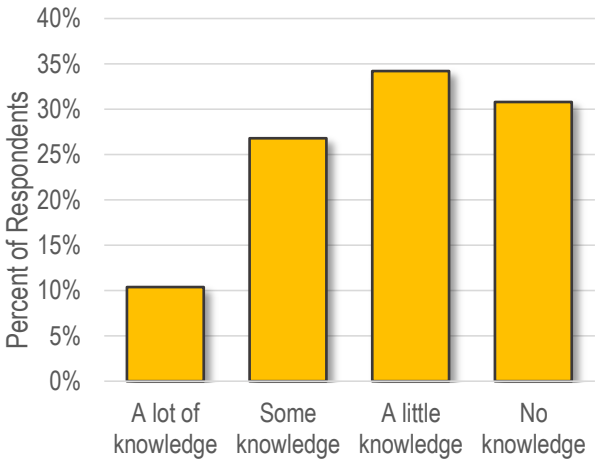


Figure 5: Perceived County Wide PEV Knowledge

PEV Charging Stations

PEVs replenish their batteries (electrical fuel) by connecting to charging stations at home, work, or public locations. BEVs are dependent on charging to extend their range, so drivers must plan ahead to park at available stations if a charge is needed during their trip. If they cannot get a charge as planned due to a broken station or it being occupied by another vehicle, they could experience "range-anxiety" as they become unsure whether their BEV can make it to the next charging opportunity or leave them stranded on the road. PHEVs rely on the back-up combustion engine once the batteries are depleted so they won't leave a driver stranded, however, it is less costly to drive electric so PHEV drivers seek out charging opportunities whenever they are available.

Charging Station Types

PEV drivers have various options available to plug in and replenish their batteries at charging stations, which are also referred to as electric vehicle supply equipment (EVSE). For the majority of users, a home charger can fulfill almost all of their charging needs. Public charging stations are used to charge PEVs while drivers are at work, shopping, or at other destinations, and help expand the functionality of electrification technology for many owners.

For many PEV owners, the vehicle they select will accommodate their normal daily driving needs without needing to charge during the day. However, if that owner needs to run extensive errands one day, wants to take their PEV to a recreational destination in the evening or on weekends, or is pushing the limits of their PEV's battery range in the winter when it operates less efficiently, they will want to find an opportunity to get an additional charge during the day. For some PEV owners, installing a charger at their

primary residence may be challenging (e.g. if they are renting or have an older house with insufficient electrical capacity to add more load) and will need charging infrastructure at their workplace or a public venue to feasibly use a PEV.

Charging stations are classified by their approximate charge rates and the form of power delivered (alternating current [AC] or direct current [DC]). Charging times for each specific vehicle vary depending on power electronics, state of charge, battery capacity, and level of charging station used.

AC Level 1 Charging is limited to 120 volts of alternating current (VAC) and uses a typical household three-prong plug. All current PEVs are sold with AC Level 1 capabilities and only need a dedicated 20 amp outlet to charge. A portable AC Level 1 EVSE (Figure 6, left) is included in the initial vehicle purchase price. AC Level 1 stations charge slowly (up to 2 kilowatts [kW]), and are generally used in home or workplace charging applications where PEVs will be parked for long periods of time. AC Level 1 charging adds 2 to 5 miles of electric range per hour of charging time. The hardware cost for a mounted AC Level 1 station (Figure 6, right) can cost up to $1,000.

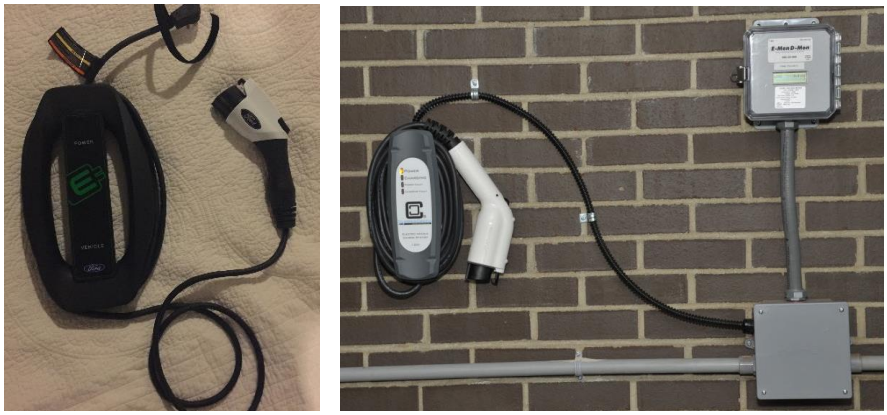


Figure 6: AC Level 1 Charging Cord (left) are typically sold with a PEV or an AC Level 1 Charging Station (right) can be mounted where a PEV parks

Figure 7: AC Level 2 Charging

AC Level 2 Charging provides electrical energy at either 240 VAC (typical for residential applications) or 208 VAC (typical in commercial and industrial applications). This level of charging is viable for both residential and public charging locations. Unlike AC Level 1 charging, AC Level 2 charging requires additional hardware that can be mounted on the wall, to a pole, or as a stand-alone pedestal (Figure 7). The increased charging rate and affordability of AC Level 2 charging stations make them the most popular choice for all PEV charging applications. These stations provide up to 7.2 kW for residential applications and up to 19.2 kW for commercial applications, which typically results in 10 to 20 miles of additional range per hour of charging time. The hardware cost for an AC Level 2 charging station is $450-$5,000, not including installation or any required electrical upgrades. The range in hardware costs are due to the features that come with a station. A wall-mounted AC Level 2 station that is non-networked (only provides power to charging and doesn't track usage, collect payment, or other useful features for the host and driver) will be a low-cost station. A networked (has cellular communication to connect with a service provider that provides information and features to the host and driver) pedestal-type AC Level 2 station with a system to retract the charging cord (keeping it off the ground) and an electronic display for messages will be a much higher cost station.

Figure 8: Tesla DC Fast Charge Stations

DC Fast Charging utilizes DC energy transfer and a 480 VAC input to provide extremely rapid recharges at heavily used public charging locations. The type of station is generally cost prohibitive for home applications. However, depending on the PEV, DC fast charge stations can provide an 80% recharge in as little as 20 minutes. This option is only available on certain PEVs. Hardware cost: $7,000 - $40,000. Costs vary based on the charging rate provided by the station, the number and type of connectors offered, and the number of stations per deployment (multiple DC fact charge stations in one location can use one larger and more cost effective electrical system to convert AC to DC that is shared among all the stations, whereas a single DC fast charging station must have its own electrical hardware). Tesla's Supercharger Network offers DC fast charge for free, but is only available for Tesla owners (shown in Figure 8). The network currently covers many major travel corridors across North America. Each Supercharger offers 120 kW charging (about 140 miles of range in 20 minutes).

Connectors, or plugs, for AC Level 1 and Level 2 charging stations have been standardized to allow owners of all PEV models to utilize the same charging infrastructure. The industry standard for AC Level 1 and AC Level 2 charging is the Society of Automotive Engineers (SAE) J1772 connector, which provides significant safety and shock-proof design elements. Up until 2013, the Japanese CHAdeMO connector was the only DC fast charge standard connector, available on both the Nissan Leaf and Mitsubishi i-Miev. In early 2013, the SAE J1772 connector standard was expanded to include DC fast charge with the SAE J1772 Combo connector, which is available on the Chevrolet Spark, Volkswagen e-Golf, and BMW i3. Tesla uses a different proprietary connector, but includes a SAE J1772 compliant adapter cable with each vehicle sold and offers adapters for CHAdeMO and SAE J1772 Combo connections for an additional price. The four connectors currently available for PEV charging in the Tompkins County area are shown in Figure 9.[8]

Figure 9: EVSE Connector Types

[8] Graphic sources: http://m.eet.com/media/1200053/sae-j1772c.jpg, http://m.eet.com/media/1200054/sae-combo.jpg, www.ryot.org/tesla-motors-releases-secrets-hopes-innovate/733589, and http://circarlife.com/sites/default/files/conector_chademo.png

Existing Charging Stations and Lessons Learned

Charging stations currently installed throughout Tompkins County include a wide variety of location types, venues, and intended uses. Lessons learned from the planning, deployment, utilization, and acceptance of these existing stations can be applied to future installations. Figure 10 shows the locations of existing charging stations within Tompkins County. As detailed in Table 1, the majority of these stations are available to the public and free. PEV drivers may even be able to use some of the private stations after business hours or in a pinch if needed. In total, Tompkins County has 1 DC fast charging port (with 2 connector options available), 1 Tesla AC Level 2 charging port, 20 AC Level 2 charging ports, and 11 AC Level 1 charging ports (several AC Level 2 charging station locations also have a 120 VAC outlet available). The majority of these chargers are in and around the Ithaca area at various business and social areas. However, several are located outside of the downtown area at apartment complexes, colleges, and businesses. As of December 31, 2015, New York State has just over 1,200 total public PEV charging outlets or ports. This number represents the number of PEVs that could plug in at one time and differs from the number of charging stations, since many charging stations have two charging ports. Some locations have multiple charging stations, so there are even fewer charging locations than the number of stations.

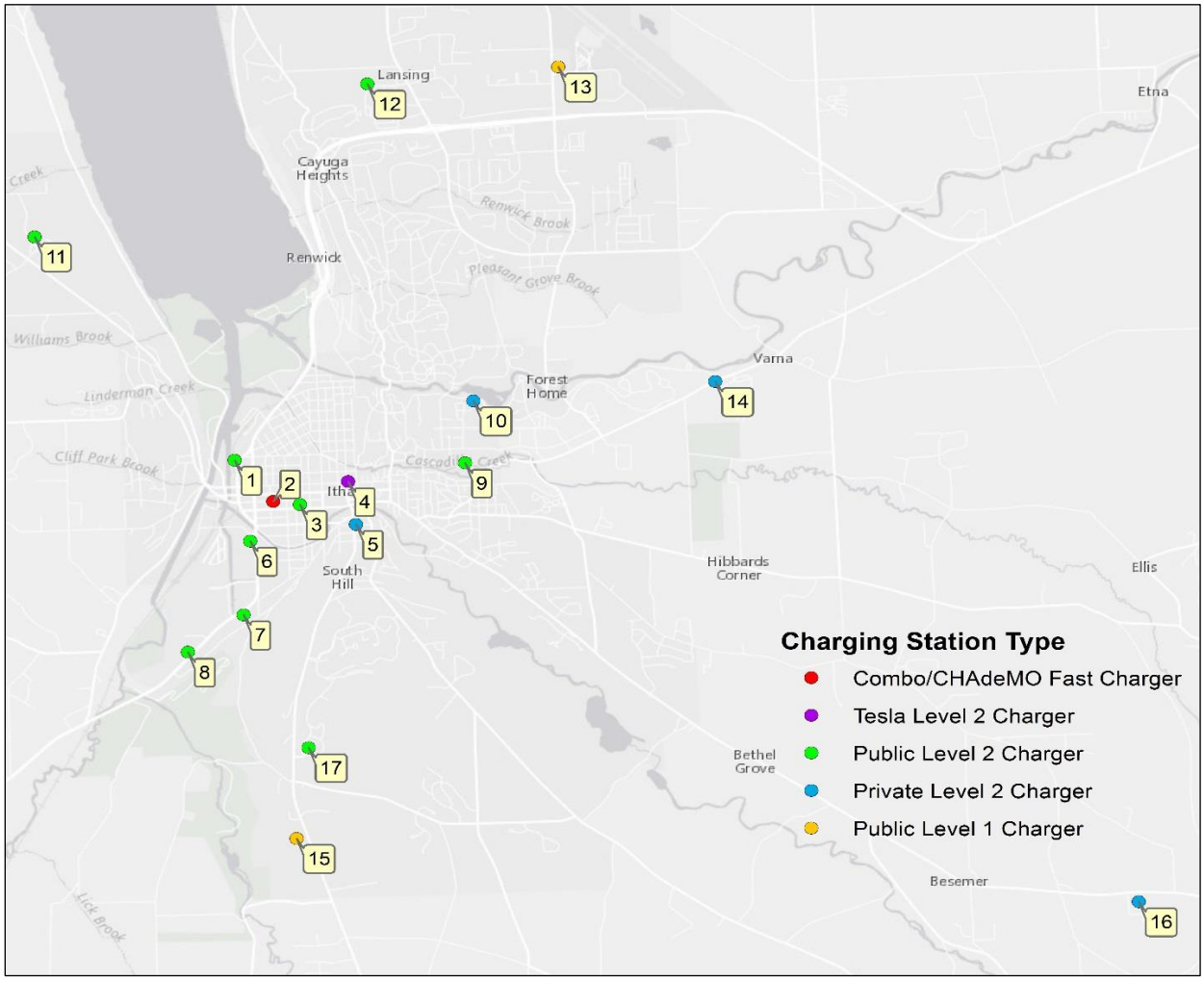


Figure 10: Existing Tompkins County PEV Charging Stations

Table 1. PEV Charging Stations in Tompkins County

Map ID	Station Name	Access	Connector	AC Level 1 Ports	AC Level 2 Ports	DC Fast Charge Ports
1	Ithaca Yards	Public	SAE J1772		2	
2	Diane's Downtown Automotive	Public (Fee)	SAE Combo or CHAdeMO			1
3	Taitem Engineering	Public (Fee)	SAE J1772		2	
4	The William Henry Miller Inn	Public	Tesla		1	
5	Three Hills Properties	Private	SAE J1772, 120V Outlet	1	1	
6	Maguire Nissan	Public	SAE J1772, 120V Outlet	1	1	
7	Honda of Ithaca	Public	SAE J1772		1	
8	Maguire Volkswagen/Toyota	Public	SAE J1772		2	
9	Hoy Garage (Cornell)	Public	SAE J1772		2	
10	Forest Home Garage (Cornell)	Private	SAE J1772		3	
11	Cayuga Medical Center	Public	SAE J1772		2	
12	BJs	Public	SAE J1772		2	
13	Cornell Business Park	Public	120V Outlet	6		
14	Emma's Acres	Private	SAE J1772, 120V Outlet	1	1	
15	La Tourelle	Private	120V Outlet	1		
16	Three Hills Properties	Private	SAE J1772, 120V Outlet	1	1	
17	Ithaca College	Public	SAE J1772 (not activated)			

Diane's Downtown Automotive

This location offers a DC fast charge station with capabilities to charge PEVs that have either the SAE Combo and CHAdeMO connectors. Nissan provided the station free of cost to Diane's provided they covered the installation and operational charges. However, due to the high power requirements of the unit, the installation was still quite costly. The charger, shown in Figure 11, was recently installed in spring 2016 and has seen limited use thus far. There is a cost of $10 per hour (prorated for durations shorter than one hour) to use this station, but it offers the convenience of a significant battery charge in 15 minutes. The owners are still finishing up the signage and removing the old gas pumps nearby. They expect increased use as they increase public awareness of the station's installation.

Figure 11: DC Fast Charger Installed at Diane's Downtown Automotive

Cornell University

Cornell University is dedicated to sustainable practices and aims to encourage PEV use on campus by offering multiple charging points and incorporating PEV charging into their construction plans for future parking structures. They have three AC Level 2 chargers on the third level of the Forest Home parking garage (permit required on weekdays before 5 pm) and two on the first level of the Hoy Road parking garage (paid parking on weekdays before 5 pm), as shown in Figure 12. The Forest Home parking garage is one of the first LEED Certified parking structures in the nation and was given points for installing these charging stations. To date, Cornell has not seen extremely heavy use of these stations but are planning additional outreach and public education efforts which are expected to increase the awareness of the chargers and PEVs in general.

Figure 12: Cornell University PEV Chargers

NYSERDA EVSE Project Installations

Three of Ithaca's charging stations were installed under a NYSERDA project in 2014 to deploy public PEV chargers throughout the state. These include the dual port AC Level 2 charging stations at Ithaca Yards, Taitem Engineering, and the Cayuga Medical Center. The Ithaca Yards location is located near the waterfront off Cascadilla Street which is near Purity Ice Cream (the owner of both installed this station and chose this location because of parking limitations at the Ice Cream Shop). Taitem Engineering is a local engineering firm that specializes in sustainable, energy-efficient design for new construction and existing buildings. They chose to place a charger in front of their office in central Ithaca which is often used by

employees. The Cayuga Medical Center installed the EVSE for hospital employees as well as visitors. Each of these locations are shown in Figure 13. The station at Taitem Engineering has a fee of $1.00 per hour to charge, while the other stations are free.

Figure 13: NYSERDA-funded EVSE at Cayuga Medical Center (left), Taitem (center), and Ithaca Yards (right)

The number of new users to a charging station each month can be a good indication of the accessibility and awareness of a station. More new users shows station use is by the general public whereas stations with few new users are primarily used by onsite employees. The cumulative new users per month for the three NYSERDA-supported EVSE are shown in Figure 14. Taitem Engineering has the highest variability of users with over 70 different drivers to date having used this station.

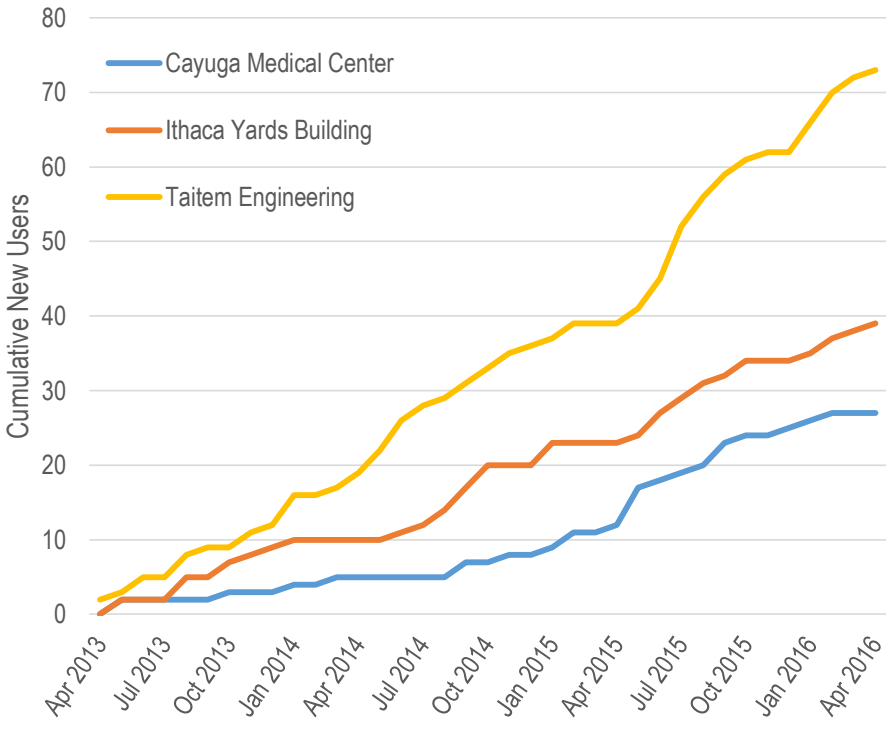


Figure 14: Cumulative New EVSE Users

The overall use of these chargers from January 2015 through March 2016 is shown in Figure 15. Seasonal fluctuations in use may be due to tourism or events that draw PEV drivers downtown during the summer.

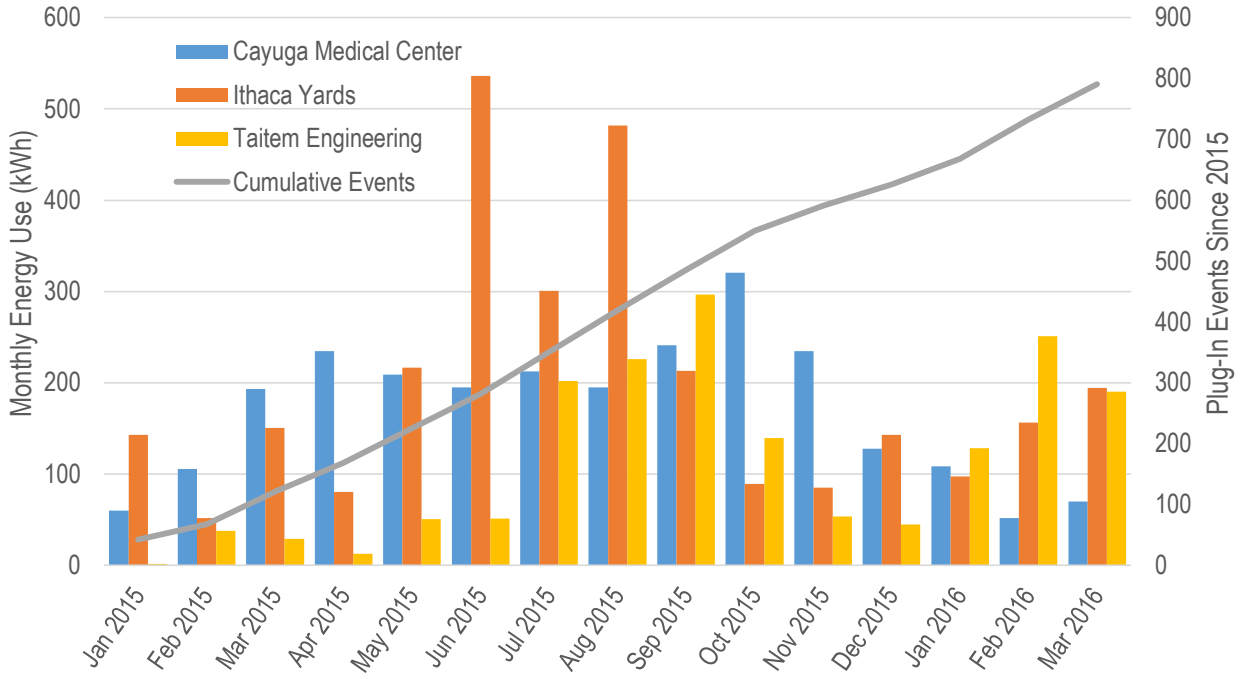


Figure 15: NYSERDA EVSE Project Charging Station Usage

The William Henry Miller Inn

Tesla provided a single AC Level 2 charger for The William Henry Miller Inn in February 2016 and offers free charging for local Tesla drivers. The station, which can only accommodate Tesla PEVs, typically experiences 5 to 10 users per month according to the Inn personnel. This installation, shown in Figure 16, was paid for by Tesla Motors but the ongoing electrical fees are billed to the Inn.

Figure 16: Tesla PEV Charger at the William Henry Miller Inn

Ithaca Area Dealerships

Several car dealerships in Ithaca have installed EVSE to support the sale of their PEV models. These stations, shown in Figure 17, are primarily installed for customer PEVs and PEVs on the lot for sale, but they are not restricted to this group and can be used by other PEV drivers when available. The dealerships with AC Level 2 charging stations include Maguire's Ford-Nissan, Maguire's Audi-Volkswagen-Toyota, and Honda of Ithaca. Some of these locations also offer an outlet for PEV charging is the station is occupied.

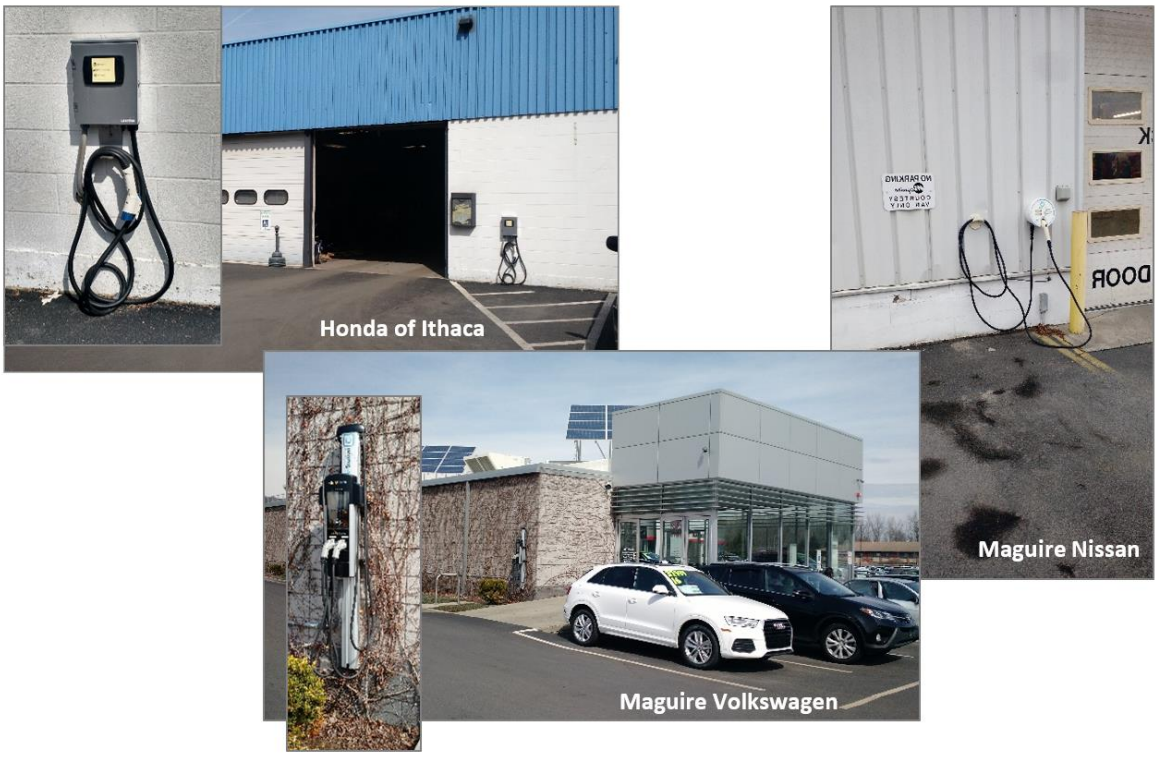


Figure 17: Dealership Chargers in Ithaca

BJs and Ithaca College

A dual port AC Level 2 charging station was installed at BJs Wholesale Club next to the Shops at Ithaca Mall off N Triphammer Road for customers or public use. An additional PEP brand charger was installed the same time at the Ithaca College Circle Apartments Community Center but has never been activated and has gone unused for several years. These stations are shown in Figure 18.

Figure 18: PEV Chargers Located at BJs (left) and Ithaca College (right)

Three Hills Properties

Three rental properties owned by Three Hills Properties, LLC offer AC Level 2 charging, including 7 Pheasant Walk, 317 South Aurora Street, and Emma's Acres at 882 West Dryden Road in Freeville. These stations shown in Figure 19, were installed primarily for residents but other PEV drivers may be permitted to use the chargers as needed if they call first to obtain permission.

Figure 19: Three Hills Properties Chargers at Their Rental Locations

Level 1 Charging Locations

There are a few AC Level 1 charging locations throughout Tompkins County. The Cornell Business Park (Figure 20) and La Tourelle's Spa only have outlets where a PEV driver can use their own portable cord to charge, but they are offering parking spaces and electricity to tenants and visitors. Several locations with AC Level 2 charging stations also have an outlet that can be used for AC Level 1 charging if the station is occupied.

Figure 20: Outlets Available for Charging at Cornell Business Park

Existing Electrical Grid Considerations

Electric utilities are the energy supplier for PEVs, but supporting the transportation industry is a market in which they have not traditionally been involved. While the increased demand from charging stations can be concerning, providing electricity to vehicles is also a growth opportunity for electric utilities.

The electric utilities are involved in PEV adoption every time a charging station is installed or a vehicle draws power to

charge its battery. To date, the utilities in the Northeast have taken a very passive role in PEV readiness. Collaborating and partnering with the electric utilities on PEV initiatives could be very effective at promoting this technology and helping to maximize benefits for both consumers and the utility itself.

Many PEV drivers adopt this technology to have a positive impact on the environment and a key factor in that is how the electricity to charge the batteries is generated. Clean electricity is clearly used in a PEV when the owner has solar panels on their house and they charge at home, but most others are unaware of the electricity source during charging. Electricity generation is tracked and published at the state level, but sharing the electricity sources and its impact on PEV use to current or potential PEV owners is valuable.

The electric utilities are logical candidates to lead by example with PEV adoption. Their fleet, where appropriate, could include PEVs and some of their facilities or buildings could host public charging stations. There are no specific electricity rates for PEV owners offered by New York State Electric and Gas (NYSEG), the local electric utility, but charging at night under time-of-use rate schedules may result in cost savings for the consumer and benefit the utility as well. Consultation or guidelines issued by the electric utility specifically for PEV owners (e.g., rate options or PEV emissions benefits based on the local electricity generation) would help them make better informed decisions on optimizing their PEV purchase.

NYSEG, who provides power and gas for all of Tompkins County, offers two separate time-of-use plans in addition to their regular energy plans, which could provide cost savings for flexible energy users. NYSEG's *Time-of-Use Rate* is for customers with at least 35,000 kWh of electricity use per year who opt for a time varied rate structure with lowest energy costs during off-peak periods, highest costs during on-peak periods, and a mid-peak cost period.[9] NYSEG's *Day-Night Service* provides cheaper energy between the hours of 11:30 pm and 7:00 am and a slightly higher rate during daytime hours.[10] Residential customers that use at least 1,000 kWh per month with over 20% of their energy use during these nighttime hours would likely experience cost savings with this rate plan.

Currently, NYSEG does not foresee any issues with increased charging station deployment throughout Tompkins County as the impact on the grid is expected to be relatively minor. Even high load systems such as DC fast chargers do not have significant enough demand to warrant a demand study from the utility (NYSEG has experience with these from the installation at Diane's Automotive). Throughout Tompkins County, NYSEG's grid is very robust and has the capacity to support additional chargers. Charging stations powered from electrical panels in existing buildings would not require consultation with NYSEG. However, if a service with a new grid tied meter is required, the utility must be involved in the planning and installation. New service costs vary from approximately $390 if connecting to an existing transformer without any system modifications to over $5,000 if additional transformers or conduit runs are required. This cost is solely for the cost to get power from the pole and does not include the cost to install the charging station.[11]

Consumer Opinion of Charging Stations

From a consumer's viewpoint, there are still many misconceptions about PEVs and the necessity to support existing and planned public charging infrastructure. Tompkins County, and the City of Ithaca in particular, have a long history of environmental awareness and activism supporting climate improvement

[9] NYSEG. Time-of-Use Service Rate. www.nyseg.com/YourHome/pricingandrates/timeofuserate.html
[10] NYSEG. Day-Night Service Rate. www.nyseg.com/YourHome/pricingandrates/daynighrate.html
[11] NYSEG Supervisor of Electric Integrated Field Design, Dennis Kuhn, DKuhn@nyseg.com, (607) 347-2501

initiatives. It is critical to understand residents' concerns and leverage the environmental benefits of PEVs for the general public to generate support for charging station initiatives. Many organizations throughout the county are either directly involved in transportation sustainability efforts or support and encourage the continued advancement of this technology.

The survey mentioned in the previous section that gathered PEV perspective from a few Tompkins County residents included questions pertaining to the number of stations that were deemed viable, where the stations should be placed, and what charging station issues could potentially arise. Given a list of potential venues for future charging station installations, the following ranking was obtained by averaging the responses. There was a clear prioritization for the top three venues on this final ranking.

1) Workplaces (average rank of 2.0)
2) Colleges or Universities (average rank of 2.7)
3) Municipal Parking Lots (average rank of 2.8)
4) Medical Facilities or Offices (average rank of 5.0)
5) Retail Stores (average rank of 5.4)
6) Parks or Recreational Areas (average rank of 5.8)
7) Entertainment Venues (average rank of 5.9)
8) Restaurants (average rank of 6.3)

The predicted utilization level of public charging stations by the 26 survey participants is shown in Figure 21. Most expect that ⅕th to ⅓rd of PEV charging will occur away from home, reinforcing the belief that public charging stations are valuable and needed.

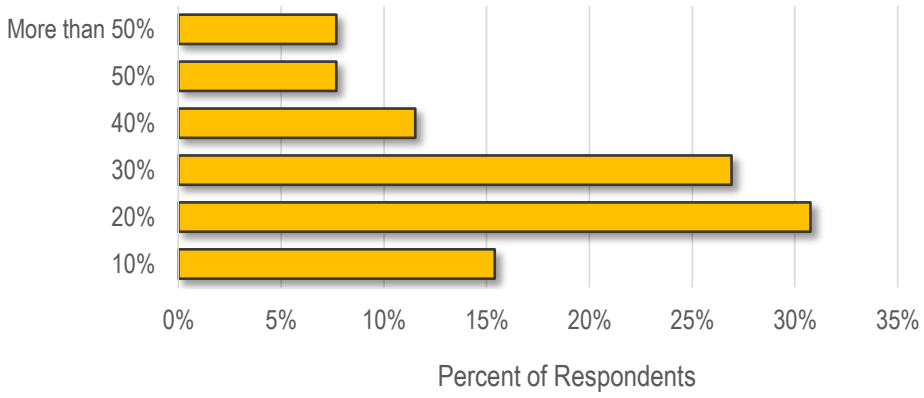


Figure 21: Percentage of Charging Expected to Occur at Public Chargers

On average, the survey participants felt that a ratio of 1 public charging station to every 20 PEVs would be sufficient to handle the charging needs of PEV drivers. For 130 PEVs registered in Tompkins County, there should be 7 public charging stations to match this expressed ratio. Currently, there are 8 active public AC Level 2 charging stations, although 3 of these are at dealerships which are not ideal for longer parking. There is also one DC fast charger for PEVs with that capability (DC fast charging ports are becoming a standard feature on most new PEVs, but in the past it has been an option that many elected not to pay for because there were very few chargers) and one Tesla-only charger. A few other AC Level 1 outlets and private charging stations are also available if necessary, but less convenient. In general, the charging network may be sufficient to serve the current population of PEVs in Tompkins County, but more public charging stations, particularly in key locations where PEV drivers would park, are needed to encourage and support expanded PEV use.

A list of potential or perceived concerns regarding PEV charging stations were given to the 26 survey participants, who expressed whether they felt that was *a big concern* (assigned a score of 4), *a concern* (3), *somewhat of a concern* (2), or *not a concern* (1). The final ranking of concerns (led by concerns about cost) with their average score were:

1) Cost to purchase and install the station (3.1)
2) Cost for station maintenance (2.7)
3) Cost for electricity to charge PEVs (2.6)
4) Managing how the station is used (2.5)
5) Vandalism or damage (2.3)
6) Loss of a parking space that may not be often occupied (2.1)
7) Permitting requirements to install the station (1.7)
8) Finding a good electrician to install the station (1.6)
9) Being a hazard or obstruction to cars or pedestrians (1.3)

Two additional potential or perceived concerns regarding PEV charging stations that were mentioned by survey participants included:

1) Handling the liability associated with multiple entities involved with installing, maintaining and owning station components
2) Ticketing and towing when an PEV needs access to the charger

Charging Station Networking Options

Most AC Level 2 and DC fast chargers come with an option to purchase a subscription to a charging network that can collect payments from users and limits use of the station to charging network members. There is often no fee for PEV drivers to become a member of any particular charging network, and there is also an option to activate the station using a toll-free number for anyone that does not have a network RFID card. In addition to listing the station on its network maps for PEV drivers and provide the option to require a fee for charging, the network will track station usage so you know when and how long it is being used among many other networking features. Network subscriptions typically cost the station owner about $20 to $30 per month per charging outlet. The charging stations located at Ithaca Yards, Taitem Engineering, Cayuga Medical Center and Maquire Volkswagen are on ChargePoint's network (https://na.chargepoint.com/charge_point). The General Electric stations used by Cornell University can be networked through Wattstation™ Connect (www.gewattstation.com/connect/). Other charging station networks used in NYS include EV Connect (www.evconnect.com/management-services/) and Blink (www.blinknetwork.com/network.html). All of these networks provide an interactive online map to locate their charging stations (and sometimes additional stations not on their network), as well as mobile phone applications that help the driver find a location to charge. There are also some third-party station location map/tool operators that add charging station information to their applications using a data pull from multiple charging station network providers or input provided by individual station owners or PEV owners. Two of examples of these are the US Department of Energy's Alternative Fueling Station Locator (www.afdc.energy.gov/locator/stations/) and PlugShare (www.plugshare.com/).

PEV Charging Station Deployment Barriers and Opportunities

Charging Station Risk Assessment

PEV charging station installation requires an investment on behalf of the host and many are accessible to the public, so any potential risks to hosts, users, pedestrians, vehicles, or the station itself, should be fully understood before implementation. The stations themselves, with the special SAE J1772 connectors, have multiple safety features (including a control pin that must communicate with a PEV before it is energized) to protect the user. Each station is also rated for various environmental settings that will keep it protected in almost all conditions as long as it was properly installed and maintained. As with everything, there are external factors or extreme situations that can compromise the safe operation of the charging station and put users, hosts, or others at potential risk. Some considerations addressed below should be understood and properly mitigated as best possible before installing or operating a charging station.

Numerous streams and rivers flow throughout Tompkins County and some areas are prone to flooding. This is particularly true in portions of the City of Ithaca where many rivers and streams empty into Cayuga Lake. The risk for flooding should be considered when planning a charging station installation as the high powered electronics could prove hazardous if submerged and would likely require replacement after such an event. The potential Tompkins County flood hazard zones outlined by the Federal Emergency Management Agency are shown in Figure 22.[12] In addition to potential flooding, snow accumulation and parking lot management methods can impact the use and proper operation of the charging station. Snow plowing can damage the EVSE if the cords were not properly coiled up or the station itself was obscured by snow drifts. Stations placed in the middle of a parking lot could disrupt where the plow would like to pass and result in unplowed PEV spaces that do not allow the station to be used. Charging stations completely buried in snow have the

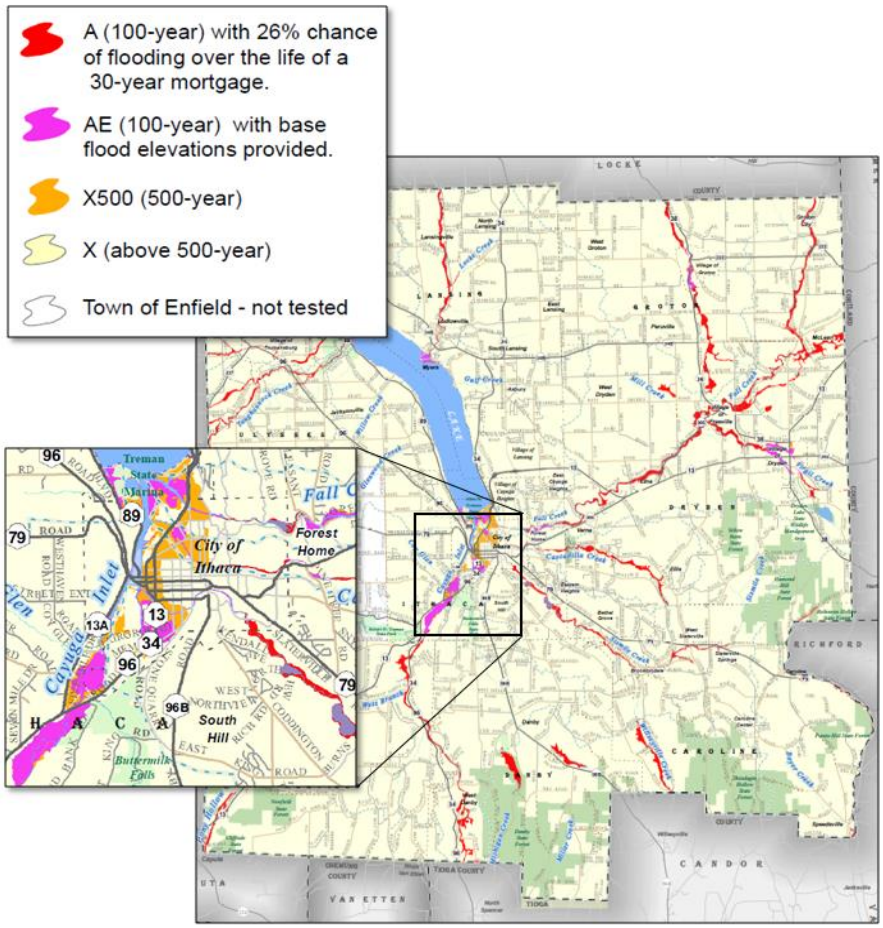


Figure 22: Tompkins County Flood Hazard Zones

[12] Tompkins County. Flood Hazard Zones. http://tompkinscountyny.gov/files/gis/maps/pdfs/TCFlood_Zones.pdf

potential to malfunction due to lack of ventilation. Particularly during winter, but really throughout the year, regular cleaning of the station and the surrounding area will improve the usability of the charging station and likely prevent damage. Similar to other equipment, charging station parts will occasionally fail or break and maintaining a maintenance/repair budget to fix the station when needed is a good practice. Most charging stations offer extended warrantees on the equipment as an option to consider.

The location of charging stations can also impact the risk of vandalism or other damage caused from accidental vehicle contact. To reduce the potential of intentional vandalism, stations should situated in well-lit areas, ideally within view of security cameras if those are used by the host. Units should be set back from primary vehicle travel areas and protected by a curb, bollard, or tire stop to reduce the risk of collision from inattentive motorists maneuvering around the parking area. Also, consider the path of the charging cord when in use as it should not cross a walkway where a pedestrian might trip on it.

Charging Station Locations

Successful charging station installations are located where they will experience regular use and provide a valuable benefit to PEV drivers. Offering charging can help businesses attract new clientele or keep customers for longer durations. PEV drivers often seek out charging locations as they go about their everyday routines at, for example, restaurants, stores, and entertainment venues. Installing PEV charging stations at workplaces can be very successful at the right business and have benefits for employers and their employees alike. PEV charging stations can attract and retain desirable employees. PEV drivers are typically tech-savvy and highly educated[13]; qualities many employers seek in prospective employees.

For public installations, consider the time a PEV driver would typically spend parked at that location, because short durations may offer fewer benefits to PEV drivers. Other important factors include, but are not limited to: patterns of travel in an area; an area's demographics, which may be correlated with characteristics typical of PEV owners; and the nature of a potential PEV charging station location, whether it is public property, private businesses such as retail companies, multifamily housing or other institutions. Building leases or third-party operated parking can complicate charging station installations and all parties should work out arrangements to clarify ownership, operation, and revenue in advance.

Charging stations visibly demonstrate an organization's commitment to sustainable energy consumption and complement other environmentally friendly initiatives. Some workplace charging locations are able to serve employees and visitors, as well as the general public. Two key examples are colleges or universities and medical campuses. Other examples of public venues that have successful charging station installations include regional transit (commuter lots), downtown multi-purpose parking lots or garages, retail destinations (malls or outlets with multiple stores) and popular year-round leisure destinations.

A Charging Station Cluster Analysis was previously developed to help planning agencies evaluate types of locations and focus deployment efforts where best suited.[14] This analysis walks through the location types where PEV charging infrastructure might be installed and informs decision-makers and prospective PEV charging station hosts of which factors make a good PEV charging location. Targeting locations for PEV charging infrastructure rollout through this cluster approach can help create a system of PEV charging in

[13] NYSERDA. Assessment of current electric vehicle use and charging station installations. November 2012. www.nyserda.ny.gov/-/media/Files/Programs/ChargeNY/Assessment-of-Current-EVSE-and-EV.pdf

[14] NYSERDA. EVSE Cluster Analysis. December 2012. www.nyserda.ny.gov/-/media/Files/Programs/ChargeNY/EVSE-Cluster-Analysis.pdf

the critical early stages of PEV adoption. Figure 23 shows data gathered during a NYSDERDA deployment in 2012 and 2013 which included approximately 700 charging outlets in total. Retail locations tend to experience shorter charging event durations, but have more charging events per day. Multi-family dwellings and parking lots or garages in New York City (which may serve as the primary parking location for residents) average much longer charging event durations with fewer charging events per day. University or Medical Campuses show the highest overall utilization due to a successful combination of charging event durations and charging events per day.

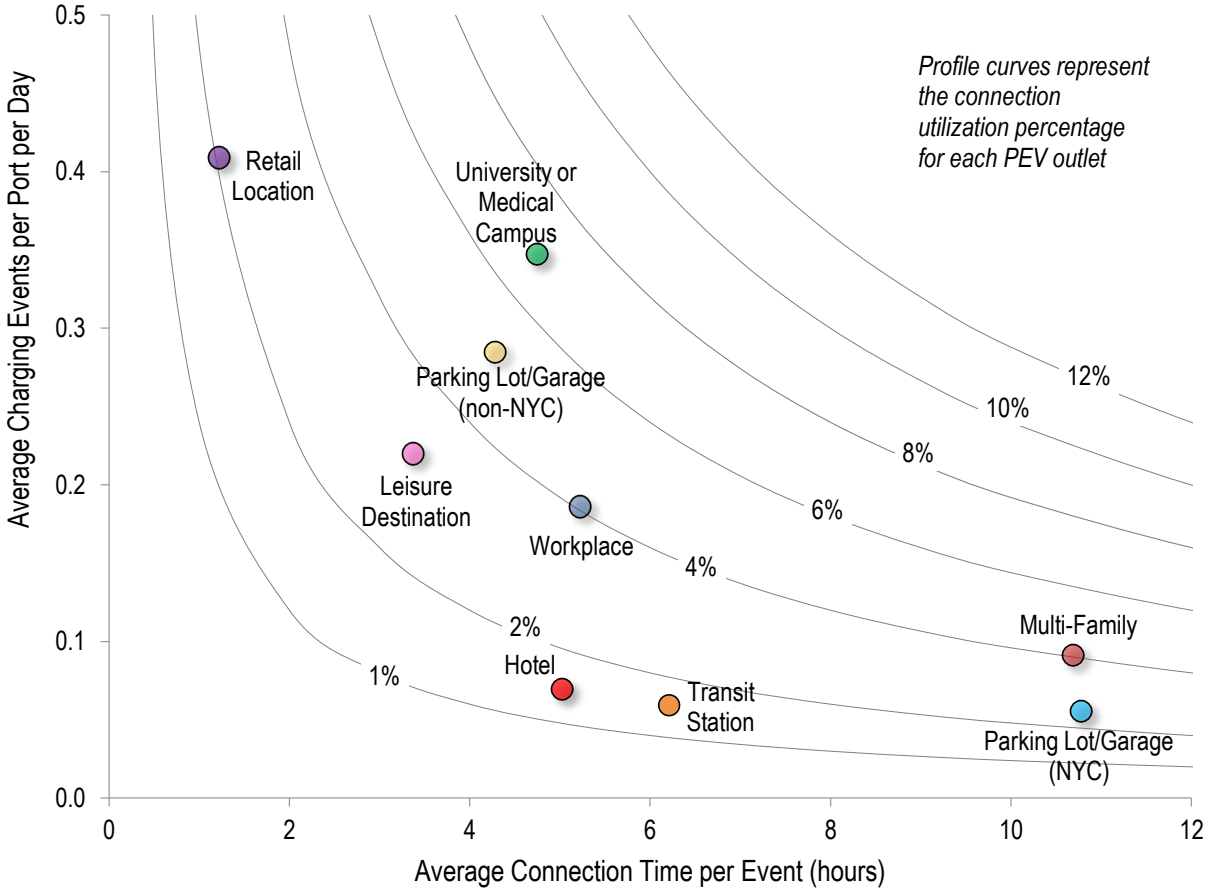


Figure 23: Comparison of Public NYS PEV Charging Station Usage by Venue

Tompkins County has some highly regarded venues that fit into several of the recommended locations for charging stations. Cornell University and Ithaca College are the two largest higher education venues, while the downtown Ithaca-Commons is the most popular retail area. There are currently 1,759 hotel rooms in Tompkins County (including a new Marriot opening downtown in August 2016) with an additional 200 coming online by the end of 2017 with the addition of a Holiday Inn Express and Hilton Canopy. There are also several small inns and Bed & Breakfasts that serve the large visitor population. There are several great opportunities for expanding the PEV Charging infrastructure in the County.

Tompkins County Road Use

Traffic in Tompkins County is concentrated around Ithaca, including the major routes heading into and out of the city as shown in Figure 24. Highly travelled routes include NY-34 (North and South), NY-13 (South and East), NY-96 (Northwest), and NY-79 (West and southeast). While Ithaca is the largest population center in Tompkins County, chargers placed in smaller towns throughout the area, along these major travel corridors, may prove beneficial as well. This would help create a network of charging locations to eliminate "range anxiety" for current and future PEV drivers traveling throughout the County.

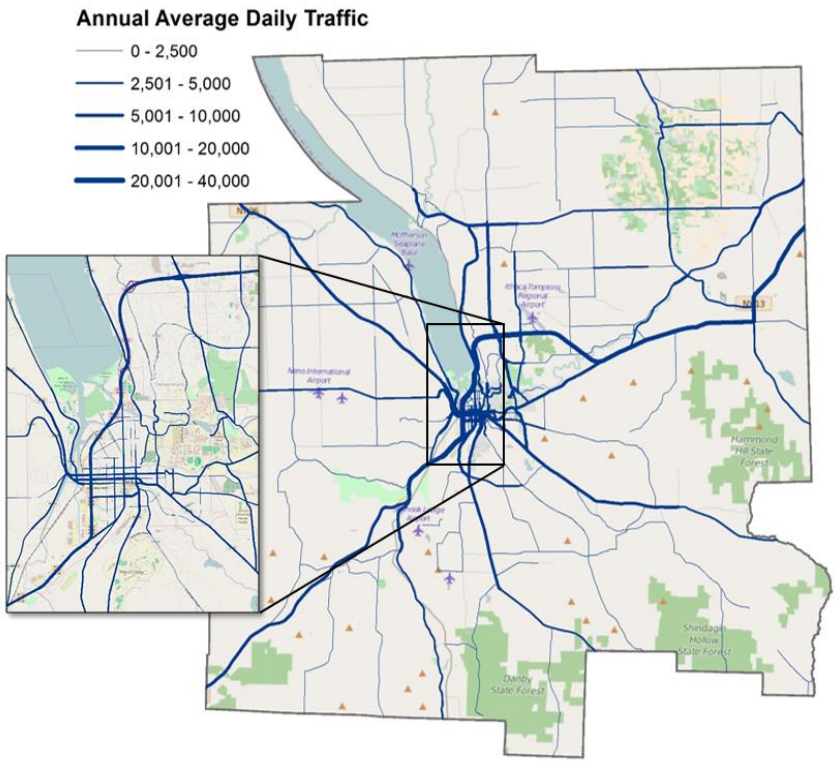


Figure 24: Tompkins County Major Roadways and Average Traffic Volumes

Charging Station Site Placement

In addition to the PEV charging station's location, where it is placed onsite and how it is installed will also impact the ease of use for PEV drivers and station cost effectiveness. Charging station installation costs can exceed the cost of the hardware itself and are influenced by a number of factors that should be considered when determining if a site is good and where to install the charging station on the property.

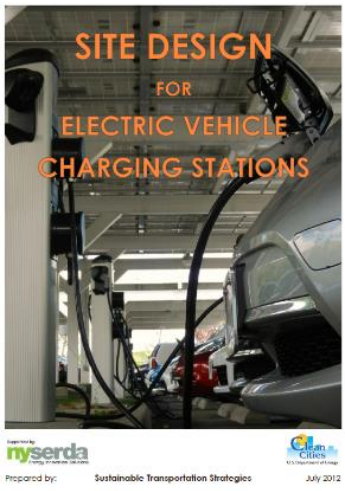
The largest factor can be the currently available electrical service. All new charging station installations should have a load analysis performed on the facility's electrical demand to determine if there is capacity to add PEV charging stations. Upgrading electrical service would add significant cost to the installation. A longer distance between the electrical panel and the PEV charging station means increased installation costs because it increases the amount of necessary trenching (and repair), conduit, and wire.

Although it is desirable to minimize the distance between the electrical panel and PEV charging station as much as possible, you also need to consider the impact of placing the station at that location on the property. For example, placing charging station parking spaces in the back of a building might discourage their use, but other customers may be upset if a charging station is installed in prime parking spaces that often remain vacant because there are few PEV drivers. Optimal PEV charging station installations are close to the building and convenient for PEV drivers, but not in the most premium parking spaces.

Figure 25. Example of Ideal Siting for a Charging Station

Other considerations have less impact on installation costs, but can impact how effective the station is at benefiting PEV drivers and other clients. Be sure to think about the path of the charging cord when in use (so it is not a tripping hazard), parking lot management practices (will the charging station get in the way of pavement cleaning or snow plowing, or is it a space where snow is piled in the winter or where equipment might be stored), and signage (for PEV drivers to easily find the station).

A NYSERDA published document "Siting and Design Guidelines for Charging Stations" identifies and diagrams key siting and design issues that are relevant to local governments as well as developers, homeowners, businesses, utility providers, and other organizations interested in best practices for PEV charging infrastructure implementation.[15]



Another valuable resource, the "Site Design for Electric Vehicle Charging Stations", highlights best practices for designing PEV parking spaces, and provides several illustrated design scenarios.[16]

Effective signage helps PEV drivers navigate to charging station spaces and helps to prevent those spaces from being occupied by a non-PEV. The "Charging Station Signage Overview" covers general service (guidance), regulatory (enforceable), and special (information/trailblazer) signage.[17] Another effective strategy for distinguishing the PEV charging space is to paint the entire space green or mark the pavement with an PEV charging symbol.

Signage helps onsite marketing and promotion of the charging stations, but the most effective strategies use a broad marketing plan that advertises this resource to employees and guests. Environmental sustainability benefits associated with PEVs can be promoted through social media and company websites because of the investment in charging infrastructure. PEV drivers find charging stations through apps and websites that should be used to list any new installations.

[15] NYSERDA. Siting and Design Guidelines for Charging Stations. November 2012. www.nyserda.ny.gov/-/media/Files/Programs/ChargeNY/Siting-and-Design-Guidelines-for-EVSE.pdf
[16] NYSERDA. Site Design for Electric Vehicle Charging Stations. July 2012. www.nyserda.ny.gov/-/media/Files/Programs/ChargeNY/Site-Design-for-PEV-Charging-Stations.pdf
[17] NYSERDA. Charging Station Signage Overview. October 2013. www.nyserda.ny.gov/-/media/Files/Programs/ChargeNY/EVSE-Signage-Overview.pdf

PEV PLANNING BEST PRACTICES

Although gasoline-powered vehicles will be around for many years, a shift in the transportation industry toward electrification will change how people drive and fuel vehicles. PEVs can be very beneficial to communities and their residents. Unlike gasoline-powered vehicles, PEVs are quiet, emit no direct air pollution, and do not require imported fuel that must be transported with the risk of spills or leaks.

To enjoy these benefits and support residents who make the investment in cleaner cars, communities can promote the use of PEVs by becoming PEV-ready. Municipalities can prepare for PEVs and the infrastructure that is used to charge them with the following best practices guides for amending local rules and regulations to be PEV-friendly.

Understanding which level and how many charging stations are feasible for different settings based on expected PEV use is critical. The type and number of PEVs in a community will help shape how many and what kind of charging station an PEV owner might need. The different types of charging stations will charge PEV batteries at different rates. The type of PEV charging infrastructure at each site should correspond with the amount of time a vehicle might be parked there while the driver is shopping, working, or enjoying entertainment. As a municipality, zoning laws must permit the installation of each charging station type in an appropriate setting.

Examples of zoning and parking policies from across the country can be found in the published document "Planning Policy Tool Guide", which also addresses local permitting practices and building codes.[18] This guide highlights best practices, some of which are highlighted below, and introduces policy options for public officials and private-sector leaders to prepare their communities, jurisdictions, states, or organizations for PEVs.

Zoning

Zoning is a form of local ordinance that governs the use of property within local jurisdictions. Zoning for electric vehicle supply equipment (EVSE, or more commonly referred to as charging stations) will need to consider the existing methods and technologies available for PEV charging, and potentially think ahead to proactively address developing technologies and installation scenarios.

As a tool for local governments in infrastructure planning, zoning ordinances are used to indicate where EVSE is allowed or prohibited. Zoning is a long-term tool, not a shortcut to accelerating infrastructure deployment. Because of the long-term nature of zoning changes and the development process, jurisdictions should prioritize zoning changes that may be necessary to allow charging stations in appropriate locations in order to achieve timely results.

Zoning should function to support any applicable plans that may be in place. A comprehensive plan or PEV agenda could be used to indicate where PEV charging stations should be allowed, where they should be concentrated, and where they should be required. In general, zoning ordinances should account for projected development over a long period of time, and guide EVSE deployment.

[18] NYSERDA. Planning Policy Tool Guide. November 2012.
www.nyserda.ny.gov/-/media/Files/Programs/ChargeNY/Planning-and-Policy-Tool-Guide.pdf

Planners and other officials can use zoning to allow, incentivize or require PEV charging stations either throughout a municipality's zoning districts, or in specific areas.

Allow Charging Stations - Defining EVSE in the local city planning and land use context is a good first step that a handful of jurisdictions have taken to ensure that EVSE installations are allowed. By incorporating language specific to EVSE and/or battery swap stations in the local zoning ordinance, local planning offices can help clear barriers to installation by answering a simple question in the zoning text: What is EVSE?

New York City's Department of City Planning reviewed PEV charging and battery swap stations and determined that a clear distinction was needed—creating clarity in the zoning text to ensure vehicle battery charging was codified as a use distinct from gasoline filling stations. In the NYC Zoning Resolution, this pointed to a need to include battery charging in a distinct use group. The city's "Zone Green" zoning text amendments, enacted by New York City Council in April 2012 defines "electric vehicle charging in conjunction with parking facilities" as an accessory use in the New York City Zoning Resolution. It places PEV charging stations and battery swap facilities in a use group for "Auto Service Establishments." This includes such facilities as automobile glass and mirror shops or tire sales establishments but not petroleum fuel filling stations, which allows EVSE in any drive-in property/use in a commercial district. For New York City, this designation supported city efforts to deploy infrastructure without being overly prescriptive.

New York City provides an instructive example, but the type of zoning district and use group categories will differ from place to place. Local resolutions will account for permissible uses, based on zoning districts (e.g. residential, commercial, industrial), special districts and potentially on the level of charge. Including clear definitions and provisions for where EVSE is allowable as-of-right (or by right) will limit barriers associated with development review. These definitions will allow the developer to avoid the costs of seeking special approvals for changes such as by rezoning, special permit or variance, all of which require a public review process.

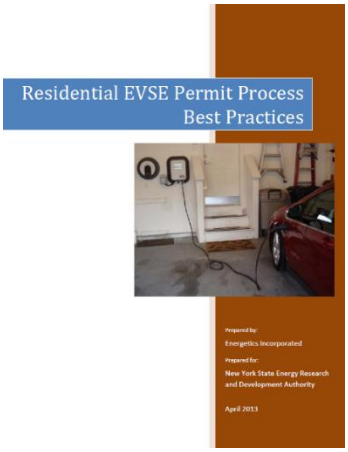
Incentivize Charging Stations - Incentive zoning provides a bonus, such as in the form of additional floor area, in exchange for the provision of a public amenity or community improvements. In New York City, for example, bonuses are provided for: public plazas, cultural venues, subway improvements, theater preservation, food stores in particular areas and affordable housing units.

In the case of EVSE, a developer incentive might be exchanged for EVSE pre-wiring or charging station installation. Typical developer incentives include an increase in allowable floor area or a reduction of required parking provided. The EVSE is the public benefit, and the incentive would be the increased density, reduced parking, or other incentive to encourage the inclusion of EVSE in new construction. Zoning ordinances could define priority areas where EVSE may be required and/or supported by programmatic incentives to install EVSE. The nature of the incentive would be outlined in the zoning ordinance as well.

Charging Station Permitting and Codes

Simple and consistent PEV charging station permitting processes can make installing PEV infrastructure much easier. Current national building and electrical codes neither inhibit nor facilitate the implementation of PEV charging stations. But at a municipal level, the adoption of certain provisions in local codes has successfully encouraged PEV-readiness in some jurisdictions.

"PEV Ready Codes for the Built Environment" provides current codes for charging stations and what code provisions could be incorporated into local code to encourage a basic or advanced level of PEV-readiness.[19] It highlights best practices from around the world to make recommendations for jurisdictions in the Northeast and mid-Atlantic.



How charging station installation work is classified within a jurisdiction can impact the time and cost of the permitting process. An overview on "Permit Process Streamlining" reviews best practices for charging station permitting and presents sample application forms.[20] While residential installations were the focus on this investigation, the results and findings also apply to commercial charging station installations.

The popularity and widespread deployment of PEVs is relatively new and the installation of required charging infrastructure is often not yet addressed in existing planning, zoning, and permitting regulations. In general, municipalities in Tompkins County demonstrated knowledge of EVSE technology and the major city and towns were familiar with the process of installing a charging station. However, no municipalities currently have specific regulations in place for the siting of this technology so each installation would require a case by case approval process. Including EVSE in a new-build plan would streamline the installation process and would not require any additional permitting once the site plan was accepted.

Many smaller municipalities throughout the county are not very familiar with PEV technology or charging station installations. To the best of their knowledge, an EVSE installation would only require an electrical permit. However, it might be possible that an inspector or town official would have questions or raise additional concerns when approached on this topic because of the uncertainty expressed during our inquiry. There are no reported limitations on zoning or placement of the stations, but they must adhere to local building and electrical codes which could present potential limitations based on interpretation.

The City of Ithaca is most familiar with PEV charging infrastructure since they have the most experience, but there is still limited regulatory information as to the placement and installation of the technology. The electrical installation of the station itself does not have any specific limitations other than it must meet NEC Article 625. There is no provision for a charger in the permitting process so each application must be reviewed on an individual basis. Overall, the installation of a charging station in a parking lot appears to require a similar process as a light pole or other electrical infrastructure. However, there may be some limitations on the signage and ability to charge for the station use depending on the station's zoning location within the City of Ithaca.

Parking Enforcement

Many organizations do not have formal policies to address potential charging station parking space conflicts. Currently there are limited PEVs, however, as more individuals purchase PEVs or organizations

[19] NYSERDA. PEV Ready Codes for the Built Environment. November 2012.
www.nyserda.ny.gov/-/media/Files/Programs/ChargeNY/PEV-Ready-Codes-for-the-Built-Environment.pdf
[20] NYSERDA. Permit Process Streamlining. April 2013.
www.nyserda.ny.gov/-/media/Files/Programs/ChargeNY/Permit-Process-Streamlining.pdf

add PEVs to their fleet, the potential for conflicts will increase. In general, PEV drivers are usually willing to work together to address the needs of other PEV drivers, especially if they are encouraged to do so.

In a workplace setting, improperly managed charging stations could create unnecessary problems. Poorly designed policies could inconvenience PEV drivers, negating their intended benefit. For instance, if employees have to move their PEVs in the middle of the workday to free up chargers this can disrupt their work. Also, having to move a car midday means they may need to park in a more remote part of the parking lot, which can be a disincentive to follow the rules or even charge in the first place. If non-PEV drivers view PEV charging as too great an incentive for a select group of employees (providing free fuel and preferential parking spaces), the PEV charging stations might lead to disgruntled employees. Organizations have found that properly communicating the business' reasoning for installing the charging stations and distributing information about the societal benefits of PEVs helps increase PEV awareness and reduce parking conflicts with non-PEV drivers.

Parking ordinances will apply to publicly accessible charging stations. Parking regulation and enforcement is typically a shared responsibility in municipalities, requiring participation of law enforcement, departments of transportation, public works, permitting, and others. Thus, there is a need to establish a clear process, and determine which agencies will handle the logistics of EVSE charging spaces in the public realm—and in publicly accessible lots and garages. Similar to all traffic statutes, statutes prohibiting parking by non-PEVs or non-charging PEVs can be enforced in any publicly accessible lot or garage in most municipalities, if such a statute is approved in a jurisdiction. Specifically, statues can make it illegal for a non-PEV to park in a PEV-designated space with fines or towing as penalties for those that violate this. Signage clearly designating charging spaces appropriately and enforcement of the statues is critical to ensuring that the charging station is available for PEVs.

Charging Station Ownership Models and Funding Sources

Different ownership options exist for charging stations with the most common model of a charging station host owning it. However, third-party charging station service providers may pay for the installation, operate the station, and share some of the profits with the host site. Some charging station manufacturers, third-party charging station service providers, or charging station network providers are considering offering the option to lease charging stations as well.

As of 2013, New York State provides an income tax credit for 50% of the cost, up to $5,000, for the purchase and installation of alternative fuel vehicle fueling and PEV charging stations. The New York State Alternative Fueling Infrastructure Tax Credit for commercial and workplace charging stations is available through December 31, 2017.[21] Federally, the Alternative Fuel Infrastructure Tax Credit provides an additional incentive. Fueling equipment for electricity (along with other alternative fuels) installed between January 1, 2015, and December 31, 2016, is eligible for a tax credit of 30% of the cost, not to exceed $30,000. Permitting and inspection fees are not included in covered expenses.[22]

[21] U.S. DOE Alternative Fuels Data Center. Alternative Fueling Infrastructure Tax Credit. www.afdc.energy.gov/laws/11180

[22] U.S. DOE Alternative Fuels Data Center. Alternative Fuel Infrastructure Tax Credit. www.afdc.energy.gov/laws/10513

Key Stakeholders for PEV Readiness

Collaboration among numerous stakeholders in Tompkins County is needed to support the growing PEV population and prepare the area for the future of electric drive technology. First and foremost, this must include the municipalities, who must ensure that regulations and policies do not limit the installations of charging stations at the homes of PEV drivers or other locations where they need to charge. As described above, there are several opportunities to facilitate and encourage residents to embrace PEVs. Due to its size and location, the City of Ithaca will likely be on the forefront of pursuing PEV-friendly policies and practices that other municipalities can replicate. However, the flexibility and motivation of smaller municipalities might allow them to position their jurisdiction PEV-friendly. From a planning perspective for developing a roadmap to support PEVs in Tompkins County, several organizations involved in this project as well as other active entities in related transportation, energy, or environmental fields should come together with a common message and vision. These stakeholders include, but are not limited to;

- Ithaca-Tompkins County Transportation Council
- Tompkins County
- Town of Ithaca
- City of Ithaca
- Cornell University
- Cornell Cooperative Extension
- NYSEG / Avangrid
- Ithaca College
- Downtown Ithaca Alliance
- Sustainable Tompkins
- Get Your GreenBack Tompkins
- Tompkins Community Action
- Ithaca Neighborhood Housing Services
- Tompkins-Cortland Community College
- Tompkins Consolidated Area Transit (TCAT)
- Tompkins County Chamber of Commerce
- Tompkins County Council of Governments (TCCOG)
- Tompkins County Area Development (TCAD)
- Ithaca-Tompkins County Convention & Visitors Bureau
- McGuire Auto

Other stakeholders critical to making Tompkins County PEV-ready are entities that are willing to host an PEV charging station. Several entities have already taken the initiative and are pioneers in supporting PEVs in this area: Cornell University, Diane's Automotive, Purity Ice Cream, Taitem Engineering, Cayuga Medical Center, BJ's Wholesale, William Henry Miller Inn, Three Hills Properties, La Tourelle, and Cornell Business and Technology Park. However, several more employers, popular attractions, common parking lots, and other entities throughout Tompkins County will need to share this vision and install charging stations for PEV adoption to flourish.

APPENDIX A

PHEVs Available, or Soon to be Available in Tompkins County

Audi A3 Sportback e-tron
Starting MSRP: $37,900
Federal Tax Credit: $4,168
MPG Equivalent: 95
Electric Range (miles): 31

Honda Accord PHEV
Starting MSRP: $39,780
Federal Tax Credit: $3,626
MPG Equivalent: 115
Electric Range (miles): 13

BMW i3 w/ Range Extender
Starting MSRP: $46,250
Federal Tax Credit: $7,500
MPG Equivalent: 117
Electric Range (miles): 81

Hyundai Sonata PHEV
Starting MSRP: $34,600
Federal Tax Credit: $4,919
MPG Equivalent: 93
Electric Range (miles): 22

BMW i8
Starting MSRP: $136,500
Federal Tax Credit: $3,793
MPG Equivalent: 76
Electric Range (miles): 15

Mercedes-Benz S-Class PHEV
Starting MSRP: $95,650
Federal Tax Credit: $4,168
MPG Equivalent: 58
Electric Range (miles): 20

BMW X5 xDrive40e
Starting MSRP: $62,100
Federal Tax Credit: $4,168
MPG Equivalent: 59
Electric Range (miles): 13

Porsche Cayenne S E-Hybrid
Starting MSRP: $77,200
Federal Tax Credit: $5,335
MPG Equivalent: 47
Electric Range (miles): 14

Chevrolet Volt
Starting MSRP: $33,170
Federal Tax Credit: $7,500
MPG Equivalent: 106
Electric Range (miles): 53

Porsche Panamera S E-Hybrid
Starting MSRP: $96,100
Federal Tax Credit: $4,751
MPG Equivalent: 50
Electric Range (miles): 16

Ford C-Max Energi
Starting MSRP: $31,770
Federal Tax Credit: $4,007
MPG Equivalent: 88
Electric Range (miles): 21

Toyota Prius Prime *(2017)*
Starting MSRP: $29,990
Federal Tax Credit: $2,500
MPG Equivalent: 95
Electric Range (miles): 11

Ford Fusion SE Energi
Starting MSRP: $33,900
Federal Tax Credit: $4,007
MPG Equivalent: 88
Electric Range (miles): 21

BEVs Available, or Soon to be Available in Tompkins County

BMW i3 BEV
Starting MSRP: $42,400
Federal Tax Credit: $7,500
MPG Equivalent: 124
Electric Range (miles): 81

Nissan Leaf
Starting MSRP: $29,010
Federal Tax Credit: $7,500
MPG Equivalent: 115
Electric Range (miles): 84

Chevrolet Bolt *(2017)*
Starting MSRP: N/A
Federal Tax Credit: $7,500
MPG Equivalent: N/A
Electric Range (miles): 200

Smart Electric Drive
Starting MSRP: $25,000
Federal Tax Credit: $7,500
MPG Equivalent: 107
Electric Range (miles): 68

Ford Focus Electric
Starting MSRP: $29,170
Federal Tax Credit: $7,500
MPG Equivalent: 104
Electric Range (miles): 76

Tesla Model S
Starting MSRP: $71,070
Federal Tax Credit: $7,500
MPG Equivalent: 95
Electric Range (miles): 265

Kia Soul EV
Starting MSRP: $31,950
Federal Tax Credit: $7,500
MPG Equivalent: 112
Electric Range (miles): 105

Tesla Model X
Starting MSRP: $80,000
Federal Tax Credit: $7,500
MPG Equivalent: 89
Electric Range (miles): 230

Mercedes B Class Electric Drive
Starting MSRP: $41,450
Federal Tax Credit: $7,500
MPG Equivalent: 84
Electric Range (miles): 87

Tesla Model 3 *(2017)*
Starting MSRP: $35,000
Federal Tax Credit: $7,500
MPG Equivalent: N/A
Electric Range (miles): 215+

Mitsubishi i MiEV
Starting MSRP: $22,995
Federal Tax Credit: $7,500
MPG Equivalent: 112
Electric Range (miles): 62

Volkswagen e-Golf
Starting MSRP: $28,995
Federal Tax Credit: $7,500
MPG Equivalent: 116
Electric Range (miles): 83