

TOMPKINS COUNTY FLEET PEV CHARGING INFRASTRUCTURE REPORT

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Existing Charging Installations

Four departments in Tompkins County have installed plug-in electric vehicle (PEV) charging infrastructure also referred to as electric vehicle supply equipment (EVSE). These charging installations are at department offices and typically charge the vehicles overnight when the PEVs are not being used by department staff.

The *Mental Health Department* was one of the first county charging infrastructure installations, shown in Figure 1, to support five Chevrolet Volts. Posts with 110 volts of alternating current (VAC) outlets, located in locking boxes, were installed to plug in the “occasional use” power cords that come with the vehicles and provide about 4 miles of electric range for every hour of charging. These power cords are typically kept with the vehicle for when charging is needed for emergency circumstances and a station is not readily available, but the Chevrolet Volts have a back-up gasoline engine, so would almost never require a charge. While this solution is extremely low cost, simple, and has worked without serious issues so far, a more permanent station may be required at some point as these power cords are not designed for long-term, exterior use (although the most common point of failure from repeated plug-ins is the three-prong outlet which remains connected in this application). Cord management may also be beneficial as there has been some issues with cord placement, particularly during winter months, and they could be easily damaged.



Figure 1: Mental Health Department EV Charging Infrastructure

Three 110VAC electrical outlets were also installed at the *Department of Social Services* on West State Street to plug-in Chevrolet Volts using the “occasional use” power cords. These outlets are wall mounted (as shown in Figure 2) and use a hose holder to wrap up the power cords that came with the PEVs. These ports may also benefit from cable management and a permanent station if the power cords begin to fail after extensive use. This Department of Social Services location has a mix of PEVs and conventional vehicles, so it was necessary to reserve the parking spaces near the outlets for the PEVs. For Plug-in hybrid electric vehicles (PHEVs) that have smaller batteries, it is also important to regularly charge them when at the office to maximize electric miles and displace gas use (which these vehicles used once the battery is depleted).



Figure 2: Social Services Department PEV Charging Infrastructure

The *Health Department* office by the airport has the largest PEV charging infrastructure installed to date, with eight, dual-port charging stations as shown in Figure 3. Each of these 16 charging ports support Level 2 220VAC charging levels which provide 20 miles of electric driving for every hour of charging. This level of charging is important for the all-electric vehicles used by the Health Department (Nissan Leafs, which must keep the “occasional use” charging cord with the vehicle in case of emergencies), but also can result in high electrical demand when multiple ports are used at the same time. The charging infrastructure required a new dedicated transformer, cabinet, and panel box. This installation could likely benefit from cable management to ensure cords are kept up and not damaged during plowing or other maintenance operations.



Figure 3: Health Department PEV Charging Infrastructure

Two 110VAC outlets on a post were recently installed near where county vehicles park at the *Recycling and Materials Management* offices as shown in Figure 4. This installation was in anticipation for a PEV that the department is planning on purchasing sometime soon. This infrastructure does not include an PEV specific plugs (J1772) or necessary hardware to charge an PEV. Once the PEV is purchased, either a dedicated Level 1 EVSE can be mounted here or the vehicle’s charging cord can be utilized. Unfortunately, charging would be limited to providing 4-6 miles of electric miles per hour of charging, which may not be enough for an all-electric vehicle that is regularly driven longer distances. It’s

recommended that charging infrastructure is installed after the PEV model is selected to ensure it will be sufficient.



Figure 4: Recycling and Materials Management PEV Charging Infrastructure

Planned Charging Installations

Additional charging stations are planned at the County offices in downtown Ithaca for future county department PEV purchases. Several department offices are near East Court Street and North Tioga Street. Several potential placements for charging stations outlined in Figure 5 were selected based on vicinity to department offices, typical parking locations for department vehicles, proximity to electrical power, and other considerations, such as snow removal. Charging infrastructure at these locations would serve PEV acquisitions for the Old Courthouse where the Department of Planning & Sustainability is based (Location A), Annex Building C (Department of Assessment and ITS) (Location B), and the Old Jail (Location C).

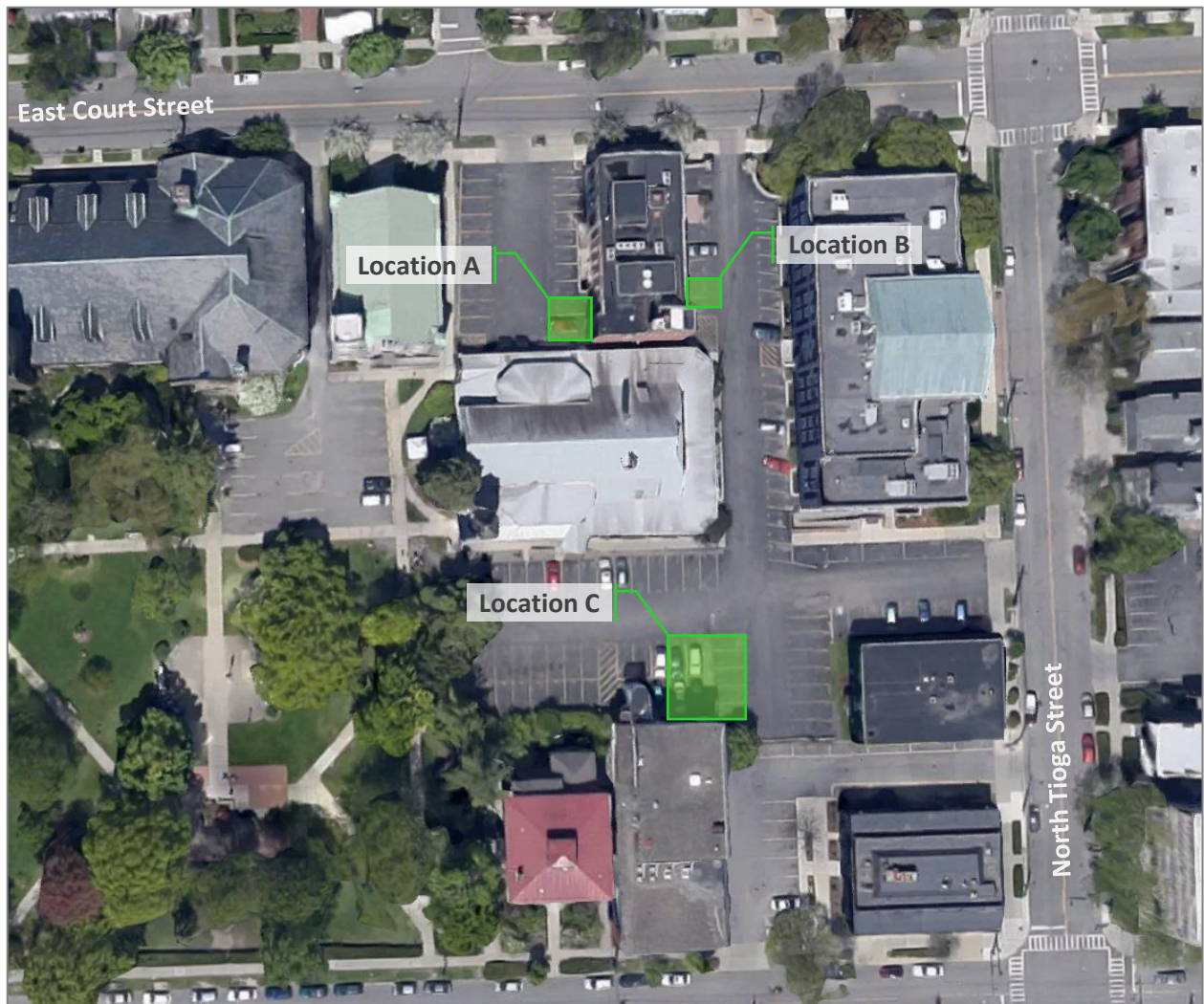


Figure 5: Planned Downtown Ithaca Charging Station Locations

In addition to providing charging for department PEVs, the charging infrastructure may be made available to employee PEVs or the general public. Factors to consider for this mixed utilization are discussed in more depth later in this report but were considered for these proposed installation layouts.

Proposed Charging Station Location A

This option would place a charging station accessible from two parking spaces between the Old Courthouse and Old Jail which is typically used by County employees and the Department of Planning & Sustainability for parking its vehicle. A wall mounted EVSE installed on the side of the building, as shown in Figure 6, could provide a cost-effective solution without power cords having to cross any walking path. This parking area is used by both county and employee vehicles, so this station could charge both (employee vehicles during the day and the county vehicles overnight).



Figure 6: Potential Charging Station Installation at Location A

Power is available directly inside the building at this location, making the power run short from the panel, through the exterior wall, and to the charging station. The wall mounted station also requires no trenching or extensive site preparation which keeps costs down. This installation is expected to be the least expensive near these downtown county offices.

Proposed Charging Station Location B

The location B option places a dual-port charging station between two parking spaces near the entrance to the Old Jail. This location, shown in Figure 7, could also be used by employees to charge during the workday. A station wall mounted to the building would not cause pedestrian interference by the charging cords at this location. Wall mounting also decreases the overall installation costs while reducing the chances that the charger will be damaged during snow removal or by vehicles. A power source is a short distance from the potential charger mounting position near the center of the building. A slightly longer wire run would be required than for Location A, but it would be inside the building up until it penetrates the exterior wall and connects to the charger. Not needing to trench or run long exterior wiring reduces the overall installation costs.



Figure 7: Potential Charging Station Installation at Location B

Proposed Charging Station Location C

The proposed location C option on the northside of Annex Building C has the potential to be shared by the most parked vehicles but has some logistical challenges with the parking configuration. The County Assessment Department vehicles currently use double-park spaces (as shown in Figure 8), so the outside ones are typically used first but likely only the inside parked vehicles could access the charging station. Perpendicular to these county spaces are six employee parking spots only separated by a concrete curb. A wall mounted charging station with a longer cord option (typically 28 feet) on the building near the center of the concrete curb could reach 2-3 county parking spaces and 2-3 different employee parking spaces should PEVs need to charge.



Figure 8: Potential Charging Station Installation at Location C

Routing power to this wall mounted charging station would be more complex than the other options because it is a longer run, but still can still be accomplished without trenching which is simpler and less expensive.

Charging Infrastructure Best Practices

Several factors should be considered for any EVSE installation to ensure optimized use of the station and the most value from the investment.

Lower-power, Lower-cost Stations

The lowest cost PEV charging option is plugging the AC Level 1 “occasional use” charging cords that come with the vehicle into an 110VAC ground fault current interrupter (GFCI) outlet on a dedicated 20-amp circuit. This configuration is used by the Mental Health and Social Services Departments for their Chevrolet Volts. The outlets should be National Electrical Manufacturers Association (NEMA) commercial grade outlets that meet National Electric Code (NEC) requirements. Commercial grade outlets, such as hospital grade outlets, are better suited for PEV charging use because they may be more durable and retain optimal tension longer than lower quality outlets. Outlets must have a cover if the installed outside, or anywhere they could get wet. Permanent AC Level 1 stations use the same electrical wiring, so the outlets can be converted to more durable AC Level 1 EVSE in the future if desired. In addition, it may also be possible to use the same electrical wiring to power a 3.3 kilowatt [kW] AC Level 2 charging station.

The AC Level 1 “occasional use” charging cord typically provide 1.3 kW of charging power. This equates to approximately 4 miles of electric driving range per hour of charging. An AC Level 1 station is slightly more powerful at 1.5 kW, but this still only adds 5 miles of electric driving range per hour of charging. At these charging rates, a current typical plug-in hybrid electric vehicle (8 kWh battery capacity) would require approximately six hours to fully charge. A typical all-electric vehicle (25 kWh battery capacity or more) would need at least 18 hours to be fully-charged from “empty”. Not all vehicles arrive at the charging station with a fully discharged battery or require the battery to be completely charged for the next trip, so AC level 1 stations may work for many situations, but all-electric vehicles will likely need to have the option to charge at a higher-powered station when needed to fully utilize its capability.

Providing outlets to use with the vehicle’s “occasional use” charging cord is a very low-cost option but may not be the best long-term option. The charging cords provided with the PEVs are not designed to be as rugged as dedicated station and may see premature wear due to exposure to the elements and frequent plug events (the three-pronged connector is particularly vulnerable to wear). However, this option could meet some departments needs and allow charging infrastructure to be easily installed cost-effectively. The department staff can then evaluate the usage to determine if an upgraded charging option is needed.

Cable Management

Cable management is recommended for all future and existing charging stations throughout Tompkins County. These systems automatically retract the charging cord once finished charging to ensure it is not left on the ground. Most use a tall post with a counter-weight inside that pulls the cord upwards when not connected to a vehicle. Charging stations are designed to have the cord wrap around it when not in use or include a hook where the cord can be coiled up, but with the responsibility of doing so left to the drivers, it is not always done properly. There is no electrical risks from the cords being on the ground in rain or snow, but it causes wear issues when stepped on or run over. It also increases the risk that it

might be a tripping hazard, damaged during maintenance (mowing, snow removal, etc.), and contribute to poor aesthetics. It will also be much dirtier which is a deterrent to PEV drivers that want to use them.

Most EVSE manufacturers offer cable management as an add-on feature for their stations (although some have it standard because they understand all the issues caused by not having cable management). For the ClipperCreek stations already installed by Tompkins County, the manufacturer offers their own cable management solution (<https://store.clippercreek.com/cable-management> - about \$1,000 for a dual mount pedestal extension kit) or one from a third party can be used; one example of which from EV Charge Solutions is shown in Figure 9 (<https://www.evchargesolutions.com/EV-Charger-Cable-Management-s/1828.htm> - cord management retractor systems around \$500).



Figure 9: EV Charge Solutions EVSE Cable Management Examples¹

Networking

AC Level 2 EVSE are available as networked (managed) or non-networked (unmanaged) stations. Managed stations operate on a charging management network (e.g., ChargePoint, Greenlots, EV Connect) that controls access (secures the plug until properly authenticated), facilitates payments, manages charging station reservations, monitors use, and sends notifications for faults. Networked stations provide this additional valuable functionality but are more expensive than non-networked EVSE to purchase because of their communication hardware. The stations have a fee to be activated, may require a cell signal repeater for reliable network communication, and have a reoccurring annual subscription fee.

EVSE site hosts should not select networked stations for the sole purpose of generating revenue as the initial costs and annual subscription fee will be challenging to recoup on top of the electricity fees imposed to users. Rather, the purpose of using networked stations is for tracking charging station usage, receiving real-time notification of issues, online availability, and other available benefits, in addition to the ability to collect user fees. Some networked systems can leverage local WiFi and Bluetooth networks for data transfer to eliminate the cost of cellular subscriptions. If a station host installed a non-networked station to keep initial purchase costs low, but later determined that networked functionality

¹ EV Charge Solutions Cable Retractor <https://www.evchargesolutions.com/EV-Cable-Retractor-92-p/evcs-ezpull-92.htm>

is needed to help manage station use (e.g., fee collection, maintenance monitoring, in-use status for online availability) or expenses, there are some options. One aftermarket solution is the eMotorWerks JuicePlug (less than \$100) that adds smart, remote monitoring and control of any SAE J1772 EVSE connector using WiFi communication.²

Station Sharing

As the county and public use more PEVs, demand for charging stations will grow. It is impractical and not cost effective to install a charging station for every PEV. In addition, PEVs in fleets or owned by employees will be parked longer than needed to be fully charged. Another issue created by trying to have more charging stations than needed is the size of the electrical infrastructure required and the demand peak created when the PEVs arrive around the same time and start charging. There are installation and operational strategies to optimize and manage charging stations that are shared among multiple vehicles.

Plug Switching

AC Level 2 charging stations provide more power than is typically required for long dwell charging events (employees parking throughout the workday or fleet vehicles parked overnight). However, these chargers may be desired or needed to provide faster charging during the day to extend the vehicle's range, or to provide a full charge on PEVs with larger batteries that are used for longer travels. Sharing a charging station among multiple vehicles by switching the cord from one PEV to another is a low-cost option to maximize use. This is much more convenient for PEV drivers if the charging spots are configured to allow the cord from a station to reach several parking spaces reserved for PEVs. If the charging station is placed between parking rows so both sides can access it or is selected with longer cords to reach adjacent parking spaces, the EVSE can be shared without the PEV drivers having to move vehicles. One driver will still need to return to the vehicles during the day to switch the plug, but this is usually easily done among colleagues. Alternatively, the driver with the fully charged PEV could move it to another parking spot so another PEV driver can use the station, but this is less convenient and challenging in a parking lot with limited spaces.

Power Sharing

Power sharing dual-port AC Level 2 charging stations use the same electrical input as a single charger. The two charging cords share the power between any connected vehicles. When one vehicle is connected, full power is provided to it, but when two vehicles are connected, power is shared between them until one completes its charge. With this strategy, there is less need to manually switch vehicles or charging cords, but it requires more stations. The advantage is that it allows twice as many stations to be installed for a given amount of electrical capacity and will lower the electrical demand when many vehicles are plugged in at one time. It is likely that the recent Health Department charging station installations could have used power sharing stations which would have reduced the size and cost for the new electrical panel, while still providing enough charging power (any vehicle requiring full power to charge faster could select a charging station where no other vehicle was charging).

ChargePoint and ClipperCreek both offer charge sharing EVSE systems for a slight increase in cost over their standard models. ChargePoint's CPF25 model includes intelligent charge management that

² eMotorWerks JuicePlug <https://www.kickstarter.com/projects/emw/juiceplug-a-universal-smart-ev-charging-adapter>

dynamically distributes power to all PEVs plugged into the system. ClipperCreek's Share2™ technology allows two 32-amp AC Level 2 EVSE to share a single 40-amp circuit.

Power Management

Automated power management systems actively control and manage power among multiple charging stations at a facility to minimize the system-level electrical demand and cost impacts by optimizing charging times and rates. Some systems communicate with the grid and incorporate pricing signals in the management algorithms. System costs (initial and monthly) can be high but can be a cost-effective solution for long dwell parking situations where the AC Level 2 charging is needed, but there is limited available electrical service capacity or minimizing demand charges is critical. The station installations at Tompkins County fleet facilities likely do not warrant the application of an automated demand management system currently. However, if large-scale installations are being considered, this technology could prove beneficial.

Multi-Use Stations

The intended charging station users dictate several installation and operational factors that should be considered prior to installation of the charging station. The user groups for Tompkins County charging stations include county owned PEVs, employee PEVs, and public PEVs.

County and Employee Use

Enabling employee access to county-owned charging infrastructure is likely the simplest option for shared charger utilization. With a small group of employees, the PEV owners will be known and can manage charge operations to prioritize charger availability for county vehicles. Employees could plug in their personal PEVs throughout the workday when the county vehicle would have a full charge from overnight and will likely be out on assignment. When county PEVs return at the end of the day, or require a charge during the day, they would unplug the charging cord from the employee vehicles. The configuration of the charger so the cords can reach both county reserved PEV spaces and employee PEV spaces is important to consider, but no special technology should be necessary. Some charge switching policies could be developed as needed. A typical concern is offering charging for free to the employees. A networked station can manage users to impose a fee on any employee charging, however the cost for the county to purchase a networked charger and maintain network services is likely more than would be recouped through usage fees by employees charging their PEVs. A better strategy may be to issue vehicle stickers to PEV drivers that pay a nominal fee to charge at work. Some stations have a key to activate it which can be issued to those that contribute to the electricity costs the County incurs when they charge their personal PEV at work.

Employee and Public Use

Public charging stations on county property could be used by employee and any other PEV owner. Such stations would likely be networked to enable access control as well as charge management. Locating these stations in a county-lot that has restricted access (e.g., employees only during weekdays from 8 am – 5 pm) to prioritize for employees. A networked station can also be set up to only allow a certain group of users (e.g., employees) to access the station during specified periods. Due to the long duration that employees are typically parked, a policy (signage) directing users to move their vehicles after a specific time may be beneficial. Through networked stations, a structure pay strategy can encourage users to move after a specific time by setting pricing increases after an initial charging period. These

parking areas should also be clearly marked as PEV parking only to avoid internal combustion engine vehicles taking up the spaces. As described, these stations would qualify for the Charge Ready NY program which can reimburse the County up to \$4,000 for each installed networked charging port.

County, Employee, and Public Use

If stations primarily installed for county PEVs are available for public use (likely after hours), a more complex management solution will likely be required to ensure the county vehicles (highest priority charging) receive charging when needed. A networked station would likely be necessary to ensure that county vehicles receive enough power when needed and are prioritized over the other ports. Access rights to the charger can be assigned to the three different groups (county, employee, public) to help manage station use. Unfortunately, public use would likely occur in the evenings or over the weekend when the county vehicle is parked in that charging space and might be still be plugged in. If the county PEV is unplugged before getting a full charge, this could impede operations the following day. While using a networked charger partially available to the public for county PEVs could leverage grant funding and be a good opportunity to increase charging options for the public, the challenges associated with sharing its use are likely greater than the County would want to deal with.