Plug-in Electric Vehicles and Infrastructure: A White Paper for the Cities Association of Santa Clara County

Driving to Net Zero

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Overview

Local governments play a key role in the widespread adoption of plug-in electric vehicles (EVs). The Cities Association of Santa Clara County (Cities Association) is in the unique position to influence and educate city officials on the important steps they can take towards EV readiness. This white paper provides background on EVs and the associated charging infrastructure, as well as resources for more information and related policy considerations. It then outlines key action areas for local governments, including building, zoning, and parking codes; permitting and inspection; planning; multiple unit dwellings (MUDs); regional charging networks; fleets; and education and outreach. Within each action area, the white paper provides best practices for local governments. This information is intended to educate the Cities Association and provide a basis for future engagement with city officials. Lastly, the white paper provides recommendations for next steps for the Cities Association.

Background

Vehicle Technology

EVs use an electric motor and energy stored in a battery, either alone or in conjunction with an internal combustion engine. EVs include both plug-in hybrid electric vehicles (PHEVs) and battery electric vehicles (BEVs). PHEVs have both a battery-powered motor and an internal combustion engine (that uses gasoline) capable of powering the wheels; BEVs are powered exclusively by a battery-powered motor and do not use gasoline. For the sake of reference, the Chevrolet Volt is a PHEV and the Nissan LEAF is a BEV. As of January 2018, there are about 46,500 EVs in Santa Clara County—64% are BEVs and 36% are PHEVs.[1]

Generally speaking, cities can focus on two markets when it comes to EVs: consumers and city fleets. Consumers driving personal vehicles are the main target of electrification; however, cities can show leadership by helping adopt EVs in their municipal fleets. EVs provide a number of benefits that cities should understand and help communicate where possible—EVs can be more affordable and have a lower impact on the environment than conventional gasoline vehicles. Although EVs are more expensive, consumers can save money over the course of owning an EV (i.e., the total cost of ownership) because the vehicles are more efficient and because electricity is cheaper. EVs do not emit any pollutants when used—and offer substantial benefits over the lifecycle of fuel emissions—which includes upstream activities like the emissions required to generate electricity. Despite the potential benefits of EV adoption, barriers to higher rates of adoption remain. These include the higher vehicle price, the availability of charging infrastructure, limited models available for purchase and concerns about the range of vehicles. Looking forward, the market is poised for growth: battery costs are coming down, charging infrastructure deployment continues to accelerate, the variety of new vehicle models is improving, and lastly, EV range is increasing.

[1] ICF analysis of vehicle registration data provided by IHS Markit.

Charging Infrastructure

Drivers will look to the availability of charging infrastructure as they consider purchasing EVs—this includes charging infrastructure at home and other destinations. To help normalize the discussion, we use the following nomenclature to distinguish between the different places and types of charging that EV drivers might seek: residential or at-home charging, workplace charging, and opportunity charging (which is often referred to as destination charging). The majority of charging will likely occur at home—most analysts estimate that 70-90% of charging currently occurs at home, where EVs are parked overnight and can charge conveniently. That leaves EV drivers of also charging at work, where employees/commuters and/or visitors are generally parked to charge their EVs for several hours, or to seek out opportunity charging. Opportunity charging describes the times when EV drivers take the opportunity to charge at convenient locations to extend the range of social or recreational trips.

The hardware that delivers electricity to the vehicle's battery is referred to as electric vehicle supply equipment (EVSE). This equipment is typically differentiated by the maximum amount of power that can be delivered to the vehicle's battery—the industry uses the terms Level 1, Level 2, and DC fast charging. The level of charging, and corresponding power delivered to the vehicle's battery determines the time that it takes to charge. For the sake of simplicity, we have provided the number of miles that are gained for each hour of charging in Table 1 below.

Table 1. Electric Vehicle Charging Types

	Level 1 Alternating Current	Level 2 Alternating Current	Level 2 & 3 Direct Current (aka DC fast charging)
Description	Uses a standard plug	• Used specifically for EV charging • ~ 240 V AC service	• Used specifically for BEV charging • Requires a dedicated circuit (20-100 A), with a 480 V service connection.
Use	Residential or workplace charging	Residential, workplace, or opportunity charging	Rapid charging along major travel corridors
Limitations	Low power delivery, slow charging times	Requires additional infrastructure and wiring	Can only be used by BEVs currently. Much faster charging, but are more expensive to deploy and operate
Time to charge	2—5 miles per hr	10—25 miles per hr	50—70 miles per hr

As of March 2018, there are 340 charging stations in Santa Clara with about 1,560, largely Level 2, public charge ports/plugs. For more information on available charging locations, see the U.S. Department of Energy's (DOE) Alternative Fuels Data Center (AFDC) Station Locator.

Policies and Programs Driving the Market

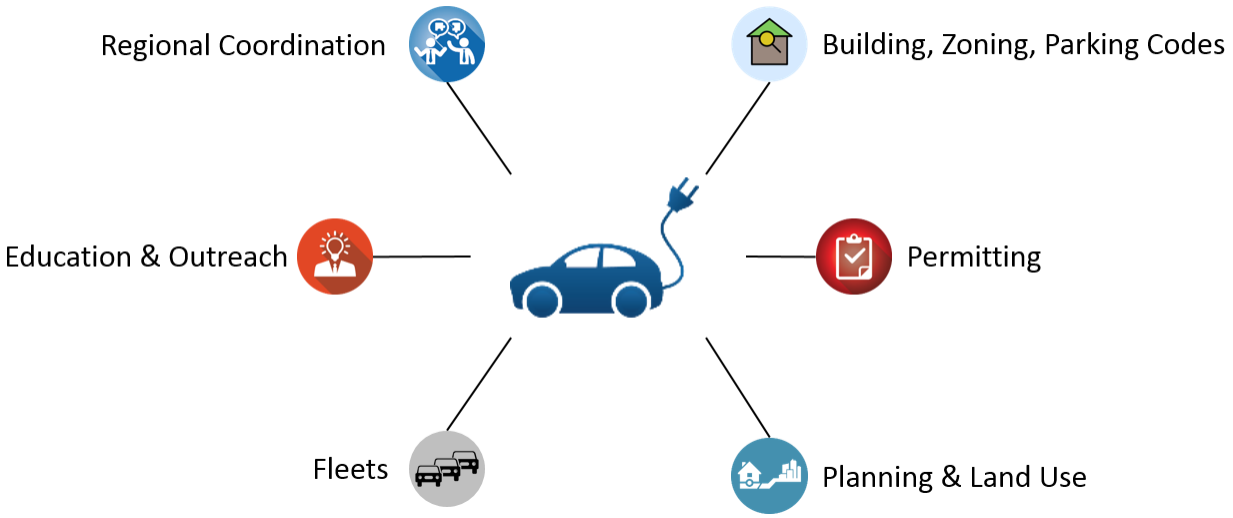
California has aggressive goals and standards for the integration of EVs–or zero emission vehicles (ZEVs) more broadly–into the State's vehicle population. Since 1990, vehicle manufacturers must produce and deliver for sale a certain percentage of ZEVs in California. By 2025, 15% of new vehicles sales in the California must be ZEVs. Governor Jerry Brown's 2012 Executive Order B-16 and 2018 Executive Order B-48 builds upon the ZEV program. In accordance with the executive orders and the resulting ZEV Action Plan, California state agencies are working towards the following goals:

- Calls for 1.5 million ZEVs on California roads by 2020; and 5 million ZEVs on California roads by 2030
- Calls for State entities work with the private sector and all appropriate levels of government to spur the construction and installation of 250,000 zero-emission vehicle chargers, including 10,000 direct current fast chargers, by 2025.

State programs and incentives, such as the Clean Vehicle Rebate Project and Hybrid and Zero-Emission Truck and Bus Voucher Incentive Project, coupled with air quality management district and utility incentives (e.g., PG&E's investment program), are part of achieving these targets. In addition, federal incentives (e.g., the federal EV tax credit) and national efforts (e.g., Volkswagen's Electrify America program) are in place to support these initiatives. For more information, see U.S. DOE's AFDC Federal and State Laws and Incentives page.

Local Action: Electric Vehicle Readiness

California has set ambitious goals for EV deployment. The transition towards higher rates of EV adoption and deployment of the corresponding charging infrastructure requires a broad range of stakeholders to prepare and plan for deployment. Local and regional governments are positioned to support EV deployment most meaningfully by making it easier and more cost effective to deploy charging infrastructure. This document—and many aspects of the Driving to Net Zero initiative at the County—focuses on the elements of EV readiness highlighted in the figure below. The balance of this document reviews these concepts and provides an overview of best practices and recommendations for cities to consider.



Building, Zoning, and Parking Codes

There are two major opportunities to create building codes that support EV deployment. The first is to specify standards for EVSE in the building code to ensure that any EVSE installations are safe and accessible. The second is to require pre-wiring for EVSE to lower the cost of future installations. Pre-wiring is when builders provide sufficient basic infrastructure, such as electrical conduits and lot space for future EVSE, and adequate electrical panel and circuitry capacity to meet anticipated future demand for .

CALGreen Building Codes

Building codes set standards for new construction, and they are the most common mechanism through which local governments can require pre-wiring or charging. The 2016 Green Building Standards Code (CALGreen) requires that all new developments include pre-wiring for Level 2 charging. CALGreen's mandatory requirements specify that new single-family homes and townhomes with attached garages must pre-wire locations where vehicles will be parked, and that multifamily developments with 17 or more units must pre-wire at least three percent of total parking spaces.[2] At non-residential developments with 10 or more parking spaces, pre-wiring is required for between 4% and 10% of total parking spaces.

Best Practice: Adopt CALGreen Voluntary Tiers or local ordinance that exceeds CALGreen

CALGreen represents a baseline upon which cities can build upon to address local conditions and fulfill local policy goals. To further strengthen EV readiness, local governments could either adopt an ordinance that specifies the more stringent EVSE requirements of the CALGreen voluntary tiers or adopt an ordinance that exceeds the voluntary tiers of CALGreen. The latter can include pre-wiring for a greater proportion of spaces or requiring actual charger installations in lieu of pre-wiring or requirements for sufficient electrical panel capacity to facilitate future installation. Table 2 lists the residential and non-residential voluntary measures in CALGreen related to EV charging infrastructure.

Best Practice in Action

The City and County of San Francisco recently approved an ordinance that includes a requirement to install sufficient electrical infrastructure to simultaneously charge vehicles in 20% of parking spaces

[2] California Building Standards Commission, 2016 California Green Building Standards Code (CALGreen), California Code of Regulations, Title 24, Part 11, Chapter 4, Section 4.106.4. http://www.bsc.ca.gov/Home/CALGreen.aspx.

Table 2. CALGreen residential and non-residential Tier 1 and Tier 2 voluntary measures[3]

	Tier 1	Tier 2
Residential Voluntary Measures	Install pre-wiring for Level 2 charging equipment (at 240 V) for new one- and two-family dwellings and townhouses with attached private garages	Reserve up to 5%, but no less than 1% of the total parking spaces for EV charging spaces for MUDs with more than 17 units
Non-Residential Voluntary Measures	Designate parking for clean air vehicles for 10% of the total space	Designate parking for clean air vehicles for 12% of the total space
	Facilitate future installation of EV charging infrastructure for 8% of the total spaces	Facilitate future installation of EV charging infrastructure for 10% of the total spaces

Zoning Codes and Incentives

Local governments can include charging requirements or incentives in their zoning ordinances, development guidelines and standards, or accompanying parking codes. These provisions ensure that there are sufficient charging opportunities to meet projected EV demand and that EV parking spaces are effectively designed and regulated to accommodate charging vehicles. Whereas building codes usually categorize land uses broadly (e.g., residential and non-residential), zoning ordinances can be more nuanced, distinguishing between residential districts of different densities or non-residential districts with differing types and mixes of uses. This means that zoning ordinances can focus new infrastructure in high priority locations such as downtowns and activity centers with high turnover that are good candidates for charging.

Best Practice: Allow EV parking to count towards minimum requirements

Many jurisdictions have minimum parking requirements specifying the number of spaces that developers must provide for new construction in different land uses. Amending the zoning or parking code to allow EV charging stations to count toward parking requirements allows developers to provide EV charging as an amenity without increasing the total number of parking spaces required. This is similar to the way that many local governments currently treat accessible parking.

Best Practice: Implement EVSE zoning incentives

A local government could require actual charger installations (as opposed to just pre-wiring) at new developments in specific areas through its zoning ordinance or development standards, or offer developers incentives such as density bonuses in exchange for providing increased charging opportunities.[4]

Best Practice in Action

The City of San Carlos provides developers with a density bonus for providing parking with EVSE. Developers are allowed to exceed the maximum allowable floor area ratio by 10% if they provide additional environmental design features, including “electric car facilities.”

[3] CALGreen 2016, Chapter 5, Section 5.106.5.3 and Section 5.106.5.1

[4] Technically, it would be possible to require charger installations in lieu of pre-wiring through a local update to the building code, but this requirement would likely only make sense in areas with high charging need, so it will be more feasible to implement through a zoning ordinance that better allows local governments to focus on these high-need areas.

Existing Developments

Far less attention has been given to requirements and ordinances that apply existing developments due to cost-inhibitive nature of electrical upgrades. One way to target existing developments is to include renovations in local building code ordinances. This was recently done in San Francisco, however the City limited the regulation to buildings undergoing major renovations that are 25,000 gross square feet or larger due to the cost-prohibitive characteristics of electrical service upgrades. There are not many proven or effective examples of how local governments can address existing development through regulations or permitting.

Best Practice: Education and outreach
Given these limitations, the most effective approach for local governments is to provide financial incentives (or outreach and education about such incentives) to building owners to reduce the cost of EV charging equipment and installation.

Parking Codes and Design Guidelines

Best Practice: Adopt EV parking enforcement code
Local governments can amend parking ordinances to specify the regulations that apply to EV-designated parking spaces. The goal of these amendments is to ensure that EVs have unobstructed access to EV charging equipment and to make sure that local governments can recoup the costs of publicly-available charging in the event that the local jurisdiction owns and operates the equipment. When designating EV parking, local governments should consider applicable definitions, restrictions, enforcement policies, time limits, and fees. In general, it is a best practice to restrict use of EV charging stations to vehicles that are currently charging to ensure that the equipment is available for drivers who need them.

Best Practice in Action

The City of Millbrae's EV parking ordinance states that EVs are prohibited "from parking longer than two hours in an EV charging station" and "the vehicle must be plugged in while parking in the space, and forbids any non-EV from parking in a charging station".[1] In Washington State a penalty of $124 is charged for cars parked in a charging station that are not connected to a charging station.

Best Practice: Implement preferential parking for EVs
Local governments should consider offering additional incentives for EV drivers by creating dedicated parking spaces or waiving parking fees for these vehicles. Local governments that are providing EV parking that exceeds current demand may also consider specifying interim regulations that allow conventional vehicles to use these spaces to avoid under-utilization.

Best Practice: Adopt charging station design guidelines
To make it easier for charging station hosts to determine the best configuration of their installation while also meeting building code requirements, local governments can adopt uniform charging station design guidelines that address the many unique considerations associated with EVEV charging spaces. Santa Clara County will be publishing station design guidelines as part of the Driving to Net Zero initiative. Local governments will likely need to create multiple sets of EVEVSE design guidelines that apply to a wide variety of parking scenarios. CALGreen describes in detail site configuration requirements. The requirements can be detailed and highly technical, particularly the electrical requirements involved in charger installation.

Permitting

Best Practice: Streamline permitting process

Making the permitting process easy, affordable, and less time consuming can help speed the roll out of charging infrastructure and make installations more straightforward. AB 1236 requires communities to adopt ordinances that expedite the permitting process for EV charging stations.[5] Cities and counties can use the latest version of the "Plug-In Electric Vehicle Infrastructure Permitting Checklist" from the *Zero-Emission Vehicles in California: Community Readiness Guidebook* published by the Governor's Office of Planning and Research.[6] While developing or adopting standardized permitting processes, local governments may also consider surveying charging station owners and installers to identify additional barriers and opportunities for improvement.

Best Practice: Minimize permitting fees

Permitting fees vary across various jurisdictions in California. To reduce the cost of permitting to building owners, local governments in Santa Clara County should aim to levy permitting fees for charging stations that are between $75 and $200.

Best Practice: Train permitting and inspection staff

If no electrical panel upgrades or additions are required, installations at single-family residences can be relatively simple and often do not require significant review by permitting staff. However, installation of commercial or public stations or stations at multi-family dwellings are more complex and require more oversight and review. Jurisdictions seeing or anticipating significant implementation of these types of projects may benefit the most by training their staff and by offering a list of professional electricians qualified to assist with EV charging station installations. There are institutions that provide training in EV charging station installations, such as the Electric Vehicle Infrastructure Training Program (EVITP).

Planning & Land Use

Best Practice: Integrate EV readiness into local planning efforts

similar documents that require or encourage EV charging. These plans are broader and less detailed than building codes and zoning ordinances, so policies calling for increased charging opportunities typically do not contain specific details on where charging infrastructure is needed or on how much charging should be provided. Adopting such policies is a critical first step in building consensus among policymakers and the public to support more specific EV readiness implementation measures, as well as make it easier to fund plans and capital projects that accelerate the deployment of EVs. The incremental cost of EV readiness planning is lower if it is part of a larger-scale effort. Furthermore, tying EV readiness to local policies can make it easier to allocate different funding streams toward EV plans and projects.

Best Practice: Create a utility notification protocol

One of the primary causes for concern for EVs, from the utility side, is clustering of the load associated with EV charging. Utilities generally have a transformer replacement program to target transformers that have reached the end of their useful life or have been identified as

[5] Full text of chaptered Assembly Bill 1236 available at the California Legislative Information webpage: https://leginfo.legislature.ca.gov/faces/billVersionsCompareClient.xhtml?bill_id=201520160AB1236

[6] Materials available from the Governor's Office of Planning and Research at: https://www.opr.ca.gov/s_zero-emissionvehicles.php

overloaded. In order for utilities to minimize the potential grid impacts of charging EVs, they should work with local governments to develop a notification protocol through the permitting process to understand where vehicles are being deployed and how they are being charged (e.g., Level 1 versus Level 2). This information will allow local utilities to evaluate whether the local distribution system is adequate to serve EV charging needs.

Fleets

Best Practice: Provide educational resources to employers and fleet managers
Information sharing can encourage investment in EVs among fleets. Fleets often require assistance navigating and weighing the various considerations associated with EV ownership as compared to conventional vehicle ownership. Local governments in Santa Clara should promote the fleet implementation plan prepared as part of the Driving to Net Zero initiative with their fleet managers as well as employers in the region.

Best Practice: Encourage fleets to opt-in to the Low Carbon Fuel Standard
By opting-in to California's Low Carbon Fuel Standard (LCFS), entities, including fleets, providing electricity as a vehicle fuel can earn LCFS credits. These credits can then be sold on the LCFS market to generate revenue that can help fund EV programs. The amount of revenue earned per LCFS credit depends on the carbon intensity of the electricity used and the market price of credits at the time they are being sold.

Best Practice: Provide employee and driver education
Introducing a new technology that changes the way drivers typically behave can be challenging for fleet managers. Drivers who have had no previous experience with EVs will have questions about how far they can travel and may express concerns over range anxiety. For EVs to be successfully integrated, fleet managers will need to ensure that drivers are familiarized with vehicle features and charging infrastructure, as well as the driving habits for optimal EV performance and safety. The fleet manager should review the vehicle and charger features with the driver or provide group workshops or training sessions. Keeping a frequently asked questions document in the vehicle with contact information is also a good back up if any questions or issues arise.

Best Practice: Minimize the cost of fleet charger installations
EV charging infrastructure can be overly expensive if it is not sited optimally. The U.S. DOE *Costs Associated with Non-Residential Electric Vehicle Supply Equipment* publication includes tips for minimizing EV charging station costs.[7] It is also important to consider long term EV fleet planning. Fleet managers should consider the quantity and location of charging stations that they plan to install over the next 5 to 15 years before they install their first charging unit. Taking a "dig once" approach can help minimize the cost of installing future units–this includes upgrading the electrical service for the estimated future charging load and running conduit to the anticipated future charging locations.

[7] Department of Energy, Clean Cities. 2015. Costs Associated with Non-Residential Electric Vehicle Supply Equipment. http://www.afdc.energy.gov/uploads/publication/evse_cost_report_2015.pdf

Education and Outreach

Best Practice: Provide resources online

Hosting a simple alternative fuel vehicle or EV website is an effective way to educate your community on the benefits of EVs and provide information on charging equipment and locations. The website should ideally be a "one stop shop" for residents interested in EVs, providing information with links to permitting, incentive finders, and utility time-of-use rates.

MUDs

MUDs or multi-family units continue to be one of the most challenging areas because of the varying dynamics between vehicle owner, property owner, parking accessibility, electricity demand and load considerations at the facility, and long-term management of the charging equipment. EV charging station installations in MUDs will vary depending on the building architecture, physical electrical designs, parking structures, and parking space ownership model.

Best Practice: Provide education and outreach to MUDs

The most important role local governments can play for MUDs is to provide outreach and education to homeowner associations, developers, and building owners. Local governments can provide funding to reduce these costs through applying for grants or providing outreach on the funding and incentives available through PG&E and the Electrify America program.

Regional Coordination

One of the challenges associated with charging infrastructure deployment is aligning local and regional planning efforts. The Driving to Net Zero initiative is helping improve this situation, especially through engagement with stakeholders and various partners throughout the County. There are myriad funding programs (e.g., via air pollution control districts and Electrify America) and planning efforts underway that can support charging infrastructure deployment. However, these efforts are not coordinated at a regional level beyond informal and *ad hoc* avenues. It is important to align local and regional efforts to the extent feasible, ensuring that regional actions can help direct charging infrastructure investment without encroaching upon the local land use considerations.

Best Practice: Coordinate with Regional EV Charging Programs

Local governments can play a critical role in accelerating regional EV adoption by identifying grants and other funding opportunities for the purchase and installation of charging stations. One of the common barriers to EV adoption is range anxiety—the fear that an EV has insufficient range or charge to reach its destination. Developing a robust charging station network will ensure that residents and visitors can easily get around the region in a EV.

Local governments should identify, apply for, and/or provide outreach on the various funding opportunities available for charging infrastructure. These include California Energy Commission's Alternative and Renewable Fuel and Vehicle Technology Program, Bay Area Air Quality Management District Transportation Fund for Clean, PG&E's Electric Vehicle Charge Network, or Volkswagen (Electrify America) settlement funding.

Recommendations for Cities Association

The figure below includes recommendations for the Cities Association to encourage EV adoption in Santa Clara County. The recommendations align with the charter of the Cities Association and are organized according to the action areas above.