

Siting of an Electric Vehicle Charging Station

Los Osos, California



Source: US Department of Energy, 2014

Senior Project

**City and Regional Planning Department
California Polytechnic State University
San Luis Obispo
2015**

Prepared by: Francisco Vargas
Advisor: Adrienne Greve

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Author: Francisco Vargas
March, 2015

Adrienne Greve
Senior Project Advisor

Hemalata C. Dandekar
Department Head

Disclaimer

The content in this report is based on observations and research conducted by Francisco Vargas. Neither California Polytechnic State University of San Luis Obispo, Central Coast Clean Cities Coalition or the Air Pollution Control District support or disapprove the findings, research, and recommendations indicated in this report.

Purpose:

The intent of this report is to test existing methods used in the siting of electric vehicle charging stations in the Central Coast. The report outlines the siting process used in the first public electric vehicle charging station in Los Osos, California. In addition, justification for the ideal location and type of charging station is developed for the community of Los Osos.

Acknowledgements

The plug-in electric vehicle (PEV) charging station project is an adopted air quality mitigation measure for the Los Osos Waste Water Treatment Plant Project. I would like to thank Melissa Guise from the Central Coast Clean Cities Coalition (C5) as well as Aeron Arlin-Genet from the San Luis Obispo Air Pollution Control District (SLO APCD) for the opportunity to work on this project.



Source: Tom Moloughney. July 28, 2014. Retrieved from: <http://bmwi3.blogspot.com/2014/07/this-city-car-is-at-home-in-country.html>



Executive Summary

The report provides background information on the increasing growth of the plug-in electric vehicle (PEV) market as a result of Federal, State, and local government action in recent years. It outlines the benefits of PEVs from different perspectives, including environmental and economic viewpoints. It also discusses some of the existing barriers in the PEV market.

In order to understand the potential benefits of PEVs it analyzes the basic features that make up electric vehicles, with information about the different types of PEVs and charging station levels. It provides details and concepts of PEVs that are easy for all readers to understand.

Using the premise of an expanding PEV market the report discusses the importance of continuing to expand charging station infrastructure in the Central Coast and provides details on environmental and economic benefits of PEVs.

The report then analyses the unique opportunities a public PEV charging station has to offer the community of Los Osos. It also goes into detail on some of the key factors affecting the siting of an electric vehicle charging station and develops location recommendations based on individual research and unique analysis.

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Introduction

The San Luis Obispo Air Pollution Control District (SLO APCD) and the Central Coast Clean Cities Coalition (C5) are working together to choose the best location for a new Level 2 plug-in electric vehicle (PEV) charging station in Los Osos. The addition of this new station will enable Los Osos to become part of an expanding network of public charging stations in San Luis Obispo County. Joining the charging station network can bring environmental and economic benefits to the community of Los Osos (M. Guise, personal communication, November 5, 2014). Both SLO APCD and C5 know finding an ideal location is important in order to maximize its use by EV owners and have greater environmental and economic impacts (Central Coast EV Readiness Plan, 2014). Finding the best location requires site-specific analysis, including proximity to electricity panels, electricity power supply, visibility, design and other features outlined in the Central Coast EV Readiness Plan. Numerous factors will play a significant role in determining the most adequate site for the charging station in Los Osos. Before we can discuss the importance of the siting process, it is necessary to discuss why we need alternative fuel vehicles such as a PEVs.

Throughout the report PEVs will refer to plug-in electric vehicles.

Environmental Effects

In 2012, the transportation sector accounted for approximately 35% of greenhouse gas (GHG) emissions in California and passenger vehicles were responsible for over 90% of those GHG emissions (CARB, 2012). GHGs are known to be the instigators of global climate change, causing altered weather patterns throughout the planet, including the Central Coast. According to the Intergovernmental Panel on Climate Change, climate change poses a wide range of potential threats, including impacts to public health and environmental resources (IPCC, 2014).

Uncertainty of Fossil Fuels

Gasoline and diesel are derived from oil, a limited resource. Even after years of research and analysis of oil production, the Energy Information Administration (EIA) and other scientists have yet to definitively project the duration of our global oil supply (M. Boswell, personal communication, December 8, 2014). Our nation's dependence on foreign oil makes it vulnerable to unstable gasoline prices, whereas electricity prices have proven to be more stable (PEV Collaborative, 2014). Scientists around the world claim it takes millions of years for fossil fuels to accumulate; making it impossible for the rate of production to keep up with demand forever, indicating it is only a matter of time before we run out of oil (California Energy Commission, 2014).

PEVs are a cornerstone for California's long-term transportation strategy to reduce localized pollution and greenhouse gas emissions (Office of Governor Edmund G. Brown Jr. - Newsroom, 2012).

Central Coast Clean Cities Coalition has reduced an average of 3,000 tons of CO2 each year throughout San Luis Obispo County since 2006 (Department of Energy, 2012).

What are ZEVs? Fuel Cell Electric Vehicles (FCEVs) & Plug-in Electric Vehicles (PEVs).

Conventional vehicles: For the remainder of this report conventional vehicles will represent gasoline or diesel vehicles.

National Vehicle Sales

National vehicle sales continue to increase every year, making it hard to imagine a future without cars. During the year 2014, gasoline and diesel fuel prices averaged close to \$3.50 per gallon for the fourth year in a row (US EIA, 2015). U.S. automakers sold over 16.5 million new vehicles, a 5.9% increase from 2013 (Autodata, 2015). While high gasoline and diesel prices don't seem to be affecting the number of vehicles on the road, different solutions to help accelerate the transition to alternative fuels must be developed in order to address environmental issues and help reduce dependence of foreign oil.

Federal Action

Recognizing environmental effects and our nation's dependence on fossil fuels, in 1993, the Federal Department of Energy launched a series of programs known as the *Clean Cities Coalitions* across the nation to help reduce petroleum dependence and accelerate the transition to alternative fuels. Today, there are over 100 similar programs across the country with a goal to promote the most prominent alternative fuels available, such as biodiesel, natural gas, hydrogen, propane, and electric vehicles. While all alternative fuels have the potential to replace gasoline and diesel in the future, plug-in electric vehicles have gained momentum in the last couple years due to increasing government support, especially in California. Plug-in electric vehicle cumulative sales between 2011 and 2014 surpassed 100,000 cars (PEV Collaborative, 2014). As sales of electric vehicles are expected to increase exponentially over the next few years, local adoption strategies need to be established in order to accommodate wide adoption of plug-in electric vehicles (PEV Collaborative, 2014).

California Government Support

In March 2012, Governor Brown issued an executive order directing California state government to continue to accelerate the market for *zero-emission vehicles (ZEVs)* in California (Office of Governor Edmund G. Brown Jr. - Newsroom, 2012). The executive order established several milestones on a path toward 1.5 million ZEVs in California by 2025. The *Governors Office of Planning and Research (OPR)* supports the idea that PEVS promise to transform California by offering residents and visitors cleaner transportation choices. In effect, OPR has worked with numerous agencies and ZEV experts to develop recommended policies in order to achieve the goal of 1.5 million ZEVs by 2025. One of the products is the Central Coast EV Community Readiness Plan intended to encourage and facilitate mass adoption of PEVs.

PEV Advantages

Growing number of incentives make PEVs a viable option to replace *conventional vehicles*. From an environmental perspective, PEVs can reduce dependence on petroleum and tap into a source of electricity that is often

more stable than oil. More importantly, PEVs have the potential to inspire innovation, create new advanced industries, spur job growth and enhance economic prosperity (California Energy Commission, 2014).

Existing PEV Barriers

Regardless of incentives, emission reductions, reduced fuel costs, and other benefits associated with electric vehicles, most consumers will be reluctant to purchase electric vehicles until they can determine there is enough infrastructure available to completely replace the functions of conventional vehicles. One of the major barriers for electric vehicles is known as “range anxiety,” the term used to describe consumers’ fear to drive PEVs because of the limited miles it can travel before it runs out of charge. Modern day drivers are accustomed to traveling long distances of over 200 miles before having to refuel, making the idea of running out of charge before the next charging station a major concern for current and potential PEV drivers. The transition from conventional vehicles to electric cars will require construction of electric vehicle infrastructure such as public and private charging stations in order to eliminate “range anxiety.” Developing a sustained market for PEVs will take concentrated effort until infrastructure and technology meet public demand (PEV Collaborative, 2014).

PEV Market

PEV sales have been increasing in the last few years throughout the US (Figure 1). California accounts for approximately 40% of the Nation’s cumulative sales since 2011 (PEV Collaborative, 2014). The following topics illustrate the potential rise of the PEV market in the next couple of years.

Increasing Availability of Electric Vehicles

The transportation sector offers a number of alternative fuels that can assist the transition away from fossil fuels. Among the most widely adopted alternative fuels is the PEV. According to a feasibility report for public charging stations, the electric vehicle market is experiencing a resurgence with traditional automakers recognizing the need to move into the market and creating demand for non-residential charging stations (UCLA Luskin Center, 2012). The state of California has introduced several policies and incentives directly influencing the electric vehicle market. While electric vehicles such as the Chevrolet Volt, Nissan Leaf, and Tesla have led the way the past couple of years, other car manufacturers like BMW, Fiat and Mercedes are now gearing up to compete in the PEV market (Figure 2). To prepare for the PEV market, researchers and battery manufacturers are dedicating significant resources to develop battery technologies. Increasing PEV sales throughout the Nation and California demonstrates that residents are responding to government incentives (Battery University, 2015). As a result, electric vehicles are in a period of transition in which consumers will soon have a number of electric vehicle options to consider (UCLA Luskin Center, 2012)(Appendix B).

Federal tax credit of up to \$7,500 is available for PEV buyer (Department of Energy).

California has numerous incentives, laws, and regulations related to alternative fuels including a rebate for up to \$5,000 for PEV buyers (Department of Energy).

Vehicles play a large role in our lives from how much we spend on fuel to where we choose to travel. What most people don’t realize is that conventional vehicles are a major source of greenhouse gas, smog forming compounds, particulate matter, and other air pollutants that directly affect human and environmental health (IPCC, 2014).

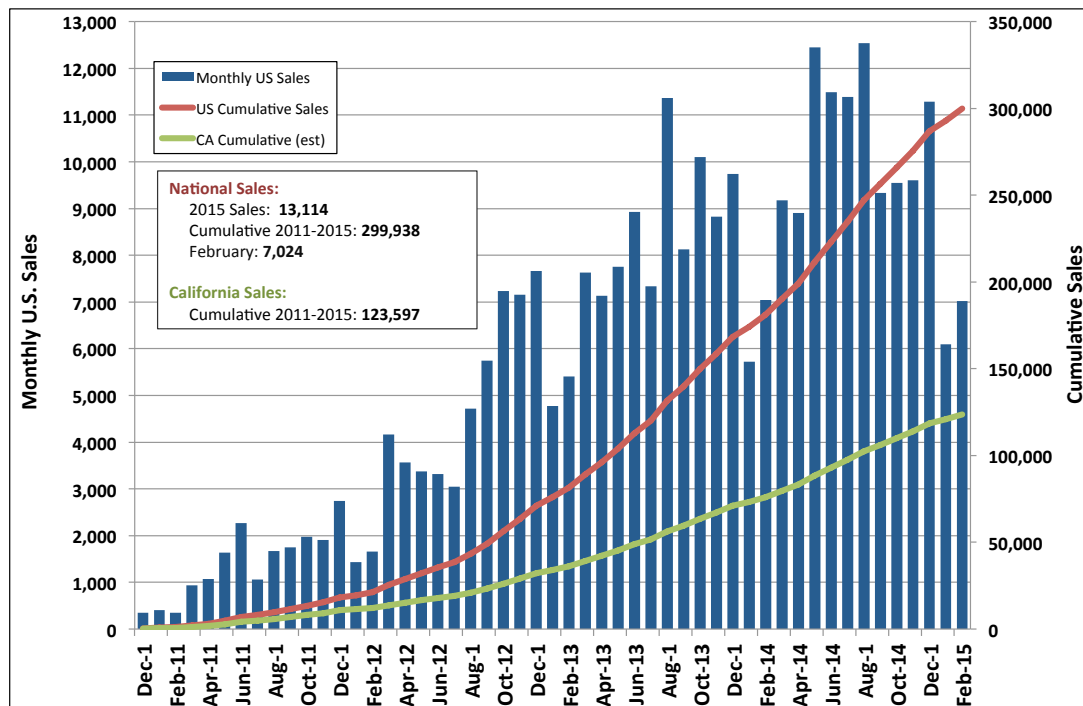


Figure 1. PEV Sales

Source: www.hybridcars.com

Note:

1. Approximation assumes CA sales are 40% of National sales.
2. This graph depicts estimated PEV sales between December 1, 2011 and February 1, 2015.

A competitive electric vehicle market can help stimulate greater adoption rates (PEV Collaborative, 2014).



Figure 2. Most Popular PEVs

Source: C5 PEV Presentation, January 2015.

PEV Basics

This section is a basic overview of PEVs with information on the different types of electric vehicles and chargers available. Although all PEVs use electricity, each type operates differently. The key takeaway from this section is that there are two types of PEVs and three types of chargers. Each type of PEV and charger has a different function mainly affected by the vehicle's capacity to take charge and the charging station's ability transfer charge.

What is a PEV?

A PEV is a plug-in electric vehicle that runs fully or partially on battery power and is recharged using electricity. Two types of PEVs exist: Pure Battery Electric Vehicles (BEVs) and Plug-in Hybrid Electric Vehicles (PHEVs). BEVs run only on electricity stored in batteries and have an electric motor rather than an internal combustion engine (ICE). PHEVs have an electric motor that can be plugged and charged as well as an internal combustion engine that uses gasoline once the battery charge runs out (*Table 1*).

Table 1. Types of PEVs?

	BEV	PHEV
Emissions	Zero emissions from vehicle; only emissions are from electricity generation	Zero emissions when driving on electricity. Emissions when driving on gasoline depend on engine emission certification
Range	Generally 70 to 100 miles depending on the battery size and capacity	All Electric range varies from 15 to 35 miles depending on battery size and capacity; Gasoline range is about 300+ miles
Propulsion	Electric Motor/ Battery Only	Electric motor/battery plus gasoline engine
Re-fueling	Recharge with electricity	Recharge with electricity and/or refuel with gasoline

Source: California PEV Collaborative (CG2-2)

What is a PEV Charger?

PEV chargers deliver electrical energy from an electricity source to charge the vehicle's battery; these systems are available for public and private use and are often called Electric Vehicle Charging Stations (Department of Energy, 2012). There are three types of charging stations: Level 1, Level 2, and Level 3 (Table 2).

Table 2. Three Types of Chargers

Charger Type	Power Supply	Charge Power	Miles of Range for 1 Hour of Charge	Pros	Cons
Level 1	Uses Standard 120 V	1.4 kW @ 12 amp (on-board charger)	3-4 miles	Low Cost Easy home installation	Longest charging time (Up to 15 hours)
Level 2¹	Uses 240V System	3.3 kW @ 30amp	8-12 miles	Newer vehicles are increasing charge power capacity (able to take faster charge from level 2 stations)	All cars have capacity for this charge power
		6.6 kW @ 40 amp	16-24 miles		Older vehicles are not equipped for higher charge (kW)
		9.6 kW @ 50 amp	32-48 miles		
Level 3	Uses Direct Current (DC) Charge 200-450 VDC	45kW (off-board)	60-80 miles	Can add 75 miles of range in 30 minutes	Very Expensive Usually requires electricity retrofits Two different plugs

Source: PEV Collaborative (CG3-3)

Note:

1. Level 2 allows for a wide range of charging speeds of up to 19.2 kW @ 100 amps but current PEV battery technology has not met these high standards.
2. Charging times will vary depending on vehicle.

Level 1

Practically all PEVs come with a Level 1 cord set so that new owners have an immediate system to charge their vehicle (*Figure 3*). Level 1 chargers provide electricity through a 120 volt (V) AC plug that is typical in all households. Depending on the battery type and vehicle, Level 1 chargers take about 10-20 hours to charge a depleted BEV or 2- 5 miles per 1 hour of charge for any BEV or PHEV. Long charging times don't make this system very convenient unless the owner plans on charging over-night or for an extended period of time. These chargers are mostly designed to be portable and in case of on-road emergencies. (Department of Energy, 2012).



Figure 3. Level 1 Charging Cord

Source: California PEV Collaborative (CG2-2)

Level 2

Level 2 charging stations use the same port connection as Level 1. The difference is in the increase of electricity flow through thicker conduit, which allows for a faster charge. Currently, there are about 2,000 Level 2 public charging stations across California. They offer a faster charging time than Level 1 through a 240 volt (V) AC plug that usually requires special installation of charging equipment and a dedicated electrical circuit. Depending on the charging power of the station and vehicle's capacity to take faster charge, Level 2 chargers can add about 10-20 miles of range per 1 hour of charge (*Table 3*).

Table 3. Level 2 Charging Options

Type of Charging	Power Levels	Miles of Range per Hour of Charging*
Level 2	240 VAC @:	
3.3 kW (low)	30 Amps	8-12 miles
6.6 kW (medium)	40 Amps	16-24 miles
9.6 kW (high)	50 Amps	32-48 miles
19.2 kW (very high)	100 Amps	>60 miles

Source: PEV Collaborative (CG3-3).

Level 2 stations offer a wide range of charging capabilities but current battery technology does not have the capacity to charge at very high rates of 19.2 kW (Battery University, 2015). Tesla and the new Mercedes B-Class Electric Drive have the fastest charging technology available today with a maximum rating of 10 kW. Most of the other PEVs charge at 6.6 kW with a few manufacturers like Mitsubishi and Chevrolet falling behind at 3.3kW (Plugincars, 2015). Others, like Volkswagen, are trying to upgrade to compete with Tesla and Mercedes. The Argonne National Laboratory predicts battery technology will eventually reach new standards where it will be possible to charge at faster rates but before that, PEVs have to penetrate the market enough to convince auto manufacturers and the public that PEVs are here to stay (Battery University, 2015).

Level 3

Level 3 charging stations, also referred to as DC fast-chargers, enable rapid charging. This level of charge requires 480 volt (V) AC. DC fast-chargers can add up to 80 miles of range to an electric vehicle in 20-30 minutes. Not all PEVs are equipped to use DC fast chargers, but some PEVs like the Nissan Leaf have the option to upgrade to a vehicle that is equipped to take DC fast charging for approximately \$3,000 more (*Figure 4*). While DC fast chargers seem like an ideal solution to “range anxiety” because of their rapid charge, the recent inception of a different plug, SAE Combo, is believed to be slowing the deployment of Level 3 chargers across California (*Appendix A*).

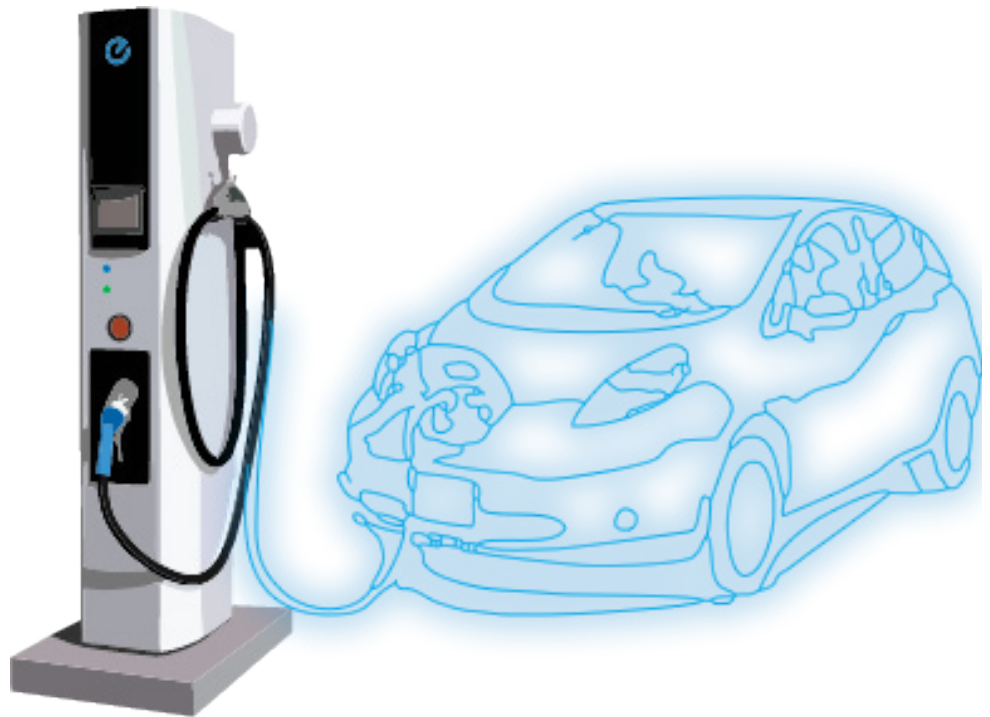


Figure 4. Nissan Leaf Quick Charger

Source: nissanqc.com/products

Benefits of PEVs

Environmental Benefits

PEVs produce zero tailpipe emissions while running on electricity. The only emissions from electric vehicles are from electricity generation. Production of electricity, especially in California continues to become more efficient as technology incorporates renewable energy sources, such as biomass, geothermal, small hydro, wind, and solar energy (Department of Energy, 2012). Projections of cleaner gasoline vehicles with advanced clean car technologies are still expected to be more polluting than PEVs available today (Figures 5 & 6).

California's goal to increase the amount of electricity generated from renewable energy sources to 20% by 2012 was pushed to 33% by 2020 by legislation in 2011 (California Energy Commission, 2012).

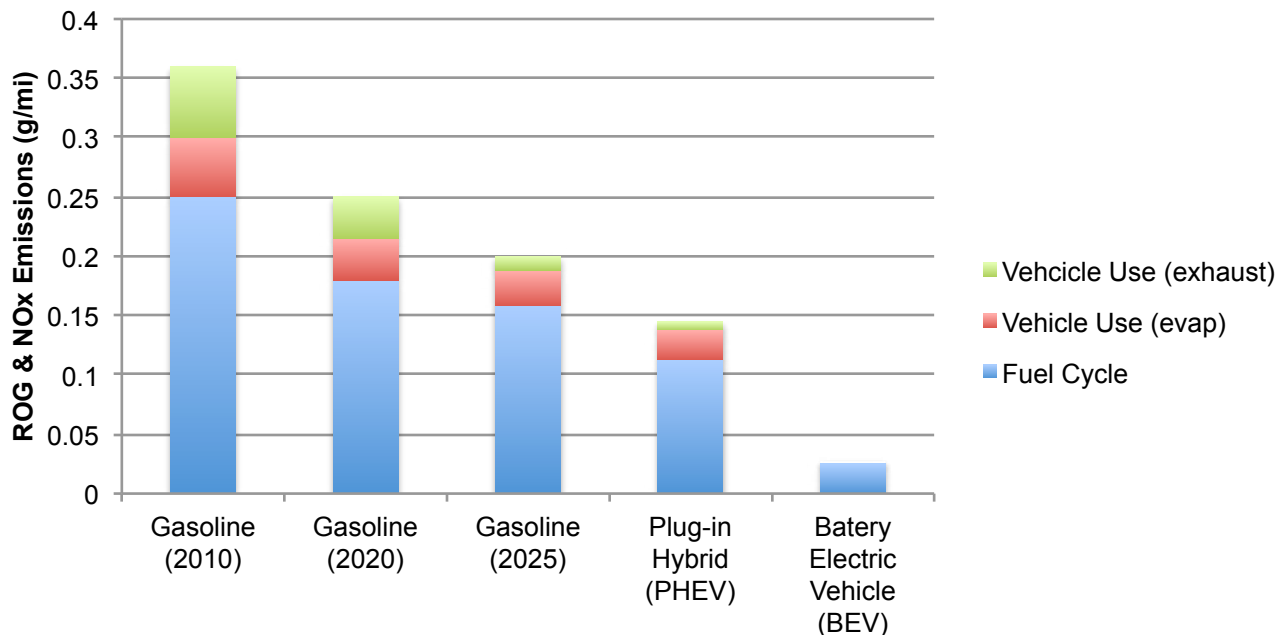


Figure 5. Smog Forming Emissions- ROG & NOx

Source: California PEV Collaborative (CGI-2). California Air Resources Board, Advanced Clean Cars Summary, 2012.

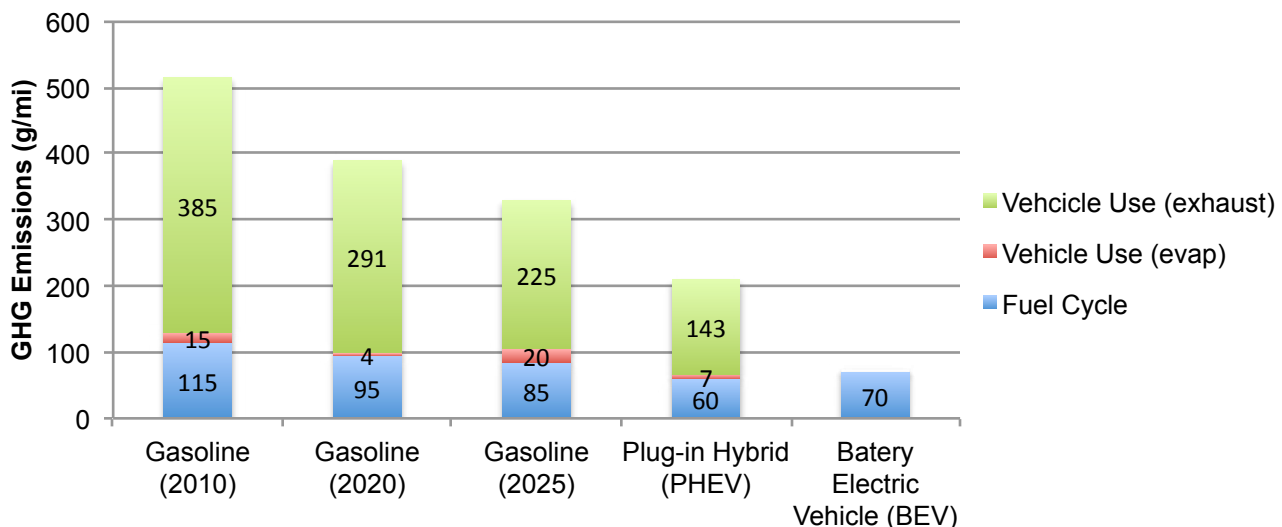


Figure 6. Greenhouse Gas Emissions

Source: California PEV Collaborative (CGI-2). California Air Resources Board, Advanced Clean Cars Summary, 2012.

Consumer Benefits

PEVs are smooth and in some case very silent while running. The technology in these vehicles usually requires less maintenance because they do not need oil, timing belts, water pumps, radiators, fuel injectors and other elements required in an internal combustion vehicle (PEV Handbook DOE, 2012). PEVS are also permitted to travel in high occupancy vehicle lanes in most states. Last but not least, electricity prices are more stable than oil and there is a significant amount of fuel cost savings compared to gasoline vehicles (Figure 7).

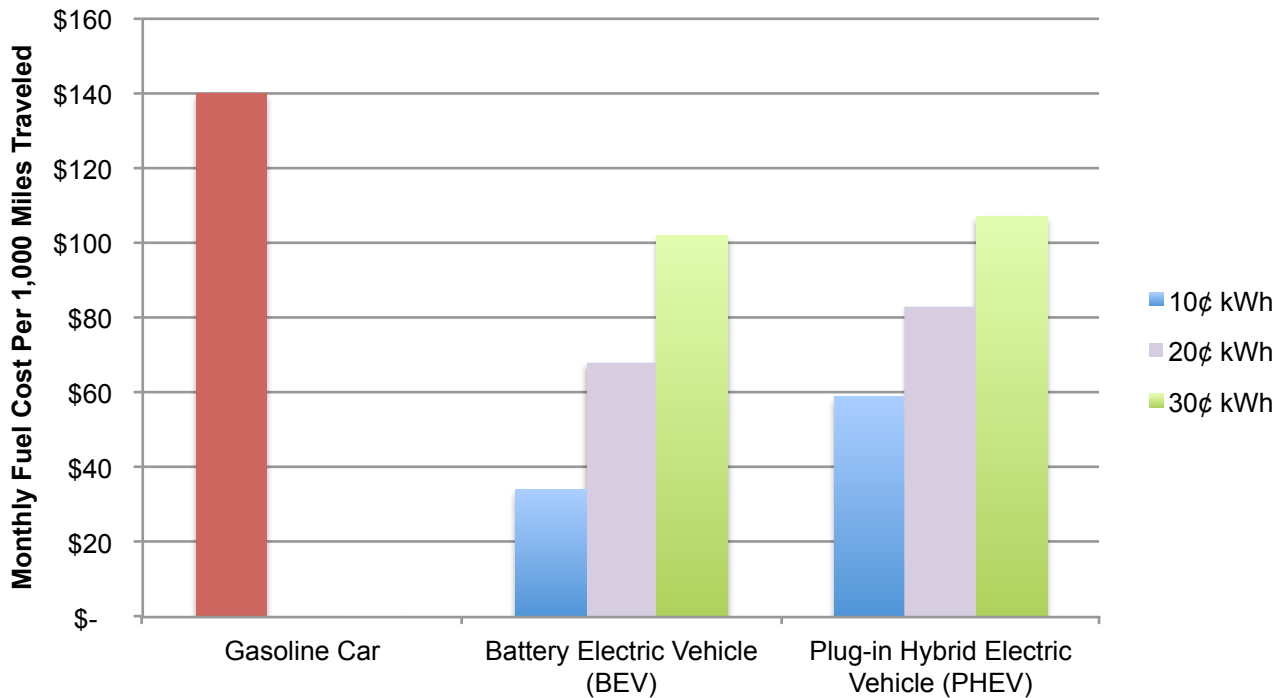


Figure 7. Driving on Electricity

Source: California PEV Collaborative (CG4-1). California Air Resources Board, Advanced Clean Cars Summary, 2012.

Note:

1. Gasoline car uses average of 26 miles per gallon (MPG).
2. Based on average California retail gas prices of \$3.65/gallon. Actual gasoline prices will vary.

Business Benefits

Offering a charging station is a direct way to encourage PEV drivers to come to your business. Hosting a charging station is a visible way to state your company, business or organization’s environmental values. This can have a positive impact and evoke a “green” image, which may help attract and retain new PEV customers with the same values.

Los Osos Charging Station

Why put an EV Charging Station in Los Osos?

Los Osos is a small community dependent on its concentrated business district along Los Osos Valley Road (LOVR). Despite being a rural community, over one million people drive through town every year on their way to Montaña de Oro (California State Parks Association, 2012) (Figure 8). Developing the first electric vehicle charging station will not only help reduce GHG and Ozone emissions but may also enhance the local economy by joining an expanding network of charging stations being developed throughout the Central Coast and the rest of California. An electric vehicle charging station may encourage environmentally friendly tourism, promote local environmental awareness and possibly persuade individuals to consider buying an electric vehicle. While the persuasion of people is probably a stretch, experts claim the development of public charging stations along major highways and thoroughfares is critical from a regional and statewide perspective (PEV Collaborative, 2014). This means, charging stations in suburban communities like Los Osos will be equally important as electric vehicle adoption rates increase and demand for charging stations grows.

The argument that most of the charging by PEV owners will be done at home does not mean a public charging station in Los Osos will not benefit local residents. After interviewing local PEV residents, several of them expressed an interest in the idea of a public charging station in Los Osos, especially near grocery stores.

Figure 8. Montaña de Oro Visitors



Source: Photo taken February 19, 2015

Opportunity for Los Osos

As mentioned earlier, installing the first public electric vehicle charging station in Los Osos presents an opportunity to join an expanding network of public charging stations in the region and California. It is important to mention, local agencies and organizations like SLO APCD and C5 are continually developing PEV infrastructure in the region and will continue to do so until government support diminishes. New incentives and policies are being introduced each year making very unlikely that PEVs will lose ground (Department of Energy, 2012). A number of monetary incentives continue to be offered and Los Osos residents will have a greater incentive to purchase a PEV once the station is in effect.

Increasing the amount of charging infrastructure is key to eliminating “range anxiety” and a direct way of attracting PEV owners (PEV Readiness Plan, 2014). Joining the PEV network at an early stage of deployment will put Los Osos ahead of other communities, and as the PEV market continues to replace conventional vehicles, Los Osos will have a greater chance at attracting a greater portion of PEV owners. While other communities fall behind in the development of PEV infrastructure, Los Osos can be proud to have a new charging station attracting new customers and advocating the environment. It is important to remember, in order for the PEV market to continue to grow and produce greater benefits, suburban towns like Los Osos are equally important in eliminating “range anxiety”.

Overview of a PEV Network

The basic idea behind the PEV network is that – unlike other vehicles – PEV purchase decisions are not only made on the basis of how much a particular PEV model costs, how it looks, and how it performs. Rather, PEV purchase decisions are significantly influenced by the answer to this question: Is my community, my region, and my state truly EV- ready? Despite the advantages of charging at home, it is inevitable that people, including Los Osos residents, will at times need to charge during their grocery shopping time or while running other errands. Developing an efficient network is key for the success of PEVs at the local level as well.

Siting

There are several aspects to consider when determining the best location for a charging station. The community of Los Osos requires a close look at the following seven factors that are key for a successful PEV public charging station (Central Coast EV Readiness Plan, 2014).

1. Financial Feasibility
 - a. Select sites must be financially feasible given available installation incentives
 - b. Provide other real benefits to the site owners
2. Visibility and Accessibility
 - a. Highest-utilization potential
 - b. Highest-visibility
 - c. Publicly accessible locations for the first few chargers in the area
3. Power supply
 - a. Select a location where Level 1 (120/15A) or Level 2 (240V/40A) or Fast Charge (480 volt) electrical supply is or can be made available with relative ease and minimal cost
4. ADA Access
 - a. Consider and comply with ADA guidelines for disabled access
 - b. Take precautions to ensure that charger cord management is optimized to reduce risk of accident or injury
5. Security
 - a. Select secure location with adequate lighting
6. Signage:
 - a. Provide enforcement and other signs that comply with the Manual on Uniform Traffic Control Devices (MUTCD) and California Vehicle Codes (CVC)
7. Equipment Protection:
 - a. EV chargers should be placed where they can be best protected from physical damage by such measures as curbs, wheel stops, setbacks, bumper guards, and bollards
 - b. Consider ease of access to the charger, mobility of users, and foot traffic in the area

The Central Coast EV Readiness Plan intends to guide the development of PEV charging infrastructure for Ventura, Santa Barbara, and San Luis Obispo County. The installation of PEV charging stations near major thoroughfares is a critical factor to support this goal.

The PEV Readiness Plan aims to construct close to 200 Level 2 charging stations and several DC Fast Charging stations along the Central Coast by 2025.

Site Selection Process

Five different locations were initially considered as potential sites for the public charging station in Los Osos. After analysis, and several site visits, the number of potential locations narrowed down to three locations (*Figure 9*). During the site visits, the objective was to assess the physical factors of each location while considering all seven factors illustrated in the Central Coast EV Readiness Plan. The following list ranks the five different locations analyzed from the most to least ideal. A detailed contact list of stakeholders for each property was developed throughout the research process (Appendix C).

1. Subway® Los Osos Village Square Inc
2. Ralphs® Shopping Center
3. Starbucks® Los Osos Valley Road Business Center
4. Vons® Shopping Center
5. Rantec Company

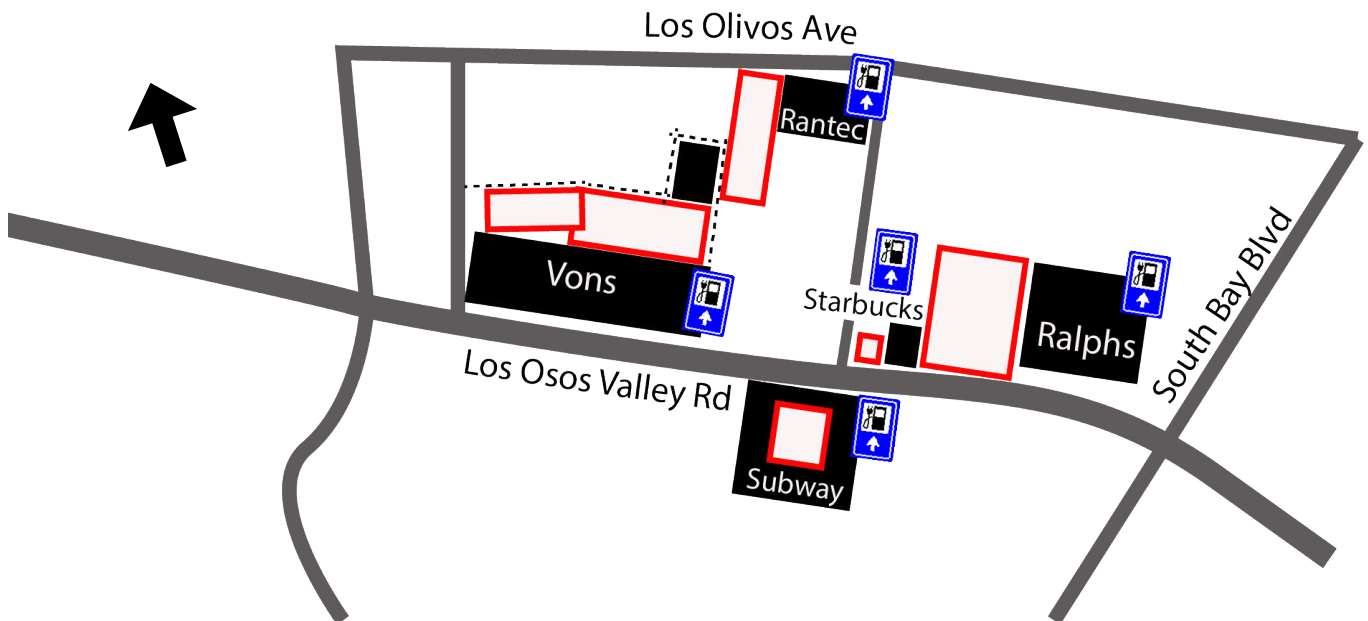


Figure 9. Five Potential Charging Station Locations

Site Visit One: December 17, 2014

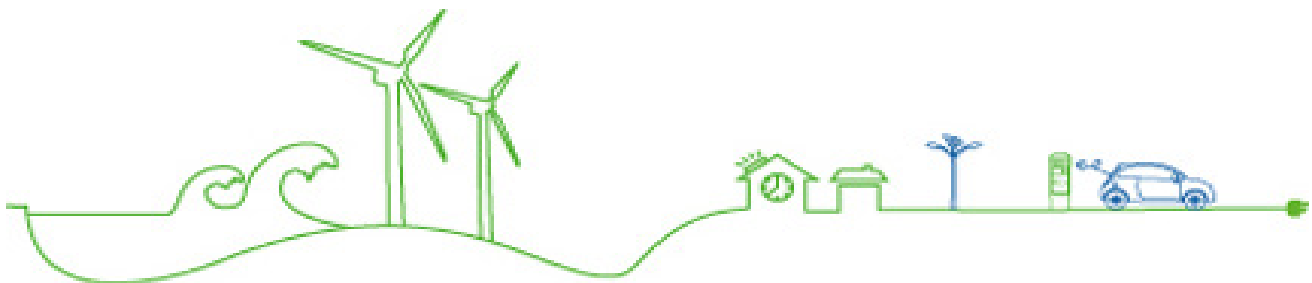
Each of the five sites in Los Osos were analyzed for visibility, accessibility, and convenience. During the first site visit, it was discovered that the Rantec parking lot was not open 24 hours a day. This limited the station's public use and was deemed "inadequate". Initial scope of other properties determined the most appropriate locations from a visibility and convenience perspective were the small business shopping centers located along Los Osos Valley Road. Pictures of site visits are documented (*Appendix D*).

Site Visit Two: January 5th, 2015

The potential sites were narrowed down to three different locations by the second site visit. Further analysis of electrical panel proximity in each site was conducted. Pacific Gas and Electric (PG&E) was then contacted for verification of findings. Based on conversations with a local contractor, Dave Bolduan, from Pacific Builders Inc and Industrial Power Engineer, J.T. Haas from PG&E it was determined that Subway®, Ralphs®, and Starbucks® shopping centers had the electrical capacity to add a Level 2 charging station.

Other Visits

Other site visits were conducted throughout the process for individual analysis and observation purposes. As part of the process, a list of key stakeholders was compiled in order to facilitate direct contact for current and future stages of this project (*Appendix C*). Maps were developed for the top two sites, Subway® Los Osos Village Square and Ralphs® Shopping Center, to demonstrate key analysis visually.



Source: California PEV Collaborative

Subway® Los Osos Village Square Inc.

Opportunities

High visibility and accessibility from LOVR are advantages of the Los Osos Village Square. Based on existing conditions, this site substantiates to be the most cost-effective due to the close proximity to the power supply. As far as utilization is concerned, Subway® is the only current business in this shopping center that may benefit from a public charging station because customers are likely to stay long enough to charge their car while they eat. Still, it is not uncommon for PEV drivers to leave their vehicles at a distant charging station while they carry on other duties such as shop, eat, or even work. The high visibility and accessibility of the site will play a large role in the success of the charging station. Depending on utilization rates of the PEV charging station, other businesses might be encouraged to lease a vacant building space in the future (Figure 10).

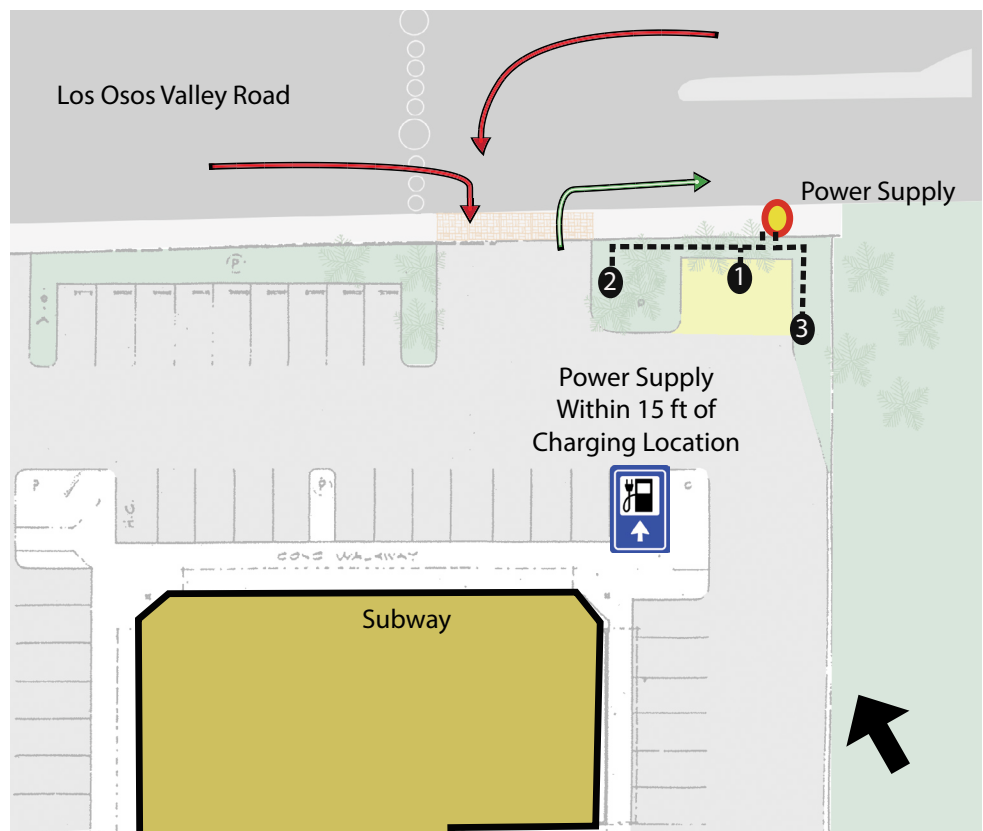


Figure 10. Subway Shopping Center Features

Constraints

As previously mentioned, the current businesses in the Los Osos Village Square are not “ideal” for PEV owners, but the potential growth of the PEV market could prove this to be a minor drawback that is worth the risk. It is important to note these businesses are not permanent. There is opportunity for new businesses to be attracted by the advantages of a public PEV charging station at their location.

Ralphs® Shopping Center

Opportunities

The Ralphs® Shopping Center is relatively large compared to the other three locations analyzed in this report. Based on observations from several site visits, the Ralphs® shopping center presents an opportunity to address most of the factors illustrated in the Central Coast EV Readiness Plan. Installing a charging station at a grocery store increases the potential for high-utilization, a great benefit. Customers find it convenient to charge their electric vehicle while they shop (PEV Collaborative 2014).

Constraints

The proximity to the electrical located in the back of the building is the biggest drawback. In some cases it is normal to trench wiring to the front of the property; however, here, trenching exceeds 300 feet from the front of the potential parking slot. Unless a different power supply closer to the ideal parking spot is found, the front parking lot is not economically feasible. Although the front of the building is an option, the back of the building is an alternative location within the Ralphs® shopping center. There are three parking spots located less than fifteen feet away from the same electrical panel. Reducing the distance from the power supply will reduce trenching, demolition, construction and material costs but it is important to mention how this alternative will require more attention to security, ADA access, signage, and visibility (*Figure 11*).



Photo taken January 7th, 2015



Photo taken February 19th, 2015

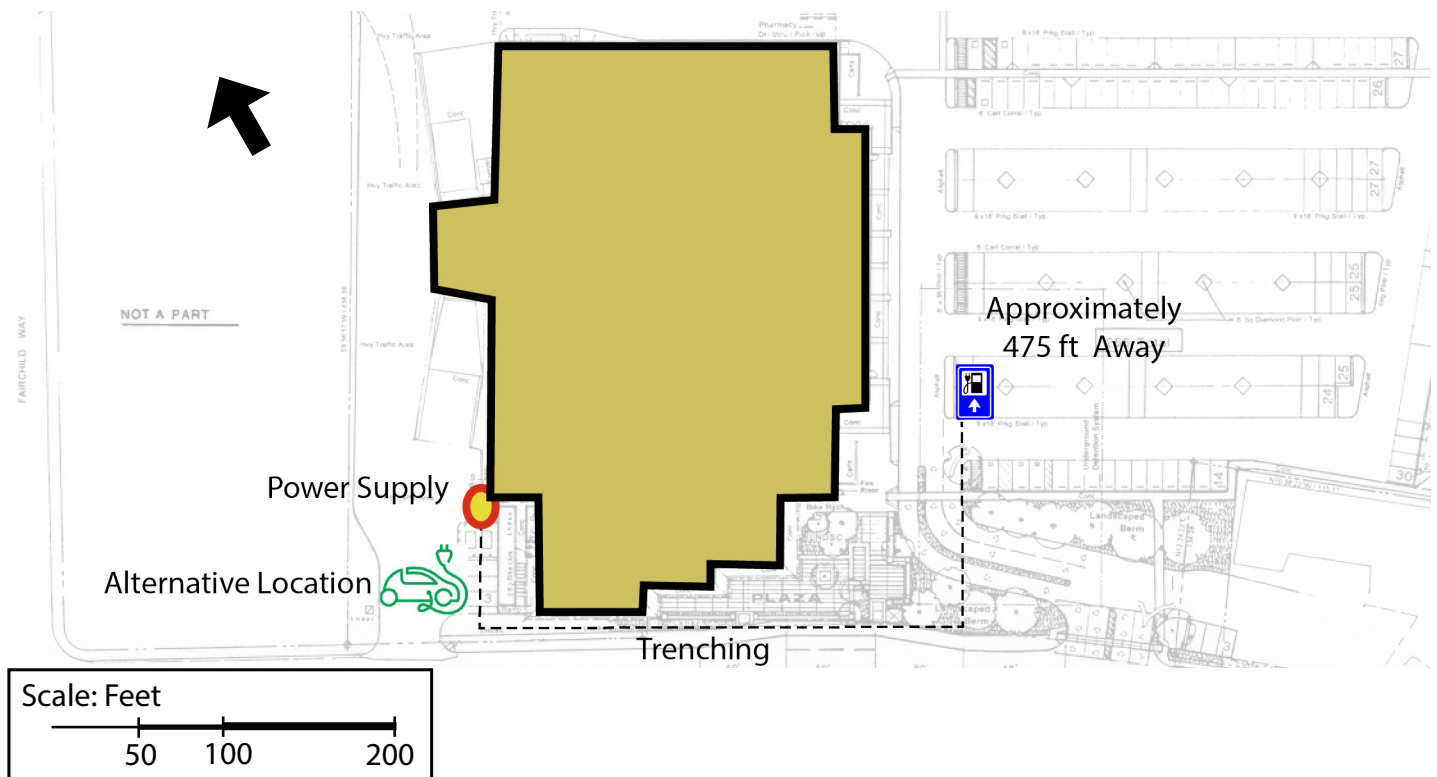


Figure 11. Ralphs Shopping Center Features

Starbucks® Los Osos Valley Road Business Center

Opportunities

This site is highly visible and accessible from LOVR. The existing Starbucks® is a major customer attractor already, and with the recent addition of Nichol's Pizza N Grill to the shopping center this site can now entice PEV owners to charge while having coffee or while dining. Depending on when the charging station is built and if indeed this site is chosen by SLO APCD, it is important to note, currently the shopping center has a vacant building space that can be occupied to reinforce the utilization of a PEV charging station (*Appendix D*).

Constraints

This site has high potential but financial feasibility is going to be a factor. With two different locations to hook up to an adequate power supply, it appears it would be the ideal situation. The problem is the most financially convenient parking slot is at the end of the site and over 300 feet away from LOVR. Since visibility would be compromised the only possible advantage would be if a small grocery store or a similar use with high customer attraction moved into the vacant building. The other ideal parking spot for this site is in front of Starbucks®. The drawback is the distance from the power source approximately forty feet away from any potential parking slots.

Note: The following sites do not have specified analysis of opportunities and constraints due to their elimination early on in the process.

Vons® Shopping Center

Initially, the Vons® shopping center appeared to be one of the best options because of its high customer attraction and longer shopping times, but access to the electrical panel was a limiting factor. The most accessible power supply was over 500 feet away from Vons dedicated parking. Unless a closer power supply is available, the cost will be extremely high at this location for trencing reasons.

Rantec Company

Rantec Power Systems Inc. was initially considered a possible location for the charging station due to the potential of encouraging the company to change some of their existing shuttle vehicles that transport employees across the County for plug-in electric vehicles. The main drawback is their parking lot is gated and closed overnight. This would not allow the charging station to be available 24 hours a day.

Recommendations

The following are recommendations based on findings and analysis of four different locations in Los Osos. Based on the seven factors outlined by the PEV Readiness Plan, the following four commercial sites should be considered for the construction of a Level 2 public charging station. The locations are ranked based on estimated financial expenses.

1. Subway® Los Osos Village Square Inc
2. Ralphs® Shopping Center
3. Starbucks® Los Osos Valley Road Business Center
4. Vons® Shopping Center

Local Contribution

Developing an electric vehicle charging station in Los Osos will help increase public awareness locally and regionally. Construction of one station in Los Osos is a footstep toward a greater goal of reducing greenhouse gases, ozone and other vehicle emissions. It is important to remember that developing PEV infrastructure will require a concentrated effort from local government (PEV Collaborative, 2014). Eliminating barriers in the deployment of electric vehicle charging stations and identifying ways to strategically locate new charging stations is key for the future of electric vehicles and reducing conventional vehicle emissions.

Level 2 Station Recommended for Los Osos

According to J.T. Haas, a PG&E industrial power engineer, each of the sites analyzed has the electrical capacity to add any Level 2 charging station. In anticipation of future advances in electric vehicle technology the ideal charging station is dual charging station with a supply circuit of 208/240V 60A (Figure 11). This station will provide a higher amperage than most public level 2 charging stations and more than most PEVs need. Multiple sources anticipate the PEV market will continue to improve battery technology and anticipate PEVs will be able to take faster charge in the near future (PEV Collaborative, 2014).

Clipper Creek Option: HCS-60 Dual Pedestal Mount, 48 amp EV Charging Station, 25 ft Cable:

Estimated Equipment Price: \$3,167.00 +tax

Installation: \$5,000

Permit Fees: \$700

Total Cost: \$8,877.00 +/-



Figure 11. Clipper Creek Charger

Source: clippercreek.com/products



Source: UCLA Anderson School of Management

The following table provides a summary of recommended actions following this report.

Table 4. Recommended Actions

Steps	Actions	Comments:
1	Re-establish contact with businesses/managers	Ongoing (Appendix C)
2	Determine PEV charging equipment or full service company	Clipper Creek, Charge Point...etc
3	Maintain contact with PG&E and SLO County Planning	Help ensure that desired equipment is adequate for existing electrical supply. (Appendix C)
4	Select site	Revisit senior project opportunities and constraints. (pages 20-22)
5	Install station	First PEV public charging station in Los Osos

Key Results

Each of the seven factors indicated in the Central Coast EV Readiness Plan is important in the selection of a PEV public charging station location. Based on individual analysis of each site, the most determining factors are the power supply levels and proximity to an ideal parking slot from the electrical panels. Both of these factors have a direct impact on the financial feasibility of the project because of the costs associated with trenching and electrical retrofits. This research found that long charging times are another factor equally influential on the site selection. The key to eliminating the combination of these existing barriers is to continue to expand PEV infrastructure until significant changes are done in local zoning, permitting, and parking regulations.

Appendix A: PEVs

This table provides a list of all the PEVs currently available in the US. It also lists some of the PEVs that will be available soon.

Plug-in Electric Vehicles						
BEV Available		Range (Miles)	Availability	PHEV	Range (Miles)	Availability
1	BMW i3	81	Now	BMW i8	25	Now
2	Chevrolet Spark EV	82	Now	Cadillac ELR	37	Now
3	Fiat 500e	87	Now	Chevy Volt	38	Now
4	Ford Focus	76	Now	Ford C-Max Energi	20	Now
5	Kia Soul EV	93	Now	Ford Fusion Energi	20	Now
6	Mercedes B-Class EV	85	Now	Honda Accord Plug-in Hybrid	13	Now
7	Mitsubishi i-MiEV	62	Now	Porche Panamera S E-Hybrid	22	Now
8	Nissan Leaf	84	Now	Toyota Prius Plug-in Hybrid	11	Now
9	Smart Electric Drive	68	Now	Audi A3 E-Tron	30	2015
	Volkswagon E-golf	83	Now	Hyundai Sonata Plug-in Hybrid	22	2015
	Tesla Model S	265	Now	Mercedes S550 Plug-in Hybrid	20	2015
	Tesla Model X	230	2016	Average Miles Per Full Charge		23
	Chevrolet Bolt	200	2017			
	Tesla Model 3	200	2017			
Avg Miles Per Full Charge			121			

Appendix B

DC Fast Charger Background

Chademo was the first standard Level 3 DC fast charger to come to the U.S with the Nissan Leaf and Mitsubishi iMiEV (TN). Today, there are over 600 stations in the U.S with Chademo (PS). Despite having the widest availability of stations, various reports indicate other vehicle manufactures like Audi, Chevrolet, Chrysler, Ford, GM, Mercedes, Porsche, and Volkswagen will be using a new plug known as the SAE Combo DC.

There are many forces at play in the decision to use a different standard other than Chademo, including competition between car manufacturers. Given the ongoing battle between car manufacturers there is no clear indication of which charging mode will become the standard in the future.

Chademo vs. SAE Combo

There are no major advantages between the Chademo or SAE Combo other than the fact Combo charger hookups will not require a second port on the vehicle since it will simply add two pins to the base of the widespread standard J1772 plug for Level 2 charging. The incongruity in the infrastructure is believed to be having an impact on how fast electric vehicles will expand in our communities.

Current News

Given the ongoing battle between car manufacturers there is no clear indication of which charging mode will become the standard in the future. It is possible for both standards to continue to develop and eventually become like gasoline and diesel, where they will coexist and grow to be two options for EV drivers. The ABB group was one of the first to recognize EV infrastructure will require modifications to adapt to this unexpected demand for two types of DC fast chargers. They believe the solution to this problem is to incorporate charging stations with both standards

Analysis:

Although ABB has introduced a possible solution, such infrastructure would be more costly for a possible short term problem. But at the same time, this type of infrastructure might be necessary in order for EV's to become more reliable, convenient, and popular among consumers. Although their solution seems temporary, it might be the next step to get EV's over the hump most people call "range anxiety".

Recently Tesla introduced a new adaptor that would allow Tesla Model S vehicles to charge at Chademo stations. This \$1000 product has already been introduced in Japan and is could be a move that will help eliminate the need for dual stations.

The first SAE Combo Fast station was opened in San Diego late 2013 (Autoblog, 2014). According to plugshare, there is another similar station in Sacramento. The success of these stations will serve as an indicator for the potential of dual stations.

Rumors that EU was drafting a bill to do away with Chademo chargers have not been confirmed by a credible source. "As the Combo technology is not fully ready at the moment and as there are more than 650 CHAdeMO chargers already installed in Europe, with more than 1,000 to be deployed by the end of 2013, it is important to set a time-limited transitional period where both systems can be deployed, with the final objective to find a single standard as indicated in the Commission proposal (plugincars).

Appendix C: Contact List

The contact information below was established throughout the research process. Initial contact has been established with each of the individuals listed. It will be important to keep close contact with them as progress is made in the Los Osos PEV charger project.

Location	Company/ Property Manager	Contact Name	Phone:	Email:
Los Osos Village Square Inc (Subway)	R. Poltl and Associates	Brenda	(805) 781-9100	brenda@rtpoltl.com
Los Osos (Ralphs) Center	Fowler Marketing International LLC Etal	Tom Phillips	(805) 782-8800	tgphillips@prodigy.net
Los Osos Valley Road (Starbucks) Business Center	Los Osos Valley Road Business Center LLC	Jim Smith	(805) 543-1500	jsmith@midstate-cal.com
PGE	Engineer	Mark Zearbaugh	Cel: (805) 440-6282	MRZ2@pge.com
PGE	Industrial Power Engineer (Planning)	J.T. Haas	(805) 664-5234	JTH1@pge.com
SLO County Planning Department	Building and Permit	Mathew Varvel	Main: (805) 781-5600	mvarvel@co.clo.ca.us
SLO County Planning Department	Receptionist	Kelly Walsh	(805) 781-5977	kwalsh@co.slo.ca.us

Appendix D: Subway® Los Osos Village Square Inc

Substantial findings were found throughout a series of site visits and were recorded using pictures. This method of gathering information was used to help interpret opportunities and constraints for each site. Sites are analyzed in order from most to least ideal.



The Los Osos Village Square is highly visible and accessible from LOVR. People on their way to Montaña de Oro or any other visitors driving through town are very likely to see the charging station. Having the station in a highly visible location will help create environmental awareness and encourage PEV to drive their electric car to Los Osos.



Subway® is the only business in this shopping center likely to retain customers for a longer period of time. A medicine shop, smoke shop, real estate agency, and local U.S Post Office are the other business in this shopping center. Depending on the stations success, installing a charging station near a post office may encourage the fleet operator to convert their current vehicle fleet into plug-in electric vehicles in the future. Evaluation of this site should consider the possibility of customers charging their PEV at this location while walking across the street to Starbucks® other shopping centers near the area.



Electricity power supply is a major factor that directly affects the cost of PEV charging station projects. This image depicts the close proximity of the electrical panel to an ideal parking slot. According to JT Haas, a PG&E Industrial Power Engineer, the underground power supply at this location has the capacity to supply power for a Level 2 charging station.

Appendix D: Ralphs® Shopping Center



The Ralphs® shopping center is the most compatible for a PEV charging station. This site has an abundance of parking spaces with various parking slot options for a PEV charging station. This image shows one of the ideal parking spots for a PEV charging station for its proximity to the entrance and ADA access.



During one of the site visits a BMW i3, battery electric vehicle (BEV), was in the same parking spot shown above. Evaluation of this site should consider further analysis of PEV frequency. Depending on the number of PEV visits; this site can be re-evaluated for cost-effectiveness based on findings.



Based on the cost to supply electricity to the front of the Ralphs shopping center, this alternative location should be considered. This site, located on the back of the building is within 10-15 feet of electricity supply. Driving down the cost of the station is important but using this site will require close attention to security, signage, and visibility. One of the benefits of this location is that it is still visible and accessible from LOVR.

Appendix D: Starbucks® LOVR Business Center



The Starbucks® LOVR Business Center shopping center is highly visible and accessible from LOVR. There is a high rate of customers visiting this shopping center every day. The addition of a new restaurant will increase the potential for PEV owners to use the station.



A few parking slots at this shopping center are highly visible from LOVR. This is an important feature to encourage PEV drivers to stop and recharge. Based on the location of the electrical supply in the back of the building, these parking spots will need to be re-evaluated for financial feasibility.



An alternative location is also a possibility at the Starbucks® LOVR Business Center. This image depicts a transformer, with adequate power supply, that is in close proximity to a parking slot. The location of this parking slot will eliminate visibility from LOVR but will still be easily accessible from multiple access points. This alternative parking slot is near a vacant building, currently up for lease. Depending on what type of business moves in, a PEV charging station may be mutually beneficial.

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